State of Hawaiʻi 2023 Hazard Mitigation Plan

August 2023

State of Hawaiʻi Emergency Management Agency (HI-EMA)

RECORD OF CHANGES

The HI-EMA Resilience Branch is responsible for the *2023 State Hazard Mitigation Plan* and is authorized to make changes. All maintenance to the *2023 State Hazard Mitigation Plan* will be tracked and recorded in the following table to ensure the most recent version is disseminated and implemented. The *2023 State Hazard Mitigation Plan* will be maintained on an annual basis.

Updates and changes that are administrative in nature may be approved by the Resilience Branch Chief. Substantial revisions must be approved by the Administrator of Emergency Management.

Change Number	Date of Change	Page or Section Changed	Summary of Change	Authorization Signature	Date of Signature
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JAMES DS. BARROS

HI-EMA Administrator

Date ______________

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LORINDA WONG-LAU

Resilience Branch Chief

Date ______________

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EXECUTIVE SUMMARY

A Note About the August 2023 Wildfires

In August 2023, as this State Hazard Mitigation Plan was being finalized, the counties of Maui and Hawaiʻi experienced extreme wildfires. As of late August, these fires had led to over 90 deaths, making them the deadliest U.S. wildfires in more than a century. The fires also damaged or destroyed thousands of buildings, including devastating damage in the city of Lahaina. The federal government issued one major disaster declaration (DR-4724) for these fires along with five fire management assistance grant declarations (FM-5474-HI, FM-5475-HI, FM-54-76-HI, FM-5477-HI, and FM-5478-HI). Hawaii's governor issued six emergency proclamations, including state of emergency proclamations and travel restrictions.

The wildfire event is still unfolding, and the State of Hawaiʻi continues to evaluate how to continually address wildfire across the state. As a living document, this plan will be updated to reflect updated wildfire hazard mitigation practices as they are identified.

As an island community, the State of Hawai'i is vulnerable to a wide range of natural and non-natural hazards that greatly impact lives, property, community lifelines, natural and cultural resources, and the economy. Between 2018 and 2022, our island community has experienced seven major disaster declarations, four emergency management declarations, two fire management assistance declarations, and numerous state declarations. The pace and scale of disasters will continue to increase due to the effects of climate change. Continued development and population growth also increase the risk profile from hazards. By updating the State Hazard Mitigation Plan (SHMP), the State of Hawaiʻi demonstrates its commitment to mitigate these risks and inform future decision-making.

Hazard Mitigation Definition

Any sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards.

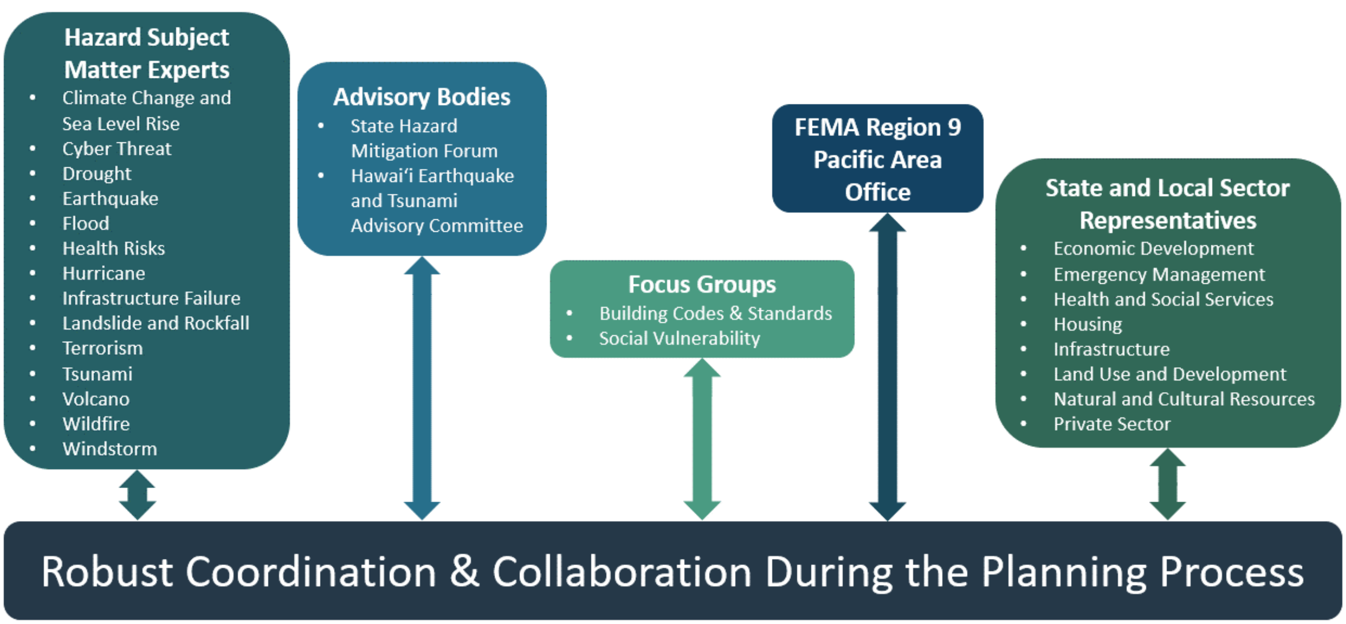
FEMA State Mitigation Planning Policy Guide, April 2023

The Disaster Mitigation Act of 2000 (DMA) amended the Robert T. Stafford Disaster Relief and Emergency Assistance Act to include Section 322, which requires states to have a hazard mitigation plan approved by the Federal Emergency Management Agency (FEMA) to be eligible for non-emergncy federal disaster assistance and hazard mitigation funding. A hazard mitigation plan is a state's plan to reduce damage to life, property, and the environment from future disasters. A plan must be updated every five years to ensure continued funding eligibility under certain Stafford Act grant programs, as shown below:

Hazard Mitigation Grant Program (HMGP)
Building Resilient Infrastructure and Communities (BRIC)
Pre-Disaster Mitigation (PDM)
Flood Mitigation Assistance (FMA)
Fire Management Assistance Grant (FMAG)
Rehabilitation of High Hazard Potential Dams (HHPD)
Public Assistance (PA) – Categories C through G

The Hawaiʻi Emergency Management Agency (HI-EMA) is responsible for coordinating disaster loss reduction programs, initiatives, and policies throughout the state. HI-EMA serves as the coordinating agency for the four county emergency management agencies and administers the State of Hawai'i's hazard mitigation program, with the State Hazard Mitigation Officer (SHMO) serving as the official point of contact and leading mitigation efforts, including development of the SHMP and implementation of both state and local HMPs.

Over the course of a year, the State updated the 2018 SHMP through a robust process that stressed an integrated, multi-level, multi-sector, collaborative approach to risk reduction with an emphasis on building community resilience. Agencies and stakeholders involved in the update process are shown in the graphic below:



Additionally, HI-EMA engaged in outreach efforts on Kauaʻi, Oʻahu, Molokaʻi, Maui, and the Island of Hawaiʻi by holding in-person public meetings to allow the voices of community members to be heard during the update process. Statewide virtual public meetings were also held.

The State of Hawaiʻi is committed to a long-term strategy to reduce risk and losses from future natural hazard events, as outlined in this 2023 SHMP Update. The SHMP is a living document that supports relationship building, promotes resiliency and sustainability, aids in consistent evaluation, and provides a means to reduce the costs associated with disaster response and recovery. It will continue to be updated according to a maintenance process outlined in the plan.

OVERVIEW OF THE 2023 SHMP UPDATE

ASSESSED HAZARDS

The 2023 SHMP Update includes 15 natural and non-natural hazards that align with HI-EMA's 2022 Hazards and Vulnerability Overview and Threat and Hazard Identification and Risk Assessment (THIRA). Each hazard is assessed by describing the hazard location, extent, previous occurrences and losses, probability of future hazard events based on overall probability and climate change impacts, and vulnerability of state and local assets, including socially vulnerable and total populations, community lifelines, general building stock, economy, and environmental and cultural resources. Assessed hazards and their statewide relative risk ranking include:

HIGH

Wildfire
Health Risks
Climate Change and Sea Level Rise
Hurricane
Tsunami
Earthquake
Volcanic Hazards

MEDIUM

Flood
Landslide and Rockfall
Drought
Windstorm
Cyber Threat

LOW

Infrastructure Failure
Terrorism
Hazardous Materials

The 2023 SHMP Update will serve as a technical reference as each county updates its local HMP, including a robust risk assessment that integrates best available data and climate science.

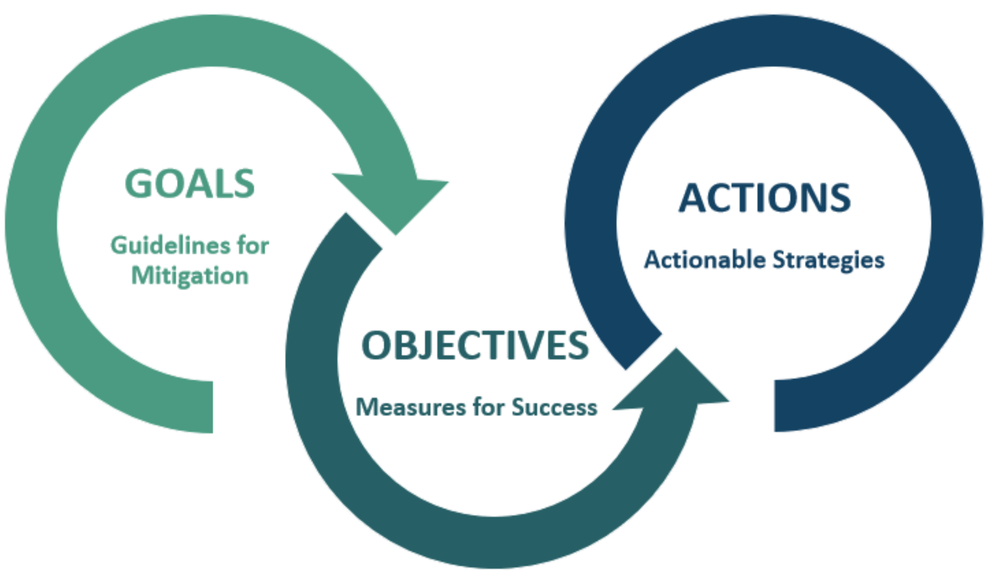
STATE AND LOCAL MITIGATION CAPABILITIES

Mitigation capabilities provide the means to accomplish desired mitigation outcomes. Capabilities include laws, regulations, policies, programs, administrative and technical staffing and resources, funding, and people-powered capabilities, such as volunteer groups. Existing State and local capabilities were reviewed and updated to determine the current capability of the State of Hawaiʻi and counties to implement mitigation strategies and challenges that can be overcome during the next five years. Part of this review included a summary of State and local building codes. Additionally, the success of the Community Rating System (CRS) was reviewed. Hawaiʻi is the first state in the nation with all the counties participating in the CRS program, which is a voluntary program within FEMA's National Flood Insurance Program (NFIP) that encourages floodplain management activities that exceed minimum NFIP standards. Residents of CRS communities receive discounted flood insurance premium rates.

MITIGATION STRATEGY AND GOALS

The State of Hawaiʻi has identified a mitigation strategy to reduce or eliminate long-term vulnerabilities from hazards of concern. The strategy, developed through a multi-stakeholder process, sets the State's mitigation priorities and assists local governments in updating local HMPs. The mitigation strategy, which includes 84 mitigation actions, is based on the following goals that reflect the State's current priorities:

- **Goal 1**—Reduce the long-term vulnerability of Hawaiʻi's people, property, and jurisdictions, including state-owned or operated buildings, infrastructure, and critical facilities, to natural hazards while conserving Hawaiʻi's natural, historical, and cultural assets. This includes High Hazard Potential Dams and high-risk properties such as repetitive loss (RL) and severe repetitive loss (SRL) properties.
- **Goal 2**—Promote actions designed to ensure long-term resiliency to natural hazards and climate change impacts.
- **Goal 3**—Strengthen partnerships and leverage existing resources and capabilities to identify, assess, and reduce the impact of natural hazards.
- **Goal 4**—Utilize state-of-the-art methods and technology and local knowledge to identify and analyze natural hazards and assess state capabilities to reduce the impact of those hazards.
- **Goal 5**—Promote public awareness of natural hazard risks and public action to reduce long-term risks.
- **Goal 6**—Provide a framework for robust local hazard mitigation planning and mitigation strategy implementation in alignment with this plan.
- **Goal 7**—Build capacity and capabilities to increase disaster resiliency among historically underserved populations, individuals with access and functional needs, and in communities disproportionately impacted by disasters and climate change.



The seven goals were developed as guidelines for mitigation. Fifteen objectives were also developed to measure the success of the mitigation strategies. During the five-year performance period of the 2023 SHMP, the State of Hawaiʻi will work to implement mitigation strategies to reduce hazard impacts to our community members, property, the economy, and the environment.

Section 1. Introduction

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[1] *Section Cover Photo: Sunrise near Kaloli Point, Hawaiʻi Island. Photo by Megan Brotherton*

SECTION 1. INTRODUCTION

The State of Hawaiʻi has experienced a range of climate, hydrological, seismic, geological, and technological hazard events that have resulted in great costs to lives, property, and the economy. The state's island-based communities have experienced numerous federal, state, and local declarations and are currently experiencing the impacts of the changing climate. The state is committed to protecting its communities through ongoing efforts to reduce risk from future hazard events. The Federal Emergency Management Agency (FEMA) approval and state adoption of each update to the Hawaiʻi State Hazard Mitigation Plan (SHMP) qualifies the State of Hawaiʻi to obtain federal assistance for hazard mitigation and for the repair and replacement of infrastructure damaged in natural disasters.

1.1 STATE HAZARD MITIGATION PLAN OVERVIEW

Key Terms

- **Hazard Mitigation**—Sustained action to reduce or eliminate the long-term risk to human life and property from hazards.
- **State Hazard Mitigation Plan**—A plan that demonstrates the State's commitment to reduce risks from natural hazards and serves as a guide for decision makers for reducing the effects of natural hazards as resources are committed.

Source: FEMA State Mitigation Planning Policy Guide, effective April 2023.

Mitigation is the effort to reduce loss of life and property by lessening the impacts of disasters. The purpose of mitigation planning is to identify hazards that impact the state, conduct a robust risk analysis of current hazards to guide risk-informed decision-making, identify actions and activities to reduce losses from those hazards, and establish a coordinated process to implement the plan. It creates safer communities and helps maintain the quality of life. To be effective, we must understand all risks and invest in long-term community well-being through the implementation of short- and long-term strategies before the next disaster (FEMA 2022).

1.1.1 HISTORY OF THE STATE HAZARD MITIGATION PLAN

On October 27, 2004, the first approved Multi-Hazard Mitigation Plan for the State of Hawaiʻi went into effect. The plan was subsequently updated in 2007, 2010, 2013, and 2018. As required by Section 322 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988 (the Stafford Act; Public Law 100-707)), the state continues to review and update the SHMP on a five-year cycle. This is the fifth update to the SHMP (2023 SHMP Update).

1.1.2 STATE'S COMMITMENT TO MITIGATION AND RESILIENCE

The state is committed to updating and implementing its long-term strategy for reducing the risks of hazards as documented in the 2023 SHMP Update. The 2023 SHMP Update presents a robust risk assessment of the hazards that present the greatest threat to Hawaii's communities and stresses an integrated, multi-level, multi-sector, collaborative approach to risk reduction with an emphasis on building community resilience. The 2023 mitigation actions include a focus on mitigating the impacts of climate change, providing equitable measures for socially vulnerable communities, and addressing potential impacts from high hazard potential dams.

The 2023 SHMP Update demonstrates the State of Hawaii's commitment to achieving the following:

- Identify, evaluate, and reduce risks from hazards, including climate change
- Serve as a guide for both state and local decision makers as they commit resources to equitably reducing the effects of hazards on lives and property and conserving natural, historical, and cultural assets
- Provide assurances that the State of Hawaiʻi will comply with all applicable federal statutes and regulations during the periods for which it receives grant funding, in compliance with the Code of Federal Regulations [44 CFR 13.11(c)]
- Maintain state eligibility to participate in all FEMA funding programs
- Amend the SHMP whenever necessary to reflect changes in state or federal laws and statutes as required in 44 CFR 13.11(d).

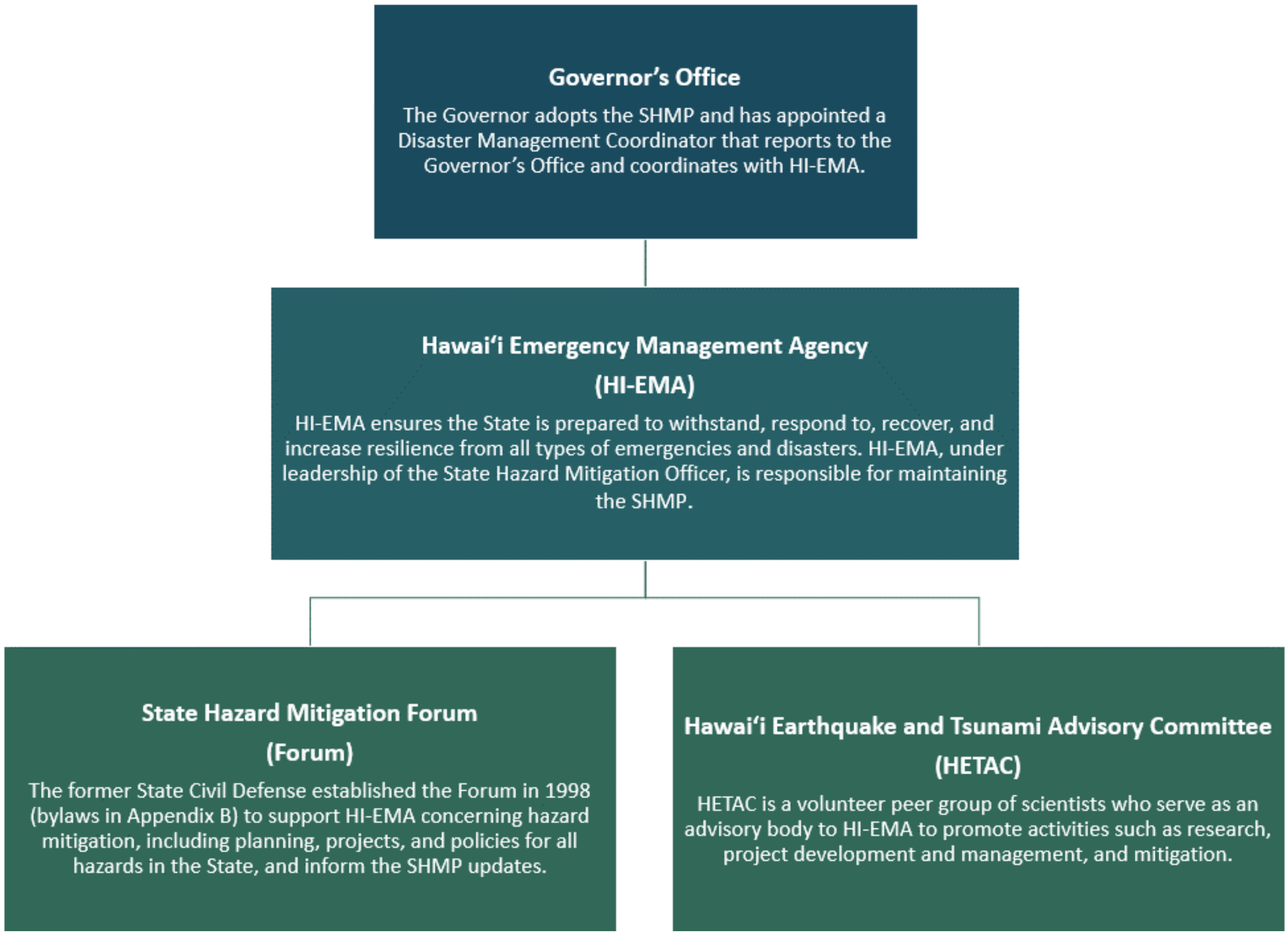
The State of Hawaii's HMP will continue to be a "living document" that supports relationship building, promotes resiliency and sustainability, aids in consistent evaluation, and provides a means to reduce the costs associated with response and recovery.

1.2 AUTHORITY, ASSURANCES, AND REFERENCES

Element S20 and 44 CFR § 201.4(c)(7): The state plan must include assurances that the state will manage and administer FEMA funding in accordance with applicable federal statutes and regulations. The state must amend and update its plan whenever necessary to reflect changes in state or federal laws and statutes.

The Hawaiʻi Emergency Management Agency (HI-EMA), formerly Hawai'i State Civil Defense, is responsible for coordinating disaster loss reduction programs, initiatives, and policies throughout the state. HI-EMA serves as the coordinating agency for the county emergency management agencies and as the State Warning Point. HI-EMA administers the state's hazard mitigation program, with the State Hazard Mitigation Officer (SHMO) serving as the official point of contact and leading mitigation efforts, including development of the SHMP and implementation of both state and local hazard mitigation plans (HMPs). Figure 1-1 identifies the state entities that are primarily responsible for hazard mitigation in Hawaiʻi.

Figure 1-1. Entities and Roles for Hazard Mitigation in the State of Hawaiʻi



Authority for this plan originates from the following federal sources:

- The Stafford Act
- Code of Federal Regulations (CFR), Title 44, Parts 79.4, 201 and 206
- Disaster Mitigation Act (DMA) of 2000, Public Law 106-390, as amended

The Stafford Act of 1988, amended the Disaster Relief Act of 1974 (Public Law 93-288). The Stafford Act constitutes the statutory authority for most federal disaster response activities.

The DMA is the current federal regulation addressing hazard mitigation planning. It amended the Stafford Act to require the preparation of HMPs by state and local governments emphasizing planning for disasters before they occur. The requirement for a state HMP is continued as a condition for disaster assistance. States must have an approved standard SHMP meeting the requirements in 44 CFR 201.4 as a condition of receiving the Stafford Act assistance and FEMA mitigation grants listed in Table 1-1.

Table 1-1. Non-Emergency Stafford Act Assistance Programs

Program	Description
Public Assistance Categories C-G	Post-disaster reimbursement of response and recovery costs
Fire Management Assistance Grants	Mitigation, management, and control of fires on publicly or privately owned forests or grasslands that threaten destruction that would constitute a major disaster
Building Resilient Infrastructure and Communities (BRIC)	Pre-disaster funding for proactive mitigation and community resilience projects and plans
Hazard Mitigation Grant Program (HMGP)	Post-disaster funding for mitigation and community resilience projects and plans
HMGP-Post Fire	Assistance to help communities implement hazard mitigation measures after wildfire disasters
Flood Mitigation Assistance (FMA)	Pre-disaster funding for flood hazard mitigation and community resilience activities that benefit properties insured under the National Flood Insurance Program (NFIP)
Rehabilitation of High Hazard Potential Dams	Technical, planning, design, and construction assistance in the form of grants for rehabilitation of eligible high hazard potential dams.

44 CFR 201.4(a): States must have an approved standard state mitigation plan meeting the requirements of this section as a condition of receiving non-emergency Stafford Act assistance and FEMA mitigation grants.

The State of Hawaiʻi will continue to comply with all applicable federal statutes and regulations during the periods for which it receives grant funding, in compliance with 44 CFR 13.11(c), and will amend its plan whenever necessary to reflect changes in state or federal laws as required in 44 CFR 13.11(d).

The following FEMA guides and reference documents were used to prepare the 2023 SHMP Update. Refer to the References section for a complete list of resources used to prepare the plan.

- State Mitigation Planning Policy Guide, effective April 19, 2023
- State Mitigation Planning Key Topics Bulletins: Planning Process, October 2022
- State Mitigation Planning Key Topics Bulletins: Risk Assessment, October 2022
- State Mitigation Planning Key Topics Bulletins: Mitigation Capabilities, November 2022
- State Mitigation Planning Key Topics Bulletins: Mitigation Strategy, October 2022

1.3 SUMMARY OF CHANGES FROM THE 2018 SHMP TO 2023 SHMP UPDATE

The state's vision for the 2023 SHMP Update is to continue refining the streamlined structure of the 2018 plan, resulting in a practical, readable document for the public and an implementable document for the state to support future risk reduction. In addition, the 2023 SHMP Update will serve as a technical reference for the next round of local HMP updates with a robust risk assessment that expands the assets assessed and integrates best available climate science.

With that in mind, the 2023 SHMP Update included a comprehensive update to the 2018 SHMP risk assessment. An internal review of the 2018 SHMP was conducted and compared against FEMA's new guidance to determine edits and enhancements. Highly technical information has been simplified, with lengthy tables, maps, and support text moved to the appendices.

One of HI-EMA's priorities was to ensure increased outreach and collaboration among a wide-range of stakeholders. HI-EMA identified and invited partners across all levels of government, private sector, subject matter experts, and the public to contribute to the plan. In addition, focus groups were established and numerous workshops held to ensure a robust risk assessment based on best available data, an extensive review of capabilities and mitigation progress, and a comprehensive updated mitigation strategy.

At the beginning of each plan section, there is a bulleted summary of changes made. The following highlights the significant changes and enhancements made for the 2023 SHMP Update organized by section.

1.3.1 SECTION 2 - PLANNING PROCESS

- One of HI-EMA's priorities for the 2023 SHMP Update was to ensure increased outreach and collaboration among various sectors and members of the public to ensure a comprehensive update. The following sectors were engaged throughout the planning process: emergency management, economic development, land use and development, housing, health and social services, infrastructure, natural and cultural resources, academia, and the private sector. Public meetings were held virtually and in-person on each of the main islands: Kauaʻi, Oʻahu, Maui, Molokaʻi, and Hawaiʻi.

1.3.2 SECTION 3 – STATE PROFILE

- All data presented is updated as appropriate, including demographic information and land use and development statistics.
- An enhanced discussion of socially vulnerable populations is included in the 2023 SHMP Update. The Social Vulnerability Focus Group chose to use the Social Vulnerability Index (SVI) published by the Centers for Disease Control and Prevention (CDC) for the analysis.
- Climate change is acknowledged as a factor that will increase average air and ocean temperatures in the state.
- Expanded discussion on community lifelines is included to provide additional context for understanding risk and identifying mitigation strategies.

1.3.3 SECTION 4 - RISK ASSESSMENT

A comprehensive update was performed to assess state and local vulnerability to the identified hazards of concern. In addition, a new feature to Section 4 is the inclusion of mitigation success stories in the state. These projects highlight risk reduction implementation using FEMA and other funding sources.

- Assessed Hazards:
  - To align with HI-EMA's Threat and Hazard Identification and Risk Assessment (THIRA) and Hazards and Vulnerabilities Overview documents, hazard sections are updated as follows:
    - Flood (Section 4.6) combines both chronic coastal flooding and event-based flooding.
    - Dam failure is assessed as the primary hazard under Infrastructure Failure (Section 4.10).
    - Qualitative discussions of Cyber Threat (Section 4.3) and Terrorism (Section 4.12) are added as new hazards.
  - Enhanced qualitative discussion is included for extreme heat for air and sea surface temperatures in Climate Change and Sea Level Rise (Section 4.2).
- Assets Evaluated:
  - **Community Lifelines and Critical Facilities**—An enhancement to the 2023 SHMP Update risk assessment is the analysis of community lifelines defined by FEMA along with additional critical facilities.
  - **State and Local Assets**:
    - The risk assessment included a statewide assessment using state-owned and leased assets, and all buildings statewide.
    - The risk assessment was performed for the County of Maui also includes the County of Kalawao.
    - Mapping includes judicial districts to provide higher resolution of risk assessment results
- **Socially Vulnerable Populations**—The enhanced risk assessment not only evaluates the population as a whole but also analyzes the location of socially vulnerable populations in relation to mapped hazards.
- **Cultural Resources**—In addition to assessing Hawaiian Home Lands, the 2023 SHMP adds six types of cultural resources (archaeology, burial sensitivity area, historic building, historic district, historic object, and historic structure) to the vulnerability assessment.
- **Environmental Resources**— The environmental resources evaluated were expanded. Reefs (both artificial and coral) are analyzed in their own category for all the natural hazards.

1.3.4 SECTION 5 - CAPABILITIES

- State and local capabilities have been comprehensively reviewed, updated, and reformatted in both Section 5 and Appendix C.
- Discussion of the processes utilized by the state to support and promote mitigation planning at the county level and processes to help counties obtain funding and technical assistance for mitigation planning have been reviewed and updated to reflect current procedures
- An expanded detailed scoring methodology to prioritize planning and project grants was developed in an effort to make the prioritization process easier to understand for the subapplicants and reviewers.

- State and local capabilities for building codes and standards are summarized.
- Mitigation capability challenges and barriers to implement mitigation and build resilience were identified in collaboration with plan stakeholders. These challenges and associated opportunities to overcome these barriers are summarized.
- The state agency/department hazard mitigation capability summaries in Appendix C were expanded to include the following new elements: capability category, effect on future mitigation, equitable outcomes, community lifelines, and 2023 SHMP goal(s) met.

1.3.5 SECTION 6 - MITIGATION STRATEGY

- Mitigation goals have been revised and objectives added using a linear approach that emphasizes multi-objective strategies. This includes expanding goal 1 to include high hazard potential dams and high-risk properties such as repetitive flood loss properties. Further, a new goal 7 was added to build capacity and capabilities and increase disaster resiliency in historically underserved populations.
- The updated action plan only includes projects that state agencies have the authority to implement. Actions that individual counties have the authority to implement will be included in their respective local HMPs.
- The 2023 mitigation actions include a focus on mitigating the impacts of climate change, providing equitable measures for socially vulnerable communities, and addressing potential impacts from high hazard potential dams.

1.3.6 EMERGENCY MANAGEMENT ACCREDITATION PROGRAM

- HI-EMA received conditional EMAP accreditation in January 2023. This update includes mitigation objectives to comply with requirements for full accreditation.

1.4 ADOPTION

Element S19 and 44 CFR § 201.4(c)(6): The state plan must include documentation that the plan has been formally adopted by the highest elected official or designee.

Adoption of the SHMP signifies Hawaii's commitment to implementing the mitigation strategy and utilizing the SHMP and its contents to guide hazard mitigation and resilience efforts over the next five years. The SHMP is the culmination of information provided by numerous stakeholders from local, native, state, and federal government agencies, nonprofits, private entities, and the community. The goals, objectives, and actions identified in the SHMP serve to communicate the state's priorities for reducing vulnerability and building resilience.

The plan serves as the State of Hawaiʻi Hazard Mitigation Plan and is formally adopted by the Governor of Hawaiʻi, as required by 44 CFR 201.4(c)(6). On September 27, 2023, the Governor adopted the SHMP after receiving "Approvable Pending Adoption" status from FEMA on August 7, 2023. Once adopted by the Governor, the adoption resolution was submitted to FEMA and FEMA provided full approval of the SHMP on September 28, 2023, making the SHMP effective as of that date.

Copies of the adoption resolution and FEMA approval letter are included at the end of this chapter, documenting the successful completion of the 2023 SHMP Update.

1.5 EMERGENCY MANAGEMENT ACCREDITATION PROGRAM

The Emergency Management Accreditation Program (EMAP) provides emergency management programs an opportunity to be evaluated and recognized for compliance with standards certified by the American National Standard Institute and recognized by the industry and for compliance with EMAP's mission to build safer communities through standards of excellence. EMAP demonstrates accountability and focuses attention on areas and issues where resources are needed to heighten preparedness efforts for any disaster that may affect communities.

Applicants must demonstrate through self-assessment, documentation, and peer assessment verification that their programs meet the Emergency Management Standard. An emergency management program uses the accreditation to prove the capabilities of its disaster preparedness and response systems. Accreditation is valid for five years. The program must maintain compliance and be reassessed to maintain accredited status.

The EMAP process accredits an overall emergency management program, of which hazard mitigation is one component. This SHMP Update has been developed to be in full compliance with EMAP standards and criteria.

EXECUTIVE CHAMBERS
KE KEʻENA O KE KIAʻĀINA

JOSH GREEN, M.D.
GOVERNOR
KE KIAʻĀINA

September 27, 2023

AN ORDER ADOPTING THE 2023 HAWAIʻI STATE HAZARD MITIGATION PLAN

The State of Hawaiʻi has historically suffered devastating loss of life and property from natural hazards. In the past five (5) years, Hawaiʻi has experienced destruction due to wildfire, health risks, hurricanes, tsunamis, earthquakes, and volcanic hazards, with many of the hazards exacerbated by the effects of sea level rise and climate change. These hazards have caused considerable human suffering and damage to homes, businesses, critical infrastructure, cultural resources, government buildings, and the economy.

Given Hawaiʻi's vulnerability to natural hazards and its history of disasters, the State has maintained and implemented a comprehensive, multi-hazard mitigation strategy to reduce the long-term loss of life and property damage. This strategy to strengthen the State's disaster resilience is embodied in the 2023 Hawaiʻi State Hazard Mitigation Plan (SHMP). The SHMP update meets the mandatory five (5) year timeline for review and update of the State and County core capabilities and efforts to reduce the impacts of natural hazards.

In recognition of the State's strong commitment to reduce or eliminate the long-term risk to human life and property from hazards, I hereby adopt the 2023 Hawaiʻi SHMP. Also adopted by reference are the hazard mitigation plans for each County.

The 2023 Hawaiʻi SHMP complies with the *Stafford Act, the Disaster Mitigation Act of 2000* (P.L. 106-390), and *44 Code of Federal Regulations Part 201 – Mitigation Planning*. The State will comply with all applicable federal statutes and regulations during the period it receives grant funding and will amend the SHMP whenever necessary to reflect changes in State or federal laws and statutes.

Mahalo,

Josh Green, M.D.
Governor, State of Hawaiʻi

U.S. Department of Homeland Security
FEMA Region 9
1111 Broadway, Suite 1200
Oakland, CA 94607

FEMA

October 10, 2023

James DS. Barros
Administrator of Emergency Management
Hawaii's Emergency Management Agency
4204 A Diamond Head Road
Honolulu, HI 96815

Reference: Approval of the Hawaii State Hazard Mitigation Plan

Dear Administrator Barros,

The Federal Emergency Management Agency (FEMA) Region 9 approves the updated Hawaii State Hazard Mitigation Plan effective September 28, 2023, through September 27, 2028. This plan is approved in accordance with applicable mitigation planning regulations and policy requirements.[1]

In addition, this plan meets the requirements to address wildfire risks and mitigation measures and the requirements to address all dam risks.

An approved state hazard mitigation plan is a condition of receiving certain FEMA non-emergency assistance and mitigation grants from the following programs:

- Public Assistance Categories C-G (PA C-G)
- Fire Management Assistance Grants (FMAG)
- Hazard Mitigation Grant Program (HMGP)
- Hazard Mitigation Grant Program Post-Fire (HMGP-PF)
- Building Resilient Infrastructure and Communities (BRIC)
- Flood Mitigation Assistance (FMA)
- Rehabilitation of High Hazard Potential Dams Program (HHPD)
- Safeguarding Tomorrow Revolving Loan Fund (STORM RLF)
- Pre-Disaster Mitigation (PDM)

[1] Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act), as amended; the National Flood Insurance Act of 1968, as amended; Title 44 Code of Federal Regulations (CFR) Part 201; and the "Water Infrastructure Improvements for the Nation Act," or the "WIIN Act," on December 16, 2016, which amends the National Dam Safety Program Act (Pub. L. 92-367).

Approval of a state hazard mitigation plan does not guarantee funding under any FEMA program. Please refer to the individual FEMA non-emergency assistance and mitigation grant program policy and/or annual Notice of Funding Opportunities for specific application and eligibility requirements for the FEMA programs listed above.

State hazard mitigation plans must be updated and resubmitted to FEMA Region 9 for approval every five years. If the plan is not updated and approved by September 27, 2028, the plan is considered lapsed, and FEMA will not obligate funds until the mitigation plan is approved.

If at any time over the plan approval period FEMA determines that the state is not complying with all applicable federal statutes and regulations in effect during the periods for which it receives funding or is unable to fulfill mitigation commitments, FEMA may take action to correct the noncompliance (44 CFR §201.3[b][5] and §201.4[c][7]).

FEMA will provide a reminder at least 12 months before the plan expiration date of the consequences of not having an approved state hazard mitigation plan, which is required to apply for and receive funding for FEMA non-emergency assistance and mitigation grant programs. To continue to apply for and receive funding from the programs listed on page 1, the state must submit a draft of the next plan update before the end of the approval period and allow sufficient time for the review and approval process. This includes any revisions, if needed, and formal adoption by the state following the determination by FEMA that the plan has achieved a status of "approvable pending adoption."

We look forward to working with you to discuss the status of the state hazard mitigation program each year over the approval period of this plan. If you have any questions please contact Kathryn Lipiecki, Mitigation Division Director, by phone at (215) 313-4176, or by email at kathryn.lipiecki@fema.dhs.gov.

Sincerely,

Robert Fenton
Regional Administrator
FEMA Region 9

Enclosure (1)
State of Hawaii Plan Review Tool, dated September 28, 2023

cc: Lorinda Wong-Liu, Resilience Branch Chief, HIEMA
Kelsey Yamanaka, Acting State Hazard Mitigation Officer, HIEMA
Kathryn Lipiecki, Mitigation Division Director, FEMA Region 9
Alison Kearns, Planning and Implementation Branch Chief, FEMA Region 9

Section 2. Planning Process

CONTENTS

TABLES

FIGURES

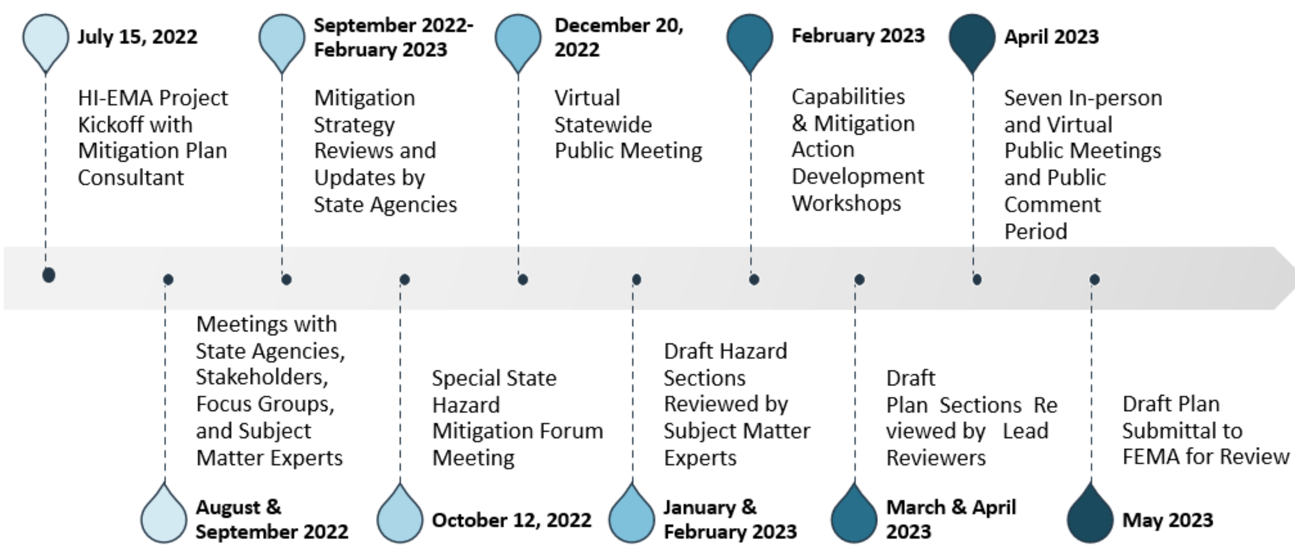
[1] *Section Cover Photo: Plumeria blossoms. Photo by Megan Brotherton*

SECTION 2. PLANNING PROCESS

The planning process lays the foundation for developing an effective plan to reduce hazard risk across the state. It involves consultation and collaboration with a variety of stakeholders to provide input to affect the plan content. This section outlines the process the State of Hawaiʻi followed to update the SHMP and demonstrates the state's ongoing commitment to ensuring a robust planning process. The following describes how the 2023 SHMP Update was prepared; which agencies and stakeholders were invited to and participated in the planning process; and how each section was reviewed, analyzed, and revised.

Figure 2-1 summarizes key planning meetings and milestones during the 2023 SHMP Update planning process. Additional milestones, participants, and supporting documents are contained in Appendix A (Planning Process Documentation).

Figure 2-1. Key Planning Meetings and Milestones



2.1 DESCRIPTION OF THE PLANNING PROCESS

Element S1 and 44 CFR § 201.4(b) and 201.4(c)(1): The state plan must include a description of the process used to develop the plan, including how it was prepared, the schedule or timeframe, specific milestones and activities, agencies and stakeholders involved, and if the process was integrated to the maximum extent possible with other state planning efforts.

The HI-EMA Mitigation Section led the 2023 SHMP Update. In mid-2019, the state applied for a FEMA 2019 Pre-Disaster Mitigation (PDM) grant to update the 2018 SHMP. The start date was August 4, 2020. In 2020, HI-EMA appointed a new State Hazard Mitigation Officer (SHMO) to lead the Mitigation Section. In July 2022, the SHMO was replaced by an acting SHMO who began leading the Mitigation Section. The acting SHMO's vision for the 2023 SHMP Update is to streamline the plan, resulting in a practical and implementable document, coordinate the SHMP with other HI-EMA planning documents, increase collaboration across a broader range of stakeholders to maximize planning efforts, and inspire continued collaboration and implementation beyond the 2023 SHMP Update. In July 2022, the state secured planning consulting services from Tetra Tech, Inc. to facilitate with the 2023 SHMP Update with a schedule to submit the updated plan to FEMA Region 9 during the summer of 2023.

The monitoring, evaluation, and update process outlined in the 2018 SHMP was well-intended; however, it was not fully actualized. HI-EMA recognizes that the Mitigation Section is limited in staffing capacity as discussed further in Section 5 (Capability Assessment) and that the Hawaiʻi State Hazard Mitigation Forum (Forum) involvement was limited due to the COVID-19 pandemic. Additionally, the frequency of hazard events combined with the state's necessity to redirect attention to disaster response and recovery diverted attention and resources away from the outlined 2018 SHMP maintenance process. Section 7 (Plan Maintenance) further details the challenges and successes of maintaining the 2018 SHMP.

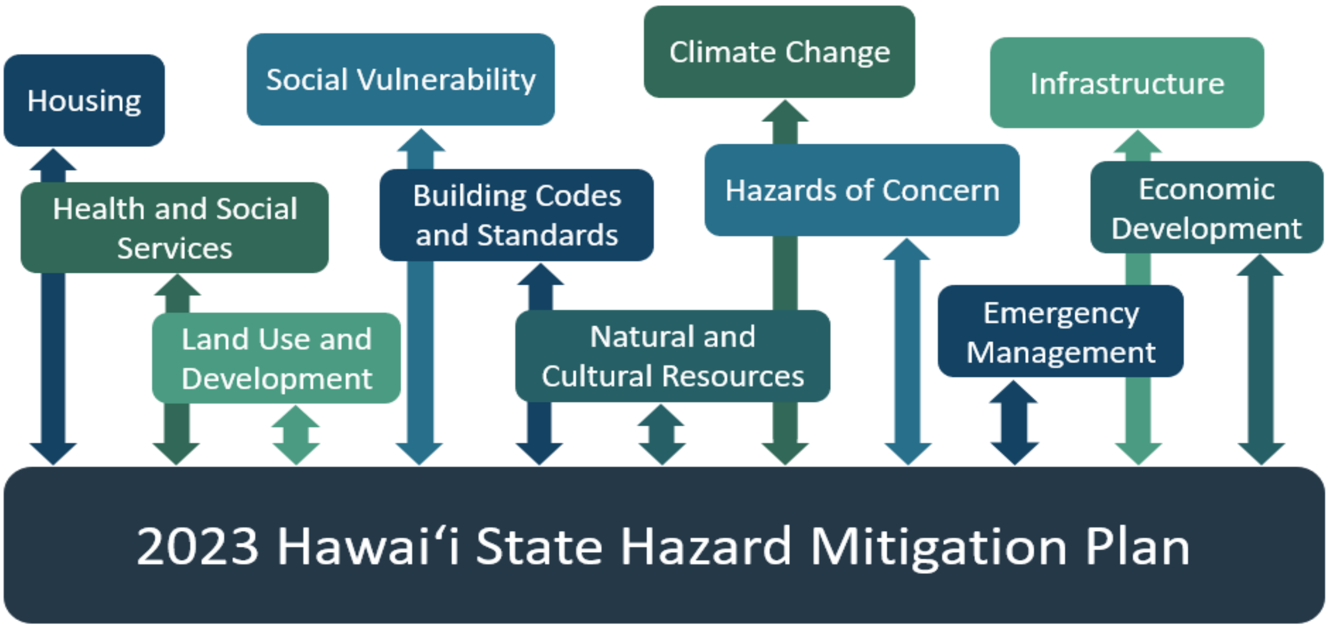
The HI-EMA Mitigation Section met weekly with the chair of the Forum and the planning consultant throughout the 2023 SHMP Update planning process. HI-EMA and the planning consultant met and/or communicated regularly with members of the Forum (individually and as a whole) as well as with key stakeholders and subject matter experts (SME) to identify hazards, assess risks, update capabilities, assist in updating and developing new mitigation goals and strategies, and provide continuity through the process. The roles of the Forum, stakeholders, SMEs, and the public are discussed later in this section. FEMA Region 9 was also consulted throughout the planning process and invited to concurrent SHMP and Forum plan update meetings.

Due to the state's unique geography, convening in-person meetings on a regular basis proves challenging, both in time and resources. Therefore, in addition to the in-person meetings held, there was a great deal of communication between HI-EMA, Forum members, SMEs, and stakeholders through virtual meetings, email, and individual meetings. Early in the planning process, Forum members were provided a roadmap outlining projected meeting dates and major milestones.

More than 75 subject matter experts across all sectors and fields of knowledge related to hazard mitigation were actively engaged and consulted during the planning process. Figure 2-2 illustrates these broad categories of expertise. Appendix A provides additional details including the name, agency, and detailed area of expertise of each subject matter expert involved in the 2023 SHMP Update.

The planning process included numerous meetings with federal and state agencies, academia, and stakeholders to ensure a robust risk assessment, thorough update of capabilities and mitigation progress, and a comprehensive updated mitigation strategy. Many natural hazard SMEs participated, including providing spatial data, guiding the vulnerability assessment methodology, and reviewing the draft Section 4 (Risk Assessment) of this plan. These SMEs were consulted from the beginning stages of the planning process to ensure the best available spatial and natural hazard data and methodologies were utilized to assess the State of Hawaii's risk. They were integral in the review of the draft SHMP Update as well. Appendix A includes a summary the SMEs identified and consulted.

Figure 2-2. SHMP Update Subject Matter Expertise



When the draft 2023 SHMP Update was completed in early 2023, the SHMO identified lead and supporting reviewers per plan section to ensure the first-round of review was conducted by SMEs. The lead reviewers are listed in Appendix A. Draft sections were distributed to the lead reviewers via the project Microsoft Teams file sharing site. All comments received from the SMEs were considered by the HI-EMA Mitigation Section and Forum chair, and incorporated into the draft where appropriate. In addition, the SHMO invited stakeholders listed in Appendix A to review the draft plan released on April 26, 2023, concurrent with public review.

On April 26, 2023, HI-EMA released the draft 2023 SHMP Update allowing the public to provide input on the draft plan prior to submittal to FEMA. The public comment period was open through May 9, 2023. The principal avenues for public comment on the draft plan were the StoryMap and HI-EMA website. In total, 29 comments were received via the form posted on the websites. Additionally, public meetings held in April allowed an opportunity to provide comment on the draft plan, ask questions, and discuss mitigation with the acting SHMO. These meetings were held on all the major islands.

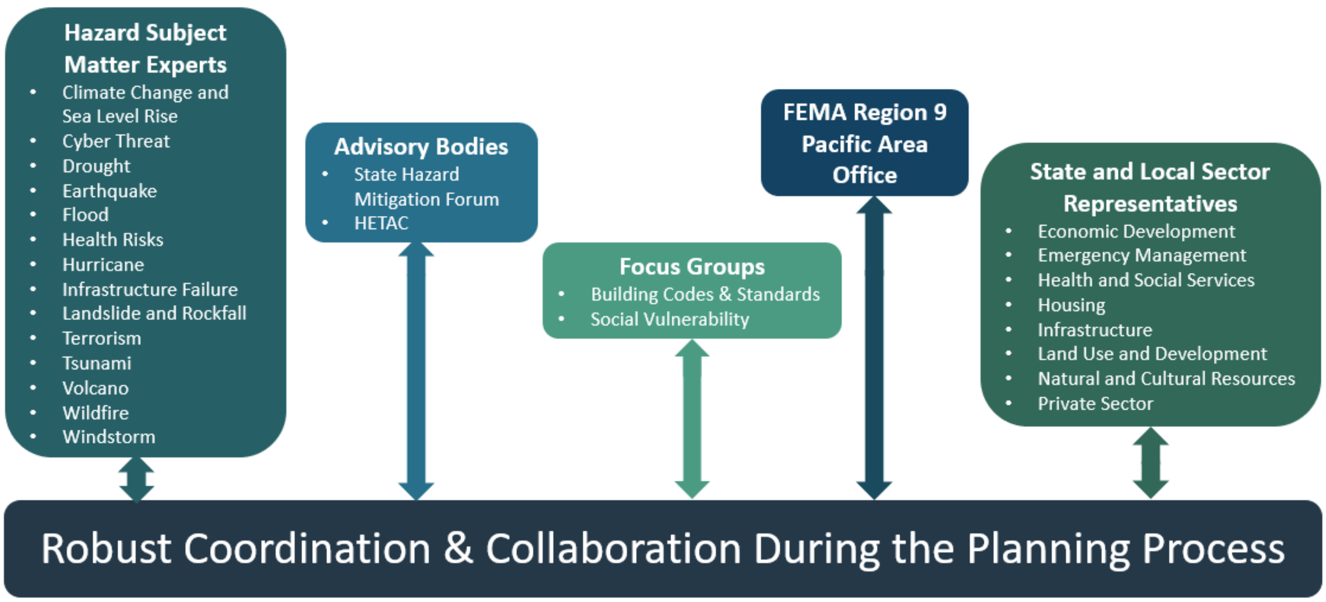
2.2 COORDINATION AMONG AGENCIES

Element S2, HHPD1, and 44 CFR § 201.4(b) and 201.4(c)(1): The state plan must describe how the state coordinated with other agencies and stakeholders, including state and federal agencies. The plan must describe how stakeholders and agencies were involved in the process. At a minimum, stakeholders from the following sectors should be involved: emergency management, economic development, land use and development, housing, health and social services, infrastructure, and natural and cultural resources.

One of HI-EMA's priorities for the 2023 SHMP Update was to ensure increased outreach and collaboration among a wide-range of stakeholders and subject matter experts across sectors to ensure a comprehensive update.

HI-EMA invited and collaborated with partners across federal agencies, state and local government, the private sector, and the public (Figure 2-3). Stakeholders across multiple sectors with mitigation capabilities were specifically identified and invited to participate in the process. In addition, two focus groups were established in September 2022 to assist with defining and enhancing areas of emphasis—one for building codes and standards and one for social vulnerability. The following section describes these stakeholders and the activities that were designed to engage, collaborate, and gather their input in the 2023 SHMP Update.

Figure 2-3. Stakeholder Coordination



2.2.1 FEMA

The HI-EMA Mitigation Section and the SHMO coordinated with FEMA throughout the planning process. This included consultations, asking questions to ensure the approach to analyzing and organizing natural hazards met FEMA requirements, and providing updates to the Region 9 Pacific Area Office about the planning process.

2.2.2 STATE HAZARD MITIGATION FORUM

Key Term

- **State Hazard Mitigation Forum**—The Hawaiʻi State Hazard Mitigation Forum serves in an advisory capacity relative to the incorporation of hazard mitigation policy in Hawaiʻi.

The former State Civil Defense established the Hawaiʻi State Hazard Mitigation Forum in 1998. The bylaws (see Appendix B) indicate each county shall be entitled to at least one member with experience and interest in hazard mitigation activities (i.e., risk and hazard analysis, public awareness, education, emergency management, environmental studies or protection, structural engineering, seismology, geology, public works, public utilities, insurance, planning, flood control, land utilization, waste management, sheltering, energy, construction, communication, building codes, architecture, coastal zone management, or grants management). Forum members may be selected from governmental agencies, the private sector, and the public.

The primary functions of the Forum are as follows:

- Coordinate hazard mitigation activities in the state.
- Recommend and prioritize project nominations for the Hazard Mitigation Grant Program (HMGP).
- Conduct a statewide public awareness campaign.
- Assist in obtaining funds for mitigation projects.
- Develop a hazard mitigation strategy for the state.

In the development of the 2023 SHMP Update, HI-EMA regularly engaged the Forum throughout the planning process. As described in Appendix A, HI-EMA scheduled regular 2023 SHMP Update meetings from October 2022 to March 2023. These meeting dates coincided with regular Forum meetings and included one special session to facilitate participation from members. The Forum provided a variety of expertise to the planning process, including emergency management, natural hazards, land use planning, building codes, transportation, and infrastructure from both state and county perspectives. The Forum was included in all aspects of the planning process and encouraged to provide data and information to support the update and review of interim and draft plan deliverables as outlined further in this section.

Currently, Forum members come from a broad spectrum of state and county agencies and the private sector. The Forum also includes ex officio representatives from all four county emergency management agencies, HI-EMA, and additional state agencies as summarized in Table 2-1. Refer to Appendix B for a list of the individual Forum representatives.

Table 2-1. State Hazard Mitigation Forum Members

Agency	Representative's Sector/Area of Expertise
Members	
Maui County Emergency Management Agency	County Emergency Management
State of Hawaiʻi Office of Planning and Sustainable Development	Land Use and Development
County of Maui Department of Planning	County Land Use and Development, Building Codes
Hawaiʻi State Energy Office	Infrastructure
Hawaiʻi State Climatologist, University of Hawaiʻi	Natural and Cultural Resources, Climate Change, Natural Hazards
State of Hawaiʻi Office of Homeland Security	Emergency Management, Terrorism and Cyber Threat
Hawaiʻi State Department of Health, State Toxicologist	Health and Social Services, Hazardous Materials
City and County of Honolulu, Office of Climate Change, Sustainability and Resiliency	Natural and Cultural Resources, Land Use and Development; Climate Change
Kauaʻi Emergency Management Agency	Emergency Management
County of Hawaiʻi Planning Department, Long Range Planning Division	Land Use and Development
County of Kauaʻi Department of Public Works	Infrastructure
Honolulu Board of Water Supply	Infrastructure (Water)
University of Hawaiʻi	Natural and Cultural Resources, Coastal Hazards
County of Hawaiʻi Civil Defense Agency	Emergency Management
State of Hawaiʻi Department of Transportation, Highways Division	Infrastructure (Transportation)
County of Hawaiʻi Planning Department	County Land Use and Development, Building Codes

Agency	Representative's Sector/Area of Expertise
Island Strategy LLC, Kaua'i Island Utility Cooperative	Infrastructure (Energy)
Hawai'i State Department of Business, Economic Development and Tourism	Economic Development
State of Hawai'i Department of Land and Natural Resources, Division of Forestry and Wildlife	Natural and Cultural Resources
State of Hawai'i Office of Planning and Sustainable Development, Coastal Zone Management	Natural and Cultural Resources, Social Vulnerability
Ex Officio Members	
Maui County Emergency Management Agency, Administrator	Emergency Management
Volunteer (former Hawai'i State Emergency Management Agency State Hazard Mitigation Officer)	Emergency Management
Honolulu Board of Water Supply	Infrastructure (Water)
County of Hawai'i Planning Department	County, Land Use and Development
Hawai'i Emergency Management Agency	Emergency Management
County of Hawai'i Civil Defense Agency	Emergency Management
State of Hawai'i Department of Land and Natural Resources, Engineering Division	Infrastructure
State of Hawai'i Office of Planning and Sustainable Development, Coastal Zone Management	Land Use and Development
Volunteer	Land Use and Development
Hawai'i Emergency Management Agency	Emergency Management
Kaua'i Emergency Management Agency	Emergency Management
City and County of Honolulu Department of Emergency Management	Emergency Management
State of Hawai'i Department of Land and Natural Resources, Engineering Division; National Flood Insurance Program Coordinator	Infrastructure
Kaua'i Emergency Management Agency, Administrator	Emergency Management
Hawai'i Emergency Management Agency	Emergency Management

Note: The State Hazard Mitigation Forum members listed in this table are current as of March 2023

2.2.3 HAWAI'I EARTHQUAKE AND TSUNAMI ADVISORY COMMITTEE

The Hawai'i Earthquake and Tsunami Advisory Committee (HETAC) was established in 1990 as a peer group of scientists who serve as an advisory body to HI-EMA. The committee meets quarterly to promote research, project development and management, and mitigation activities. HI-EMA consulted HETAC throughout the 2023 SHMP Update process.

2.2.4 STATE AGENCIES AND STAKEHOLDERS

The National Mitigation Framework emphasizes the valuable role of collaboration among sectors to ensure that mitigation capabilities continually develop and that comprehensive mitigation includes strategies for all community systems. In addition to collaborating with the Forum, the HI-EMA Mitigation Section coordinated with additional federal and state agencies and stakeholders throughout the 2023 SHMP Update. The following sectors were engaged throughout the planning process and were provided opportunities to provide plan input: emergency management; economic development; land use and development; housing; health and social services; infrastructure; natural and cultural resources; academia and SMEs; private and public sectors. Representatives from each of the sectors were invited and engaged in small workshops to allow for specific input on capabilities, explore gaps and challenges, and collaborate to develop proposed solutions (Figure 2-4). New mitigation action items were submitted by state agencies for this update based on discussion outputs from the February workshops. Detailed participant lists and discussion outputs are included in Appendix A.

Figure 2-4. Sector Workshops

A summary of the sectors engaged in the update process and further details on coordination with other agencies and stakeholders (e.g., distribution of capability assessment tables, interactive exercises at Forum meetings, individual meetings to discuss and collect risk assessment data and methodology, etc.) is found in Appendix A.

HI-EMA is committed to increasing coordination and collaboration in future hazard mitigation planning and grant activities. As noted throughout, this is a "living" document, and hazard mitigation planning is an ongoing process. HI-EMA will integrate agencies, departments and stakeholders further, as noted in Appendix A, the updated mitigation strategy action plan (Section 6), and the plan maintenance strategy outlined in Section 7.

2.2.5 FOCUS GROUPS

SOCIAL VULNERABILITY

Broad representation from state agencies and non-government organizations (listed in Appendix A) considered existing datasets for the social vulnerability analysis in the 2023 SHMP Update. Social vulnerability indices, datasets, and tools—including the state's ALICE (Asset Limited, Income Constrained, Employed), the Centers for Disease Control Social Vulnerability Index (CDC SVI) and the National Risk Index (NRI)—were discussed to determine which one best reflected vulnerability in the State of Hawaiʻi. While each dataset has limitations in reflecting the complex community structure in the islands, the CDC SVI was chosen by the Social Vulnerability Focus Group for this planning effort. It was learned during this plan update that, due to the unique nature of the State of Hawaiʻi and its population, state agencies are currently engaged in a collaborative effort to develop a state-specific social vulnerability dataset that can be used in the future for coordinated planning purposes.

Building Codes and Standards

State agencies, county representatives, and non-government organizations met to discuss building codes and standards requirements for the SHMP, how building codes facilitate resilience, and where land use regulations and capabilities contribute to hazard mitigation efforts (see Appendix A for a list of participants). It was acknowledged that a lack of capacity on both the state and county level make it a challenge to adopt and enforce current building codes and provide education to officials and community members on the benefits versus the cost of higher regulatory standards. Lively discussion ensued about the need to increase the state's Building Code Effectiveness Grading Scale (BCEGS) score which would make Hawaiʻi more competitive on the national level for FEMA BRIC grants. Refer to Section 5 (Capability Assessment) for additional discussion.

2.2.6 COUNTIES

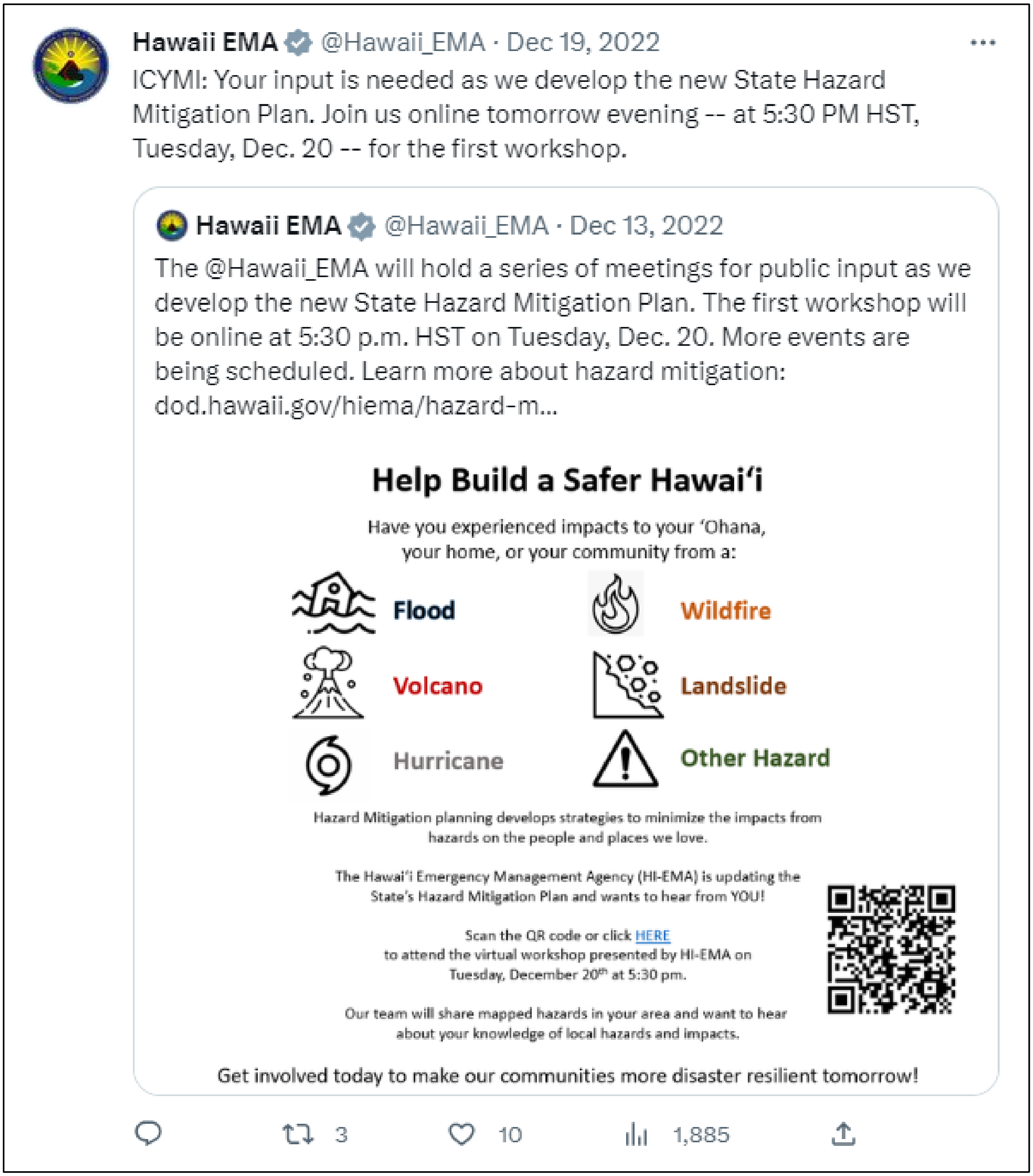
As noted above, the Forum includes representatives from all four county emergency management agencies who were invited to all 2023 SHMP Update meetings and participated in the planning process. The County of Kauaʻi, City and County of Honolulu, County of Maui, and County of Hawaiʻi partnered with HI-EMA to hold public meetings in their jurisdiction to inform the public of the 2023 SHMP Update and solicit input. Appendix A summarizes these meetings and attendance.

2.2.7 PUBLIC

The HI-EMA Mitigation Section and the administrator chose to expand public involvement in the planning process for the 2023 SHMP Update. HI-EMA placed importance on providing multiple opportunities for residents on all the islands to participate in the process. In July 2022, the hazard mitigation website was updated to keep the public informed of the process (Hawaii Emergency Management Agency | Hazard Mitigation Plans). On December 20, 2022, a virtual state-wide public meeting was held to provide a status update and present risk assessment results. A survey was released during the public meeting to gauge awareness of hazards. The meeting was publicly advertised to give residents an opportunity to provide input on the planning process (refer to Figure 2-5).

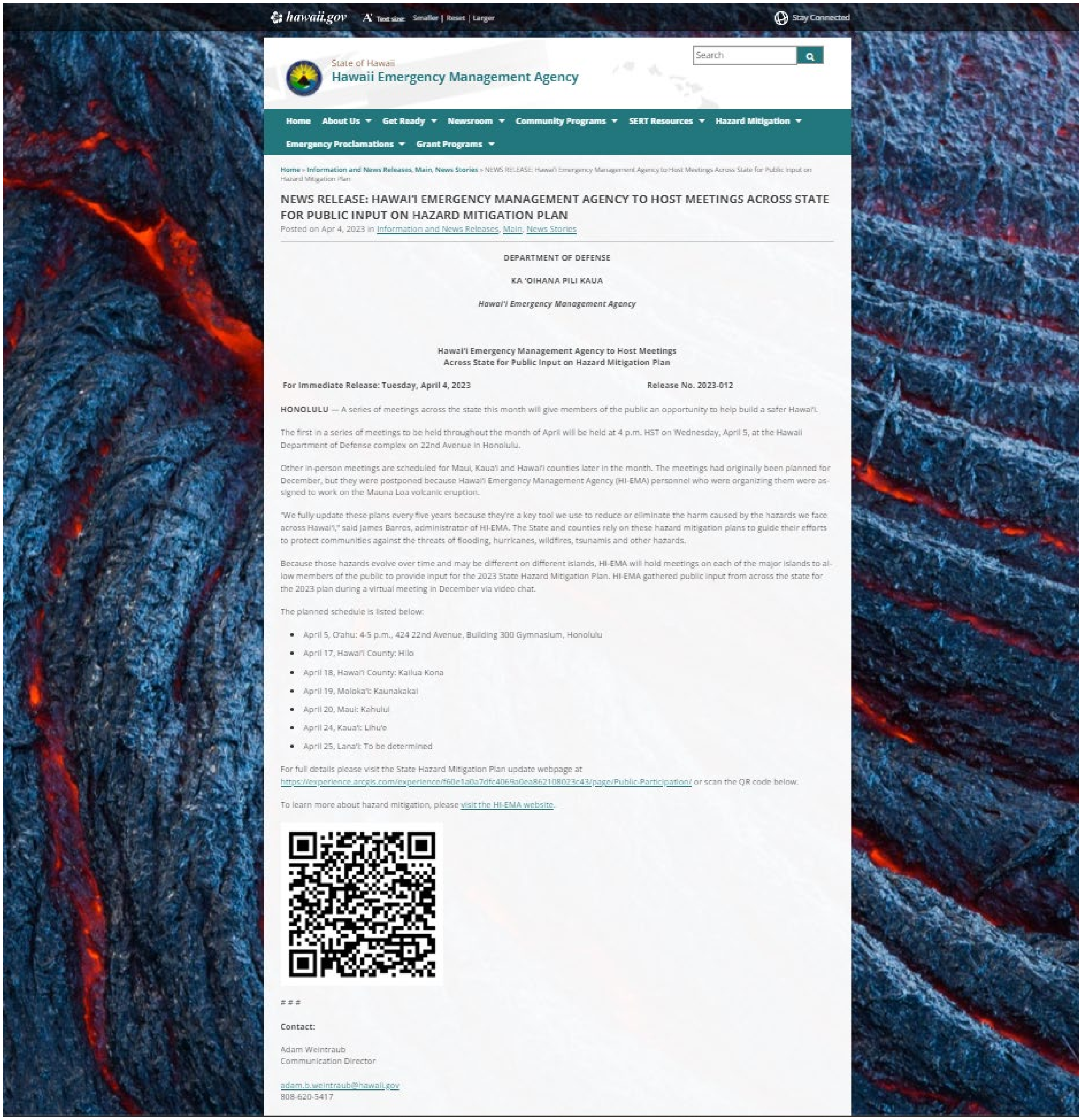
The HI-EMA Mitigation Section scheduled seven in-person public meetings on the major islands to discuss the 2023 SHMP Update. These meetings were held in the City and County of Honolulu (April 5, 2023), County of Hawaiʻi (Hilo on April 17, 2023 and Kona on April 18, 2023), County of Maui (Molokaʻi on April 19 and Maui on April 20), County of Kauaʻi (April 24, 2023), and a statewide meeting in Kapolei (May 3). Locations and times were promoted through HI-EMA press releases (Figure 2-6 and Figure 2-7) and with links to the StoryMap (Figure 2-8). Refer to Figure 2-9 of the meeting locations and Appendix A (Planning Process Documentation) for further details on additional outreach conducted and public comments received on the draft 2023 SHMP Update.

Figure 2-5. Social Media Post Announcing the December 20, 2022 Virtual Public Workshop



Source: [Hawaii EMA (@Hawaii_EMA) / Twitter]

Figure 2-6. April 4, 2023 HI-EMA Press Release for Statewide In-Person Public Meetings



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NEWS RELEASE: HAWAI'I EMERGENCY MANAGEMENT AGENCY TO HOST MEETINGS ACROSS STATE FOR PUBLIC INPUT ON HAZARD MITIGATION PLAN

Posted on Apr 4, 2023 in Information and News Releases, Main, News Stories

DEPARTMENT OF DEFENSE

KA 'OIHANA PILI KAUA

Hawai'i Emergency Management Agency

Hawai'i Emergency Management Agency to Host Meetings Across State for Public Input on Hazard Mitigation Plan

For Immediate Release: Tuesday, April 4, 2023 **Release No. 2023-012**

HONOLULU — A series of meetings across the state this month will give members of the public an opportunity to help build a safer Hawai'i.

The first in a series of meetings to be held throughout the month of April will be held at 4 p.m. HST on Wednesday, April 5, at the Hawaii Department of Defense complex on 22nd Avenue in Honolulu.

Other in-person meetings are scheduled for Maui, Kauai and Hawai'i counties later in the month. The meetings had originally been planned for December, but they were postponed because Hawai'i Emergency Management Agency (HI-EMA) personnel who were organizing them were assigned to work on the Mauna Loa volcanic eruption.

"We fully update these plans every five years because they're a key tool we use to reduce or eliminate the harm caused by the hazards we face across Hawai'i," said James Barros, administrator of HI-EMA. The State and counties rely on these hazard mitigation plans to guide their efforts to protect communities against the threats of flooding, hurricanes, wildfires, tsunamis and other hazards.

Because those hazards evolve over time and may be different on different islands, HI-EMA will hold meetings on each of the major islands to allow members of the public to provide input for the 2023 State Hazard Mitigation Plan. HI-EMA gathered public input from across the state for the 2023 plan during a virtual meeting in December via video chat.

The planned schedule is listed below:

- April 5, O'ahu: 4-5 p.m., 424 22nd Avenue, Building 300 Gymnasium, Honolulu
- April 17, Hawai'i County: Hilo
- April 18, Hawai'i County: Kailua Kona
- April 19, Moloka'i: Kaunakakai
- April 20, Maui: Kahului
- April 24, Kaua'i: Lihu'e
- April 25, Lana'i: To be determined

For full details please visit the State Hazard Mitigation Plan update webpage at https://experience.arcgis.com/experience/f60e1a0a7dfc4069a0ea862108023c43/page/Public-Participation/ or scan the QR code below.

To learn more about hazard mitigation, please visit the HI-EMA website.

# # #

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Source: Hawaii Emergency Management Agency | NEWS RELEASE: Hawai'i Emergency Management Agency to Host Meetings Across State for Public Input on Hazard Mitigation Plan

Figure 2-7. May 2, 2023 Press Release for Final Statewide Hybrid Public Meeting

Office of the Governor
GOVERNOR JOSH GREEN, M.D.
Ke Ke'ena O Ke Kia'āina

Home | About Governor Green | News | Contact Us | Get Involved | State of the State Address 2023 | Newsletter | Office on Homelessness

Home » **Latest Department News**, **Newsroom** » HIEMA NEWS RELEASE: Public Invited to Provide Input on State Hazard Mitigation Plan at Final Meeting

HIEMA NEWS RELEASE: PUBLIC INVITED TO PROVIDE INPUT ON STATE HAZARD MITIGATION PLAN AT FINAL MEETING

Posted on May 2, 2023 in Latest Department News, Newsroom

HONOLULU — Members of the public can help build a safer Hawai'i for themselves, their families, and their communities by providing input on the State Hazard Mitigation Plan.

The plan will be used to guide work in the years ahead to reduce or eliminate the harm caused to Hawai'i and its communities by flooding, hurricanes, wildfires and other hazards. The Hawai'i Emergency Management Agency (HI-EMA) has been collecting public input on the new plan since December, including a series of meetings across the state starting last month.

The final public meeting in that series will be held on O'ahu on Wednesday, May 3 at 5 p.m. HST at the Hawai'i Army National Guard Building 19 in Kapolei, located at 19 Shangrila Street, Room 121.

A draft version of the 2023 State Hazard Mitigation Plan was published last week. To view the draft Hazard Mitigation Plan, visit the Hazard Mitigation Plans section at the Hawai'i Emergency Management Agency's website. Feedback can be provided via a survey link on that page. The deadline for comments is May 9, 2023.

For more information, visit the StoryMap or scan the QR code below.

To learn more about hazard mitigation, please visit the HI-EMA website.

To join the Wednesday meeting online, follow this link: https://bit.ly/44pgzLl.

# # #

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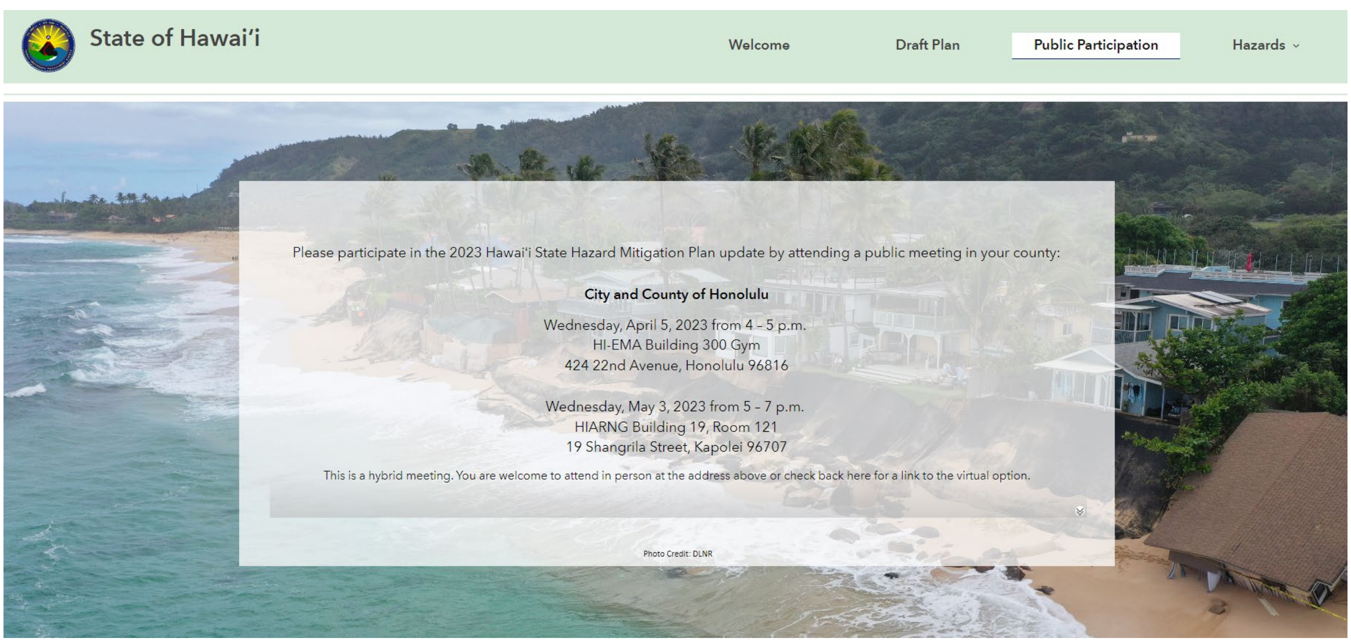
Figure 2-8. StoryMap Promoting the Public Meetings in April 2023



Source: Public Participation | HI State Hazard Mitigation Plan Update (arcgis.com)

Figure 2-9. Public Meeting Locations

On April 26, 2023, HI-EMA released the draft plan for public review and comment. The public comment period was open through May 9, 2023. A link to the draft plan was posted on the HI-EMA website (Hawaii Emergency Management Agency | Hazard Mitigation Plans) and added to the StoryMap (Draft Plan | HI State Hazard Mitigation Plan Update (arcgis.com)). Once approved by FEMA, the plan will be posted on the same HI-EMA website. The public was encouraged to submit comments through an online comment form. All comments received through May 9, 2023, were reviewed and taken into consideration by the HI-EMA Mitigation Section. Applicable and appropriate comments are summarized in Appendix A.

2.3 PROGRAM INTEGRATION

Element S1 and 44 CFR § 201.4(b) and 201.4(c)(1): The state plan must include a description of the process used to develop the plan, including how it was prepared, the schedule or timeframe, specific milestones and activities, agencies and stakeholders involved, and if the process was integrated to the maximum extent possible with other state planning efforts.

Mitigation plan implementation is most effective when mitigation planning efforts are integrated and coordinated with other state and federal programs and initiatives. A vision of the 2023 SHMP Update was to enhance coordination among sectors and integrate the SHMP with other planning efforts. The integration of mitigation into other programs and progress on 2018 SHMP mitigation actions that addressed integration into other planning mechanisms and/or encourage collaborative planning are discussed further in Section 5 (Capability Assessment), Section 6 (Mitigation Strategy), and Appendix C (Capability Assessment Supplement).

2.3.1 STATE MITIGATION PROGRAMS AND INITIATIVES

Within the State of Hawaiʻi, there are several state programs and initiatives that foster SHMP integration and coordination. These programs and initiatives are summarized below, with further details discussed in Section 5 (Capability Assessment) and Appendix C (Capability Assessment Supplement). HI-EMA used this update of the SHMP as an opportunity to further promote integration. In addition, numerous plans were reviewed and integrated into the 2023 SHMP Update, as documented in the References section. The following list highlights integration opportunities during the planning process as well as a sampling of plans that were integrated into the risk assessment:

- **Broad SME and County Collaboration on the Risk Assessment**—SMEs from state and federal agencies and academia were consulted during the data collection phase and risk assessment methodology development for the 2023 SHMP Update through one-on-one meetings as well as phone and email outreach. Further, these and additional SMEs were requested to conduct a technical review of Section 4. Each county has representation on the Forum with opportunity to collaborate and participate throughout the planning process, including at the risk assessment meeting when draft results were reviewed and discussed. Appendix A lists the SMEs that were specifically identified to conduct technical reviews of the draft plan prior to release for public comment. Additional input from SMEs is summarized in Section 4 (Risk Assessment). This collaboration produced an assessment that incorporated best available data and allowed for revisions throughout the process to achieve the greatest accuracy when representing risk.
- **Economic Expansion of Forum Representation**—Starting in 2022, the Department of Business, Economic Development & Tourism was represented on the Forum and participated in the planning process by attending Forum meetings and contributing to the mitigation strategy. As a result of greater representation, the economic sector was more involved in this update process by contributing to revisions in the hazard risk ranking and including coordinated mitigation strategies in the SHMP.
- **Local HMPs**—Local HMPs were reviewed, and data and information were integrated as possible, including hazards of concern and potential new development. Goals and objectives identified in local HMPs were used to inform the development of goals and objectives for the 2023 SHMP Update. County leaders worked with the state in goal and objective development and all aspects of plan development through their involvement on the Forum. The outcome of these reviews emphasized the need for ongoing coordination between the SHMP and local HMPs to produce strong mitigation plans with a unified approach to assessing risk throughout the state.
- **HI-EMA Strategic Plan**—Mitigation as one of the four phases of emergency management (preparedness, response, recovery, and mitigation) is a key element of the HI-EMA Strategic Plan, and the SHMP will continue to support and be integrated into Strategic Plan updates.
- **Forum Meetings Discussing FEMA HMGP Projects**—The Forum met during the 2018 SHMP performance period to identify and rank FEMA DR HMGP projects for DR-4282, DR-4365, DR-4366, DR-4395, DR-4549,

DR-4604, DR-5404, and DR-4510. As a result of this coordination, numerous projects have been funded by HMGP grants. Seven HMGP grant-funded projects closed during the past five years. Twenty-two are currently open and 17 more are under FEMA review.

- **Hazards and Vulnerabilities Overview 2022 (HVO)**—The HVO was used to align hazard categories across HI-EMA planning efforts, resulting in coordination among planning efforts. The 2023 SHMP Update hazard list reflects this alignment.
- **2015 Hawaiʻi Catastrophic Hurricane Plan**—To align with the *2015 Hawaiʻi Catastrophic Hurricane Plan*, the statewide and four county-specific hurricane scenario events were evaluated for the 2023 SHMP Update. This produced a robust, inclusive risk assessment for the hurricane hazard.
- **Threat and Hazard Identification and Risk Assessment (THIRA) and Stakeholder Preparedness Review (SPR)**—The results of the THIRA capability assessment were reviewed for the adaptive capacity component to the hazard ranking methodology, as outlined in Section 4.17 (Vulnerability Summary) resulting in ongoing coordination among HI-EMA planning efforts.
- **Hawaiʻi 2050 Sustainability Plan**—The Sustainability Plan, notably the social vulnerability strategies, were reviewed for the capability assessment and mitigation action development. This coordination further identified the ongoing need to develop a state-specific method for identifying socially vulnerable populations.
- **Annual Consultation**—The FEMA Region 9 annual consultation summary was reviewed and used to identify challenges and opportunities as documented in Section 5 (Capability Assessment). The annual consultation allowed HI-EMA to develop targeted strategies to strengthen the state mitigation program.
- **Hawaiʻi Highways Climate Adaptation Action Plan 2021**—The Hawaiʻi Department of Transportation is a member of the Forum and provided the Hawaiʻi Highways Climate Adaptation Action Plan for review. It was used to identify mitigation actions for the 2023 SHMP Update. Information from this plan was also used to facilitate discussions and answer questions about HDOT's awareness of at-risk state roads during the in-person public meetings in Hawaiʻi County and Maui County.
- **The County of Hawaiʻi Volcanic Risk Assessment 2020 and the Kīlauea Recovery and Resilience Plan**—These two documents were reviewed for the volcanic hazards profile, mitigation action development, and capability assessment. During the SHMP planning process, the 2022 eruption of Mauna Loa emphasized the need to coordinate these two documents with other county and state planning efforts.
- **Makani Pahili 2017 Emergency Power Prioritization Workshop Series Report**—In 2017, HI-EMA led a collaborative planning effort with county, state, federal, private sector, and non-governmental organizations to address temporary emergency power planning requirements outlined in the *2015 Hawaiʻi Catastrophic Hurricane Plan*. The results of this effort were memorialized in the *Makani Pahili 2017 Emergency Power Prioritization Workshop Series Report* and included the identification of community lifelines and critical facilities within the state. This robust critical facility inventory was utilized for the 2023 SHMP Update risk assessment to provide a foundation for other state and county planning efforts.
- **Pacific Risk Management Ohana (PRiMO)**—The State Hazard Mitigation Forum, the HI-EMA Administrator, and acting SHMO participated in PRiMO meetings in 2023, resulting in additional collaboration with emergency managers throughout the state.

- **Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report (2022)**—The 2022 *Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report* was an update to the 2017 report. This report quantified the potential area and assets exposed to projected sea level rise, mapped vulnerability zones, and formulated a comprehensive adaptation strategy. Adaptation strategies were integrated into the 2023 SHMP Update mitigation strategy to facilitate additional opportunities to mitigate the sea level rise hazard.
- **Hawaiʻi Drought Plan 2017 Update**—Information from this plan was used to support the drought risk assessment and prompted additional discussions with drought SMEs on recent and ongoing studies conducted in the state to better understand the potential impacts from the drought hazard.
- **Natural Disaster Economic Recovery Strategy (NDERS)**—The NDERS was reviewed for integration in the 2023 SHMP Update within the mitigation action plan. Discussions about the NDERS during the workshop with sector representatives allowed for better understanding of how economic impacts may be lessened by implementing creative mitigation strategies.
- **U.S. Coral Reef Task Force (USCRTF)**—Mitigation Section staff, including the SHMO, attended the 45th USCRTF meeting in Kailua-Kona and participated in working group meetings, site visits, and special sessions to support the development of coral reef restoration mitigation actions. This increased awareness of the ability of healthy coral reefs to reduce hazard impacts on state structures and infrastructure located in coastal areas.
- **Communities at Risk from Wildfire (CAR)**—The CAR data was provided by the Hawaiʻi Wildfire Management Organization (HWMO) for use in the vulnerability assessment. The available **Community Wildfire Protection Plans (CWPPs)** were reviewed and integrated into the wildfire risk assessment. This supported coordination among the plans to represent the increasing risk from wildfires in the islands.
- **Climate Change Impacts in Hawaiʻi, 2014**—Local impacts of climate change on the State of Hawaiʻi were integrated into the risk assessment update.
- **State of Hawaiʻi Databook**—The State of Hawaiʻi Databook was utilized to report current and projected population and development statistics in Section 3 (State Profile) and support the hazard-specific analyses on projected changes in development in the risk assessment.
- **Hawaiʻi Earthquake and Tsunami Advisory Committee**—Several members of HETAC are SMEs and draft plan reviewers for the 2023 SHMP Update: earthquake, landslide, tsunami, volcanic hazards. The HI-EMA Mitigation Section attended quarterly HETAC meetings, updated members on mitigation, and provided status updates on the 2023 SHMP Update during the planning process. Coordination allowed for HETAC scientists to be fully engaged in the analysis and provide recommended revisions to the draft plan.
- **State Building Code Council (SBCC)**—The HI-EMA Mitigation Section attended and participated in State Building Code Council meetings. As a result, closer coordination between HI-EMA the SBCC is anticipated to help narrow the gap between Building Code Effectiveness Grading Scale (BCEGS) scores and potential mitigation funding opportunities.
- **Legislative Briefings**—The HI-EMA Mitigation Section attended numerous legislative briefings on pending legislation during the performance period of the 2018 SHMP. During the 2023 SHMP Update planning process, the Hawaiʻi State Legislature passed a resolution (SR35) designating coral reefs as critical natural infrastructure and supporting nature-based solutions such as coral reef restoration for risk reduction.
- **Hawaiʻi Statewide GIS Program, Office of Planning and Sustainable Development (OPSD)**—Much of the spatial data used for the 2023 SHMP Update was facilitated through the OPSD geospatial data portal. The

need for ongoing coordination and collaboration among planning efforts in the state was acknowledged when reviewing data outputs.

- **Meetings with the State National Flood Insurance Program (NFIP) Coordinator**—HI-EMA and Planning Consultant met with the state NFIP Coordinator to discuss recent flood events, insurance policy counts, the update of the 2018 SHMP mitigation strategy, and the capability assessment and to identify mitigation actions for the 2023 SHMP Update. These meetings enabled an accurate representation of the flood and dam failure hazards to be presented in the SHMP.
- **National Emergency Managers Association (NEMA) Forums (2022 and 2023)**—The SHMO attended the week-long NEMA Forums to enhance the 2023 SHMP Update. Outcomes included networking with decision-makers who influence mitigation policy and funding in the state.
- **Hazard Mitigation Partners Workshops (2021 and 2022)**—The SHMO attended the virtual workshops presented by FEMA to gather information about mitigation grants and other applicable updates to benefit the SHMP planning process and help the state to be more effective in the grant application process.
- **State Agency Meetings**—The HI-EMA Mitigation Section attended meetings with state agency representatives and legislators on various issues to advance progress on mitigation efforts in the state.

Section 3. State Profile

CONTENTS

TABLES

FIGURES

[1] *Section Cover Photo: Aerial view of Honolulu and Diamond Head Crater, Oʻahu. Photo by Megan Brotherton*

SECTION 3. STATE PROFILE

2023 SHMP Update Changes

- All data presented was updated as appropriate, including demographic information and land use and development statistics.
- Sections for socially vulnerable populations and community lifelines were added and expanded to provide additional context for understanding mitigation and risk within the State and to frame the Risk Assessment presented in Section 4 of the 2023 SHMP Update.
- All mapping was updated using the best available data.

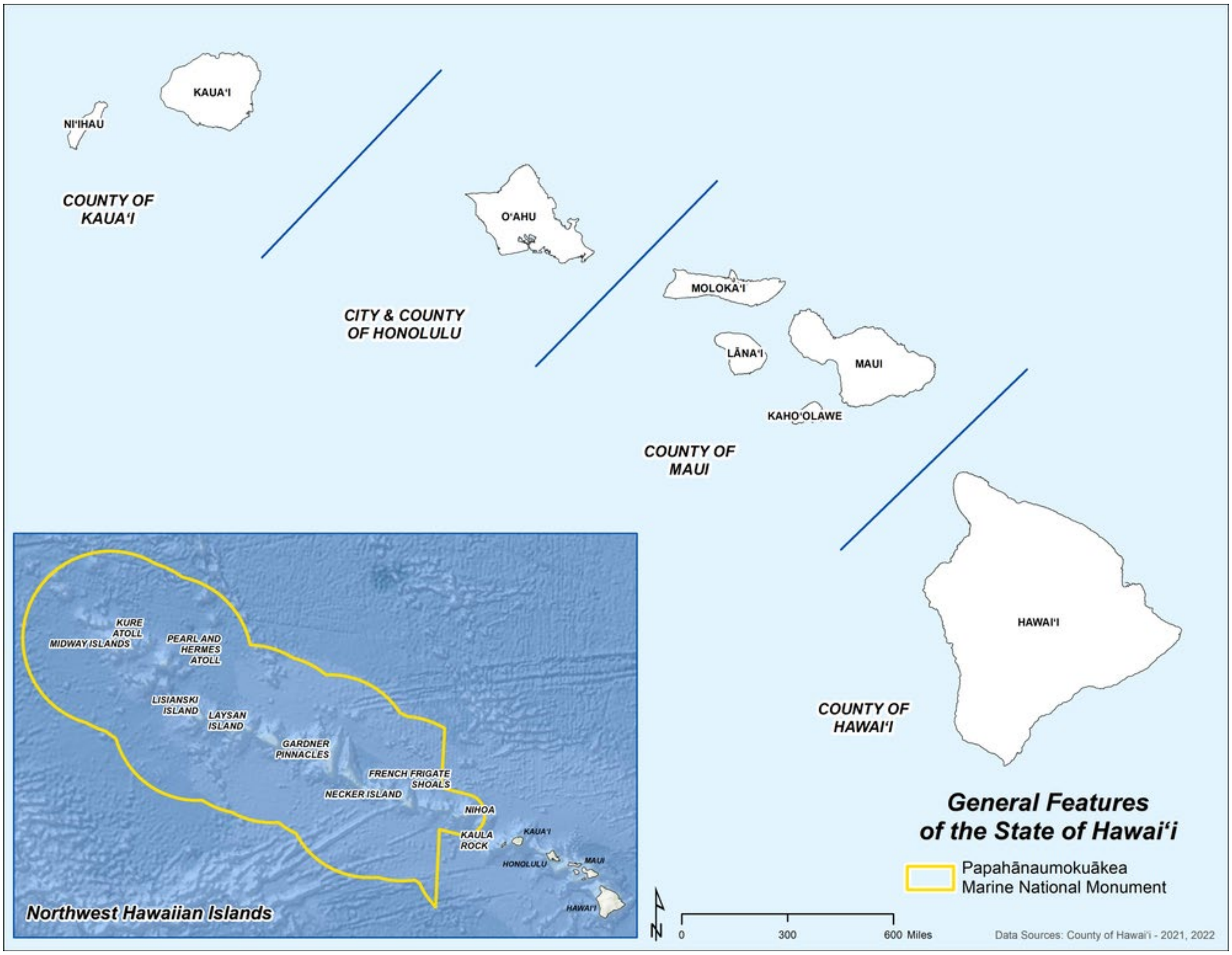
3.1 GEOGRAPHIC OVERVIEW

The Hawaiian Archipelago, located about 2,400 miles southwest of the continental Unites States, is composed of 132 volcanic islands, atolls, reef, shoals, and seamounts stretching over 1,500 miles from the Island of Hawaiʻi in the southeast to Kure Atoll in the northwest (NOAA 2021). The Hawaiian Islands cover 6,422 square miles of land, with eight main islands located at the southeastern end of the island chain: Niʻihau, Kauaʻi, Oʻahu, Molokaʻi, Lānaʻi, Kahoʻolawe, Maui, and Hawaiʻi. The remaining islands, atolls, and shoals are known as the Northwestern Hawaiian Islands and form part of the Papahānaumokuākea Marine National Monument created in June 2006 (DLNR 2019). The general features of the State can be seen in Figure 3-1. Given the State's relative isolation and dependency on imported goods and services, mitigation takes on added importance.

3.2 HISTORIC OVERVIEW

The Hawaiian Islands were first settled approximately 1,500 years ago when Polynesians traveled more than 2,000 miles by canoe from the Marquesas Islands to the Island of Hawaiʻi (Hawaiʻi Tourism Authority 2022). Hawaiian society was highly stratified with the mōʻī, or king, acting as the highest authority, and aliʻi, or chiefs, below this highest level. Ancient Hawaiians divided land using the ahupuaʻa system, a complex land division system where whole islands, or moku, were divided into smaller, wedge-shaped segments running from the mountain crest to the shore, called ahupua'a (NPS 2019). The first westerners to arrive in the Islands were Captain James Cook and his crew in 1778. Not long after in 1810, King Kamehameha conquered all other rulers, and the entire archipelago was united into one kingdom. In 1820, Christian missionaries arrived followed by traders and whalers who brought diseases that devastated the Native Hawaiian populations. The first sugar plantation was established on the Island of Kauaʻi in 1835, and agriculture became a dominant part of the Hawaiian economy. In 1893, Queen Liliʻuokalani was placed under house arrest, and the overthrow of the Kingdom of Hawaiʻi began, resulting in the annexation of the Islands of Hawaiʻi by the United States in 1898. On August 21, 1959, following a popular vote, Hawaiʻi became the 50th state of the United States of America (Hawaiʻi Tourism Authority 2022).

Figure 3-1. General Features of the State of Hawaiʻi



3.3 POLITICAL DIVISIONS

Politically, the State of Hawaiʻi is divided into five counties: County of Kauaʻi, City and County of Honolulu, County of Maui, County of Kalawao, and County of Hawaiʻi. The County of Kauaʻi encompasses the Islands of Kauaʻi and Niʻihau. The City and County of Honolulu includes the Island of Oʻahu and the Northwestern Hawaiian Islands. The County of Maui consists of the Islands of Molokaʻi (with the exception of the Kalaupapa peninsula, which constitutes the County of Kalawao), Lānaʻi, Kahoʻolawe, and Maui. Lastly, the County of Hawaiʻi has jurisdiction over the Island of Hawaiʻi (Office of Hawaiian Affairs 2016). For the 2023 SHMP Update, the County of Kalawao statistics are included with the County of Maui's statistics.

3.3.1 JUDICIAL DISTRICTS

Each county is divided into judicial districts for election, taxation, education, city, county, and all other purposes (State of Hawaiʻi n.d.). Hazard mapping developed for the 2023 SHMP includes the judicial district boundaries to provide a higher resolution of vulnerability and to inform local decision-making.

3.4 PHYSICAL SETTING

The following sections describe the geography, topography, and climate of the State of Hawai‘i.

3.4.1 GEOGRAPHY AND TOPOGRAPHY

The following sections provide a brief overview of the geography and topography of each of the state’s counties. The information throughout the 2023 SHMP Update is typically presented from the westernmost part of the state, County of Kaua‘i, to the easternmost, County of Hawai‘i.

COUNTY OF KAUA’I

The County of Kaua‘i is situated northwest of the Island of O‘ahu, separated by the Kaua‘i Channel. Known as the Garden Island, the Island of Kaua‘i is the northernmost and geologically oldest of the major Hawaiian Islands. The County of Kaua‘i includes the Island of Ni‘ihau (73 square miles) and the tiny uninhabited islets of Ka‘ula and Lehua. These islands are volcanic in origin, although there are currently no active volcanoes in the county. The circular Island of Kaua‘i rises 3 miles from the ocean floor and is roughly 550 square miles (County of Kaua'i 2021).

In the center of the Island of Kaua‘i is Kawaikini Peak, rising 5,170 feet, and Mount Wai‘ale‘ale, rising 5,080 feet. Mount Wai‘ale‘ale is the rainiest location on Earth, averaging 460 inches of rain per year, and contributes to this island's nickname—the Garden Island. Many streams flow from these mountains to the sea through canyons in the volcanic rock. Waimea Canyon has colorful rock walls that are 2,857 feet high. Rugged cliffs along the northwestern coast make it impossible to build a road around the whole island (University of Massachusetts 2018). The Island of Ni‘ihau, nicknamed “The Forbidden Island,” is a privately owned island. The island is semi-arid with a dry climate, although several lakes provide fresh water (NASA 2020).

CITY AND COUNTY OF HONOLULU

The City and County of Honolulu consists primarily of the Island of O‘ahu but also includes the Northwestern Hawaiian Islands, with the exception of Midway Atoll, which is administered by the U.S. Fish and Wildlife Service (City & County of Honolulu 2020). The Northwestern Hawaiian Islands consist largely of uninhabited low-lying atolls and islets. The Island of O‘ahu consists of the remains of two shield volcanoes: the Ko‘olau Volcano on the east side of the island and the Wai‘anae Volcano on the west side of the island. The valley between the mountains of these two extinct volcanoes consists of a fertile, rolling plain that supported both sugar and pineapple plantations in the past. Those industries have now been largely replaced by residential development and diversified agriculture. A most notable landmark is the 760-foot extinct volcanic crater, known as Diamond Head, located on the southeastern end of the island at the end of world-famous Waikīkī beach (Hawai‘i Tourism Authority 2017). The Hawai‘i Emergency Management Agency (HI-EMA) emergency operations center is located within Diamond Head due to its relatively protected surroundings.

COUNTY OF MAUI

The Island of Maui is the second largest island in the Hawaiian Archipelago, covering 772 square miles. It was formed by two volcanic cones: Haleakalā on the east side of the island, with a current elevation of 10,023 feet; and Pu‘u Kukui (Mauna Kahalawai) on the west side, with a current elevation of 5,788 feet. Haleakalā, which last erupted in 1790, is a dormant volcano that could erupt in the future; its eruptive history indicates it could erupt every 200 to 500 years. A relatively flat isthmus of sand joins the two cones. East Maui is geologically younger than West Maui, as apparent by the absence of deeply incised canyons and extensive areas of volcanic lava and cinders on the southwestern slopes of Haleakalā. The lands more suitable for agriculture, including the gentle slopes of central Maui and tablelands of West Maui, resulted from alluvial deposits and the decomposition of basaltic materials (County of Maui 2020).

The Island of Molokaʻi is the fifth largest of the main Hawaiian Islands, covering approximately 261 square miles. It has 88 miles of coastline and is the most rural of the Hawaiian Islands, often being referred to as the "Last Hawaiian Island". It was formed primarily by the coalescence of two shield volcanoes 1.8 million to 1.3 million years ago: the East Molokaʻi Volcano (also known as Kamakou) and the West Molokaʻi Volcano (also known as Mauna Loa) (County of Maui 2020).

The Island of Lānaʻi is the sixth largest of the main Hawaiian Islands, with an area of 141 square miles. The island was formed from a single shield volcano that last erupted about 1.3 million years ago. A low-lying basin in the center of the island is what is left of the volcano's caldera (Smithsonian Institution 2013). Lānaʻi is one of the driest of the inhabited main Hawaiian Islands, as it lies within the rain shadow of Maui's West Maui mountains (County of Maui 2020).

The smallest of the main Hawaiian Islands, Kahoʻolawe is 11 miles long, 7 miles wide, with an area of about 45 square miles (County of Maui 2020). It was formed by a single volcano that underwent shield and post-shield stages; the island itself is the exposed top of a shield volcano. The highest point on the island is a crater Puʻu ʻO Moaʻula Nui, at 1,483 feet above sea level (Hawaiian Volcano Observatory 2004).

County of Hawaiʻi

The Island of Hawaiʻi is the southeasternmost island in the Hawaiian Archipelago. At approximately 4,028 square miles, the Island of Hawaiʻi, also known as the "Big Island", is larger than all the other islands combined and continues to grow as a result of ongoing eruptions. The Island of Hawaiʻi was formed from the coalescence of five volcanoes—Kohala, Mauna Kea, Hualālai, Mauna Loa, and Kīlauea (County of Hawaiʻi 2020). Two of the five volcanoes have erupted in the past year. Mauna Loa erupted from November to December 2022, and Kīlauea began erupting in January of 2023 (NPS 2023a) (NPS 2023b).

As the geologically youngest island, Hawaiʻi Island's landforms have not been weathered to the extent of the other islands. Thus, rainfall runoff flows in narrow V-shaped stream valleys without broad floodplains or sheet flows in relatively undefined drainageways, especially in the drier leeward areas. The relatively immature reef development and related lack of white sandy beaches is also characteristic of the youthful geologic age of this island (County of Hawaiʻi 2020).

3.4.2 CLIMATE

The following sections provide a general overview of the climate in the State of Hawaiʻi and how the El Niño-Southern Oscillation cycle affects climate conditions in the state.

General Overview of the Climate of the State of Hawaiʻi

The following description of the climate of the State of Hawaiʻi was extracted and condensed, in part, from the National Weather Service (NWS) National Oceanic and Atmospheric Administration's (NOAA) website. According to the website, it is a condensed chapter on the State of Hawaii's climate from the Second Edition (University of Hawaiʻi Press 1983) of the "Atlas of Hawaiʻi." The author is the late Saul Price, former Hawaiʻi state climatologist and staff meteorologist for the NWS Pacific Region (NWS 2019).

Air, Ocean Temperatures, and Seasons

The climate of the State of Hawaiʻi can be generally characterized as including mild temperatures throughout the year, moderate humidity, persistence of northeasterly trade winds, significant differences in rainfall within short distances, and infrequent severe storms. For most of the state, there are only two seasons: "summer" (*kau*), between May and October, and "winter" (*hoʻoilo*), between October and April. The State of Hawaii's longest and shortest days are about 13½ hours and 11 hours, respectively, compared with 14½ and 10 hours for Southern California and 15½ hours and 8½ hours for Maine. Uniform day lengths result in small seasonal variations in incoming solar radiation and, therefore, temperature.

Like the ambient air temperatures, ocean temperatures differ slightly between the seasons with about 6 degrees of fluctuation, from a low of 73 degrees Fahrenheit (˚F) or 74˚F between late February and March to a high near 80˚F in late September or early October. Because the State of Hawaiʻi is more than 2,000 miles from the nearest continental land mass, air that reaches it, regardless of source, spends enough time over the ocean to moderate its initial harsher properties. For example, Arctic air that reaches the State of Hawaiʻi during the winter may have a temperature increase by as much as 100˚F during its passage over the waters of the North Pacific. The State of Hawaii's warmest months are August and September. Its coolest months are February and March, reflecting the seasonal lag in the Pacific Ocean's temperature.

As climate change impacts are accelerating, average temperatures of both the air and the ocean surrounding Hawaiʻi are increasing.

Terrain

The State of Hawaii's mountains significantly influence every aspect of its weather and climate. The endless variety of peaks, valleys, ridges, and broad slopes gives the State of Hawaiʻi a climate that is different from the surrounding ocean as well as a climatic variety within the islands. The mountains obstruct, deflect, and accelerate the flow of air. When warm, moist air rises over windward coasts and slopes, clouds and rainfall are much greater than over the open sea. Leeward areas, where the air descends, tend to be sunny and dry. In places sheltered by terrain, local air movements are significantly different from winds in exposed localities. Since temperature decreases with elevation by about 3˚F per thousand feet, the State of Hawaii's mountains, which extend from sea level to nearly 14,000 feet, contain a climatic range from the tropic to the subarctic.

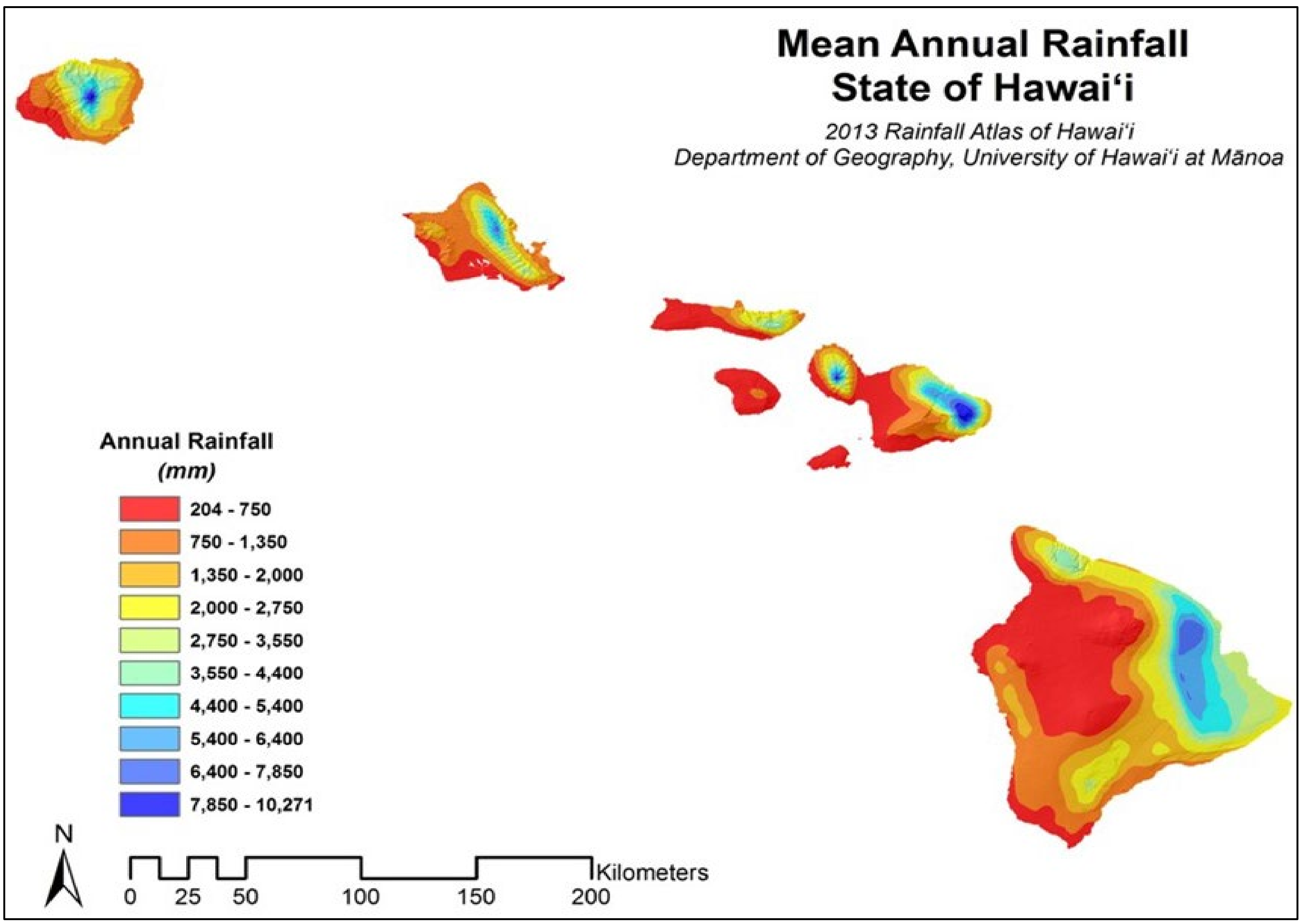
The climate of the State of Hawaiʻi can be defined by what it has and by what it does not have. It does not have the extremes of cold winters and summer heat waves, and it usually does not have hurricanes and hailstorms. However, the State of Hawaii's tallest peaks do get their share of winter blizzards, ice, and snow. Highest temperatures may reach 90˚F or higher. Thunderstorms, lightning, hail, floods, hurricanes, tornadoes, and droughts are not unknown. However, these phenomena are usually less frequent and less severe than their counterparts in continental regions.

The highest temperature ever recorded in the State of Hawaiʻi was 100˚F at Pahala (elevation 870 feet) on the Island of Hawaiʻi on April 27, 1931. The lowest ever recorded was 12˚F on Mauna Kea (elevation 13,770 feet), also on the Island of Hawaiʻi, on May 17, 1979.

Rainfall

Over the ocean near the State of Hawaiʻi, rainfall averages between 25 and 30 inches a year. The islands receive as much as 15 times that amount in some places and less than one-third of it in others (see Figure 3-2). This is caused mainly by orographic or mountain rains, which form within the moist trade wind air as it moves from the sea over the steep and high terrain of the islands. Over the lower islands, the average rainfall distribution closely resembles the topographic contours. Amounts are greatest over upper slopes and crests and least in the leeward lowlands. On the higher mountains, the belt of maximum rainfall lies between 2,000 to 3,000 feet, and amounts decrease rapidly with further elevation. As a result, the highest slopes are relatively dry.

Figure 3-2. Average Annual Rainfall in Hawaiʻi



Source: (Giambelluca, et al. 2013)

Another source of rainfall is the towering cumulus clouds that build up over the mountains and interiors on sunny calm afternoons. Although such convective showers may be intense, they are usually brief and localized. Hawaii's heaviest rains come from winter storms between October and April. While the effects of terrain on storm rainfall are not as great as on trade wind showers, large differences over small distances do occur because of topography and location of the rain clouds. Differences vary with each storm.

Frequently, the heaviest rainstorms do not occur in areas with the greatest average rainfall. Relatively dry areas may receive, within a day or a few hours, totals exceeding half of their average annual rainfall.

The leeward and other dry areas obtain their rainfall mainly from a few winter storms. Therefore, their rainfall is usually seasonal, and their summers are dry. In the wetter regions, where rainfall comes from both winter storms and trade wind showers, seasonal differences are much smaller.

At the opposite extreme, drought is not unknown in the State of Hawaiʻi, although it rarely affects an entire island at one time. Drought may occur when there are either no winter storms or no trade winds. If there are no winter storms, the normally dry leeward areas are hardest hit. A dry winter, followed by a normally dry summer and another dry winter, can have serious effects. The absence of trade winds affects mostly the windward and upland regions, which receive a smaller proportion of their rain from winter storms.

The State of Hawaiʻi has seen an overall decline in rainfall in the last 30 years, with widely varying precipitation patterns on each island. Projections show that the State of Hawaiʻi will see more drought and heavy rain events. A decline in overall precipitation totals have caused a decrease in stream base flow, which may reduce aquifer recharge and freshwater supplies. This may also negatively impact aquatic and riparian ecosystems and agriculture.

Between 1958 and 2007, the amount of rain falling in the very heaviest downpours has increased by approximately 12%. These heavy rain events may lead to more flash flooding, damage to infrastructure, runoff, and sedimentation.

El Niño and La Niña Effects on The State of Hawaii's Climate

El Niño and La Niña are opposite phases of what is known as the El Niño-Southern Oscillation (ENSO) cycle. The ENSO cycle is a scientific term that describes the fluctuations in temperature between the ocean and atmosphere in the east-central Equatorial Pacific (approximately between the International Date Line and 120 degrees west). La Niña is sometimes referred to as the cold phase of ENSO and El Niño as the warm phase of ENSO. These deviations from normal surface temperatures can have a large impact on ocean processes, global weather, climate, and influences on extreme weather (NOAA 2009).

El Niño and La Niña episodes typically last 9 to 12 months, but some prolonged events may last for several years. While the frequency of events can be quite irregular, El Niño and La Niña events occur on average every 2 to 7 years. Typically, El Niño occurs more frequently than La Niña (NOAA 2009).

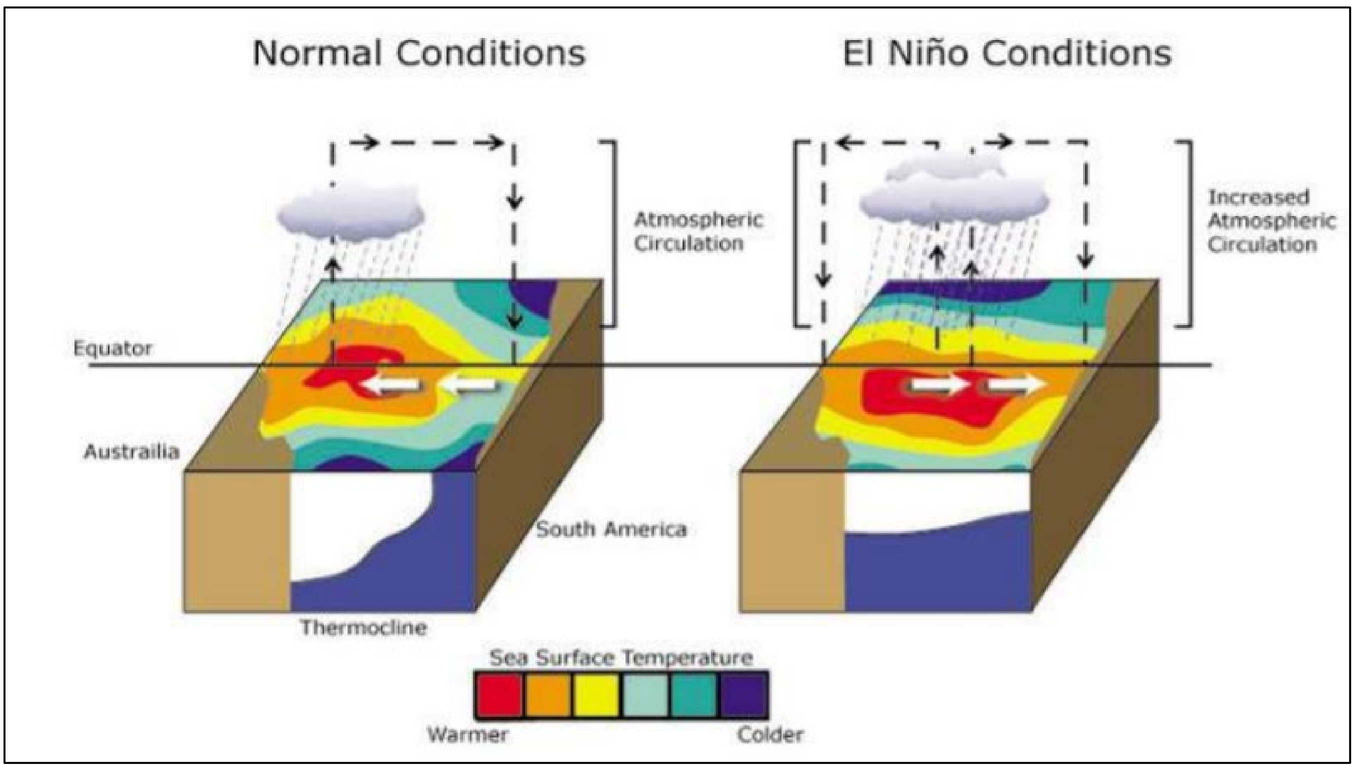
It is hypothesized that El Niño may increase in frequency with global warming. The impacts of El Niño may exacerbate the consequences of sea level rise. El Niño events in the tropical Pacific Ocean can cause sea levels to rise 6 to 12 inches above mean conditions in some areas are typically characterized by higher waves in winter (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017).

El Niño

El Niño refers to the large-scale, ocean-atmosphere climate interaction linked to a periodic warming in sea surface temperatures across the central and east-central Equatorial Pacific. It brings increased rainfall to the East Pacific Basin and drought at locations west of the Pacific Basin, such as in Australia. El Niño is typically responsible for destructive flooding in the East Pacific and drought in the West Pacific, sometimes associated with devastating brush fires in Australia. Observations of conditions in the tropical Pacific are considered essential for the prediction of short-term (a few months to 1 year) climate variations. To provide necessary data, NOAA operates a network of buoys which measure temperature, currents, and winds in the equatorial band. These buoys transmit data daily which are available to researchers and forecasters around the world in real time (NOAA n.d.).

Figure 3-3 illustrates the difference between normal conditions and El Niño conditions. In normal conditions, the trade winds blow from east to west, pushing warm surface waters toward Asia, piling it up in the western Pacific. During El Niño conditions, the trade winds weaken, and the warm surface water moves eastward. This reduces the upwelling of cold water off the coast of South America. The climate impacts of El Niño show up mostly during the winter months over North America.

Figure 3-3. Normal Conditions vs. El Niño Conditions



Source: NOAA 2015

During El Niño, the State of Hawaiʻi typically experiences more rain in the beginning of the season and then rapidly less, causing a drier wet season. Trade winds are weaker, and occasionally the state will experience westerly (or Kona) winds. Sea level is near to slightly above normal, causing high run-up from distant swells. Ocean temperatures are much warmer at and below the surface. Other significant impacts include increased risk of wildfires associated with drought; coastal erosion with changes in sea level and storm impacts; coral reef bleaching (coral reefs protect islands from waves and storm impacts); loss of plants, agriculture, and degradation of habitat; and landslides associated with heavy rainfall (NOAA 2015).

La Niña

La Niña episodes represent periods of below-average sea surface temperatures across the east-central Equatorial Pacific. It occurs after El Niño as the warmer ocean fuels an intensification and southward shift of the jet stream. Eventually, the trade winds pick up again and can become stronger than normal. When this occurs, the trade winds blow the warm water back into the western Pacific. This restarts the upwelling of cool water toward the surface in the eastern Pacific, known as La Niña. La Niña brings unusually cold conditions to the tropical Pacific and displaces the jet stream northward. In the tropics, ocean temperature variations in La Niña also tend to be opposite to those of El Niño (National Geographic 2022).

During La Niña, rainfall in the State of Hawaiʻi tends to be near or above normal during the winter months. The rainy season usually lasts longer into the spring. The state may receive above-normal rainfall not only during the wet season of January through March, but during a strong La Niña period, the excess wetness may continue through May in many locations (Guide of US 2023).

3.5 DEMOGRAPHICS

The following sections discuss demographic information for the State of Hawaiʻi.

3.5.1 RESIDENT POPULATION

TOTAL POPULATION

Knowledge of the composition of the population, how it has changed in the past, and how it may change in the future is needed to make informed decisions. Information about the population is a critical part of planning because it directly relates to needs such as housing, industry, stores, public facilities and services, and transportation. According to 2020 estimates, the State of Hawaiʻi has a resident population of 1,455,271 people. The majority of the population is concentrated on the Island of Oʻahu (City and County of Honolulu), with a total of 1,016,508 residents. Between 2010 and 2020, the State of Hawaii’s resident population increased by 6.6% (Hawaiʻi DBEDT 2022). Resident population figures by county are shown in Table 3-1.

Population projections indicate that the statewide population is expected to increase by approximately 220,000 by 2045, representing a 0.5% growth rate per year over the projected period. The Neighbor Island counties are projected to have higher population growth than Honolulu County during the projected period, with these Neighbor Island counties projected to increase by 34.9% by 2045. Table 3-2 shows population projections for each county until 2045.

Table 3-1. Resident Population by County, 1990 to 2020

County	Resident Population				
	1990	2000	2010	2020	% Change (2010 to 2020)
County of Kauaʻi	51,177	58,463	67,091	73,298	+9.3%
City and County of Honolulu	836,231	876,156	953,207	1,016,508	+6.6%
County of Maui	100,504	128,241	154,924	164,836	+6.4%
County of Hawaiʻi	120,317	148,677	185,079	200,629	+8.4%
Total [a]	**1,108,229**	**1,211,537**	**1,360,301**	**1,455,271**	**7.7%**

Source: Hawaiʻi DBEDT 2022
Note:
a. These estimates include military personnel stationed or homeported in the state. The U.S. Department of Defense estimates that there are 25,394 active-duty military in the state as of December 2022. Additional military personnel who are not stationed or homeported in the state but are currently ported or otherwise present in the state are not included.
The de facto population of the State of Hawaiʻi is much larger than the resident population due to the substantial number of visitors in the state on any given day. The statewide average daily visitor population was 264,747 visitors as of December 2022 (Department of Business, Economic Development & Tourism 2023). This means that the de facto population is 18.2% greater than the resident population. Additional discussion on tourism can be found in Section 3.5.8.

Table 3-2. Resident Population Projections by County, 2025 to 2045

County	Resident Population			
	2025	2035	2045	Average Annual Growth Rate (2025-2035)
County of Kauaʻi	78,000	84,300	90,000	6.8%
City and County of Honolulu	1,032,700	1,062,100	1,073,800	1.1%
County of Maui	181,600	197,800	211,500	6.9%
County of Hawaiʻi	222,400	248,500	273,200	9.9%
Total	**1,514,700**	**1,592,70**	**1,648,600**	**6.2%**

Source: Hawaiʻi DBEDT 2022

Socially Vulnerable Population

For the 2023 SHMP Update, the Social Vulnerability Focus Group identified the 2018 statewide Social Vulnerability Index (SVI) published by the Centers for Disease Control and Prevention (CDC) as the best available dataset to identify areas where mitigation efforts can be prioritized to benefit socially vulnerable populations. At the time of the direction and analysis, the 2020 SVI updates had not been made public. Updated residential population data compiled from the Census Bureau was integrated into the 2018 SVI analysis. See Section 4.1 (Risk Assessment Overview) for more information on how the SVI was used to determine hazard risk to socially vulnerable populations. An overview of the socially vulnerable population for the 2023 SHMP indicates that more than 22% of the state's population has an SVI greater than 0.8 (see Table 3-3). The County of Kauaʻi contains the smallest percentage of socially vulnerable populations at about 15%.

CDC Social Vulnerability Indicators

- Socioeconomic status
- Household composition and disability
- Minority status and language
- Housing type and transportation

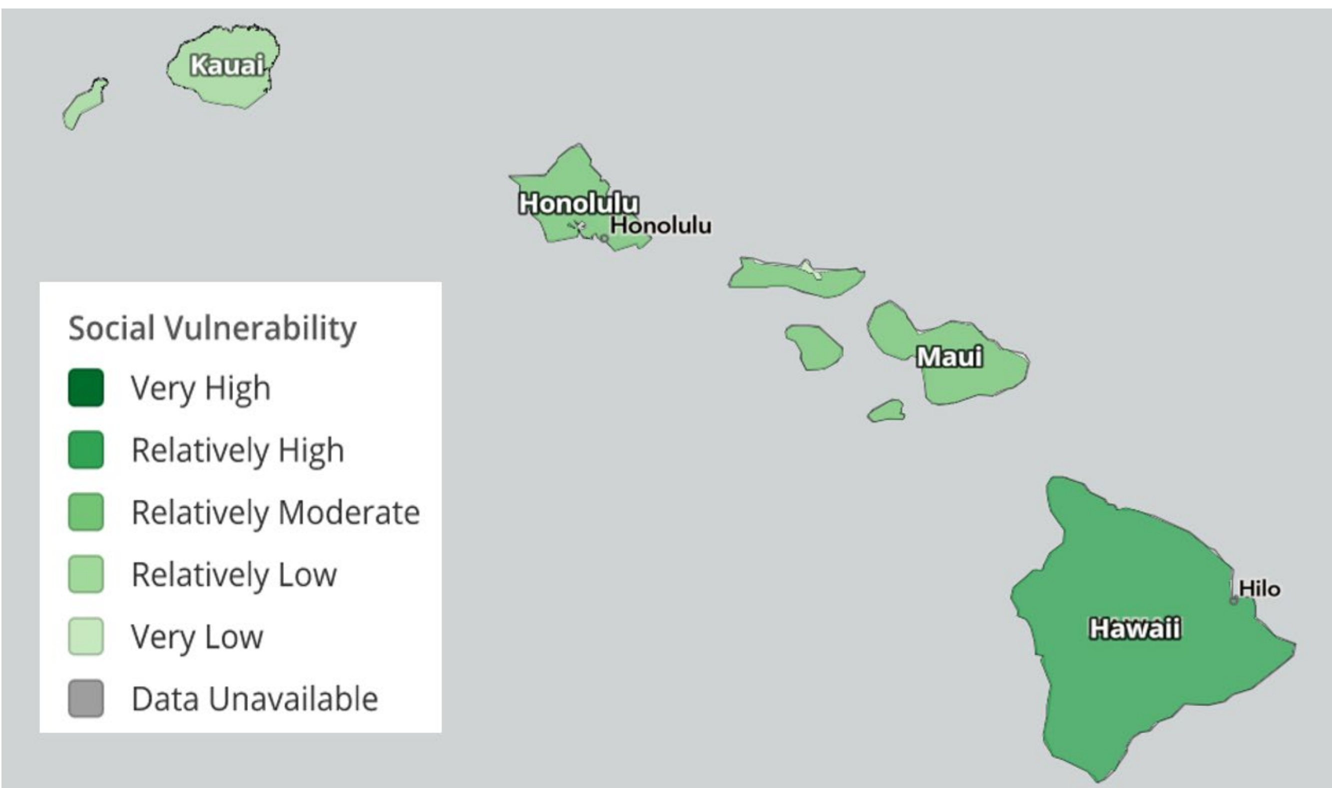
(U.S. Department of Health & Human Services 2022)

Table 3-3. Socially Vulnerable Population by County

County	Total Population	Socially Vulnerable Population	Percent of Total Population
County of Kauaʻi	71,949	11,149	15.5%
City and County of Honolulu	979,682	224,567	22.9%
County of Maui	167,093	35,284	21.1%
County of Hawaiʻi	201,350	45,257	22.5%
Total	**1,420,074**	**316,257**	**22.3%**

In additional to the CDC SVI dataset selected by the Social Vulnerability Focus Group, additional indices were reviewed including the National Risk Index (NRI) Comparison Report (FEMA 2023). The NRI summarizes social vulnerability at both the county and Census Tract levels. The report compares the social groups in each county's susceptibility to the adverse impacts of natural hazards when compared to the rest of the U.S. and within the state Kauaʻi County is ranked "Relatively Low", while the City and County of Honolulu and Maui County ranked "Relatively Moderate". Hawaiʻi County ranked "Relatively High" when compared to the other counties. Figure 3-4 summarizes the NRI social vulnerability at the Census tract level within each county.

Figure 3-4. National Risk Index Social Vulnerability County View

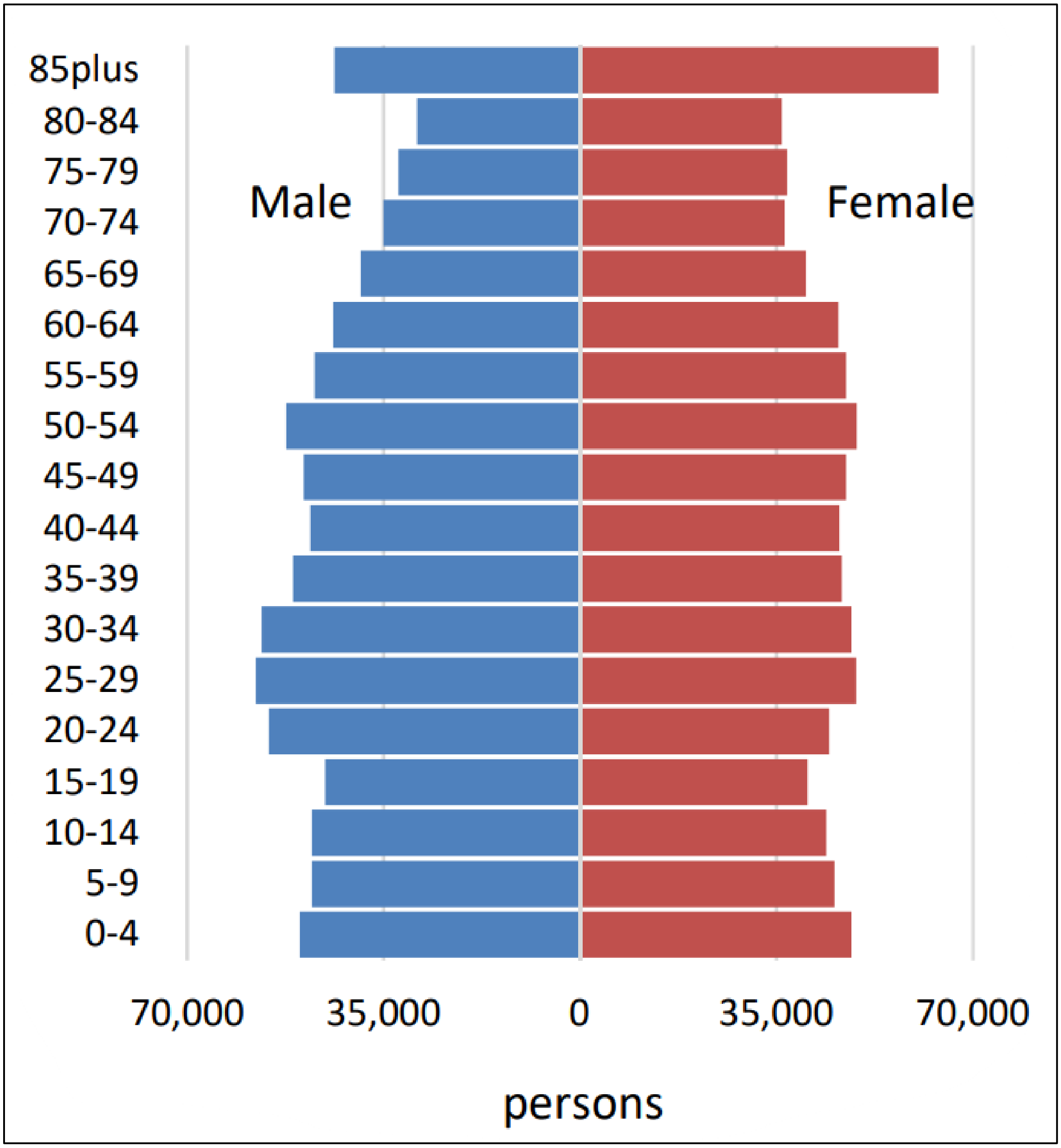


Source: (FEMA 2023)

3.5.2 AGE DISTRIBUTION

The residents of the State of Hawai'i have a median age of 39.7 as of 2020, which is slightly older than the national average of 38.6. Women in Hawaiʻi have a median age of 41.1, which is slightly older than the median age of men (38.5). As of 2020, 18.8% of the population is now over the age of 65, and the single largest age group is 30–34 years old (Hawaiʻi DBEDT 2022). By 2045, the share of the population aged 65–74 is projected to decrease to 38.4% of total elderly population, while the population aged 85 years and over is projected to increase its share to 27.4% (Hawaiʻi DBEDT 2018). The age distribution of the projected population for 2045 is shown in Figure 3-5.

Figure 3-5. State of Hawaiʻi 2045 Projected Population Distribution by Age and Gender



Source: (Hawaiʻi DBEDT 2018)

As a group, the elderly are more apt to lack the physical and economic resources necessary for response to hazard events and are more likely to suffer health-related consequences, making recovery slower. Elderly residents living in their own homes may have more difficulty evacuating their homes and could be stranded in dangerous situations. This population group is more likely to need special medical attention, which may not be readily available during natural disasters due to isolation caused by the event.

Children under 14 are also particularly vulnerable to disaster events because of their young age and dependence on others for basic necessities. Very young children may additionally be vulnerable to injury or sickness; this vulnerability can be worsened during a natural disaster because they may not understand the measures that need to be taken to protect themselves from hazards.

3.5.3 RACE, PLACE OF BIRTH, AND LANGUAGE

According to the 2020 U.S. Census, persons of Asian descent make up the largest proportion of the population in the State of Hawaiʻi at 36.9%, followed by White residents (25.3%) and residents of two or more races (24.7%) (Hawaiʻi DBEDT 2022). Table 3-4 shows the racial distribution by county. Native Hawaiians and Pacific Islanders account for 10.5% of the total population (Figure 3-6).

Table 3-4. Racial Distribution of the State of Hawaiʻi Population by County

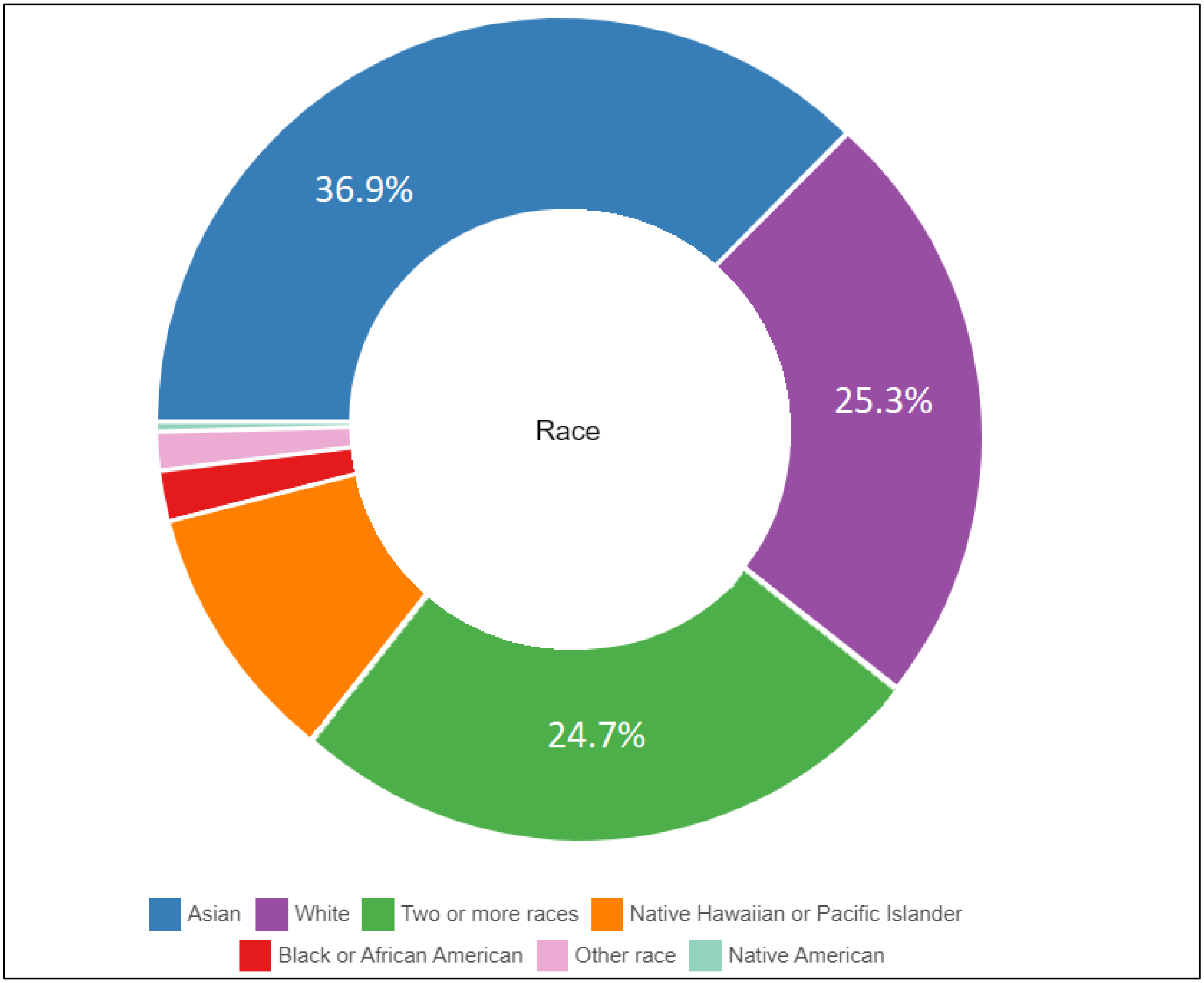
County	White	Black or African American	American Indian and Alaskan Native	Asian	Native Hawaiian and Pacific Islander	Some other race	Two or more races	Total
County of Kauaʻi	23,217	384	220	22,696	6,938	729	19,063	73,247
City and County of Honolulu	201,564	25,178	2,494	429,491	103,982	25,897	237,561	1,026,167
County of Maui	54,194	1,120	569	48,176	18,459	3,421	38,629	164,568
County of Hawaiʻi	65,306	1,458	995	44,271	24,088	4,586	59,754	200,458
Total	**344,281**	**28,140**	**4,278**	**544,634**	**153,467**	**34,633**	**355,007**	**1,464,440**

Source: American Community Survey 2021; American Community Survey 2021; American Community Survey 2021; American Community Survey 2021

According to the 2021 Hawaiʻi State Date Book, approximately 81.7% of the state population was born in the United States, with about 53.3% born in Hawaiʻi. Of the 18.3% of foreign-born residents, approximately 10.7% are U.S. Citizens. More than 44% of residents born outside of the United States were born in the Philippines, followed by Japan at 9.2% and China at 7.3% (Hawaiʻi DBEDT 2022).

Approximately 347,961 of State of Hawaiʻi residents, just under a third of all residents over the age of 5, speak a language other than English at home. Over 40% of these residents (43.8%), approximately 152,407, speak English less than well. Pacific Island languages are the most common language spoken other than English, followed by Tagalog and Japanese (Hawaiʻi DBEDT 2022). Understanding the language that residents speak is important in ensuring that risk and emergency information is effectively communicated to the population. This applies to both residents and visitors, as discussed in Section 3.5.8 below.

Figure 3-6. Racial Distribution in the State of Hawaiʻi



Source: Hawaiʻi DBEDT 2022

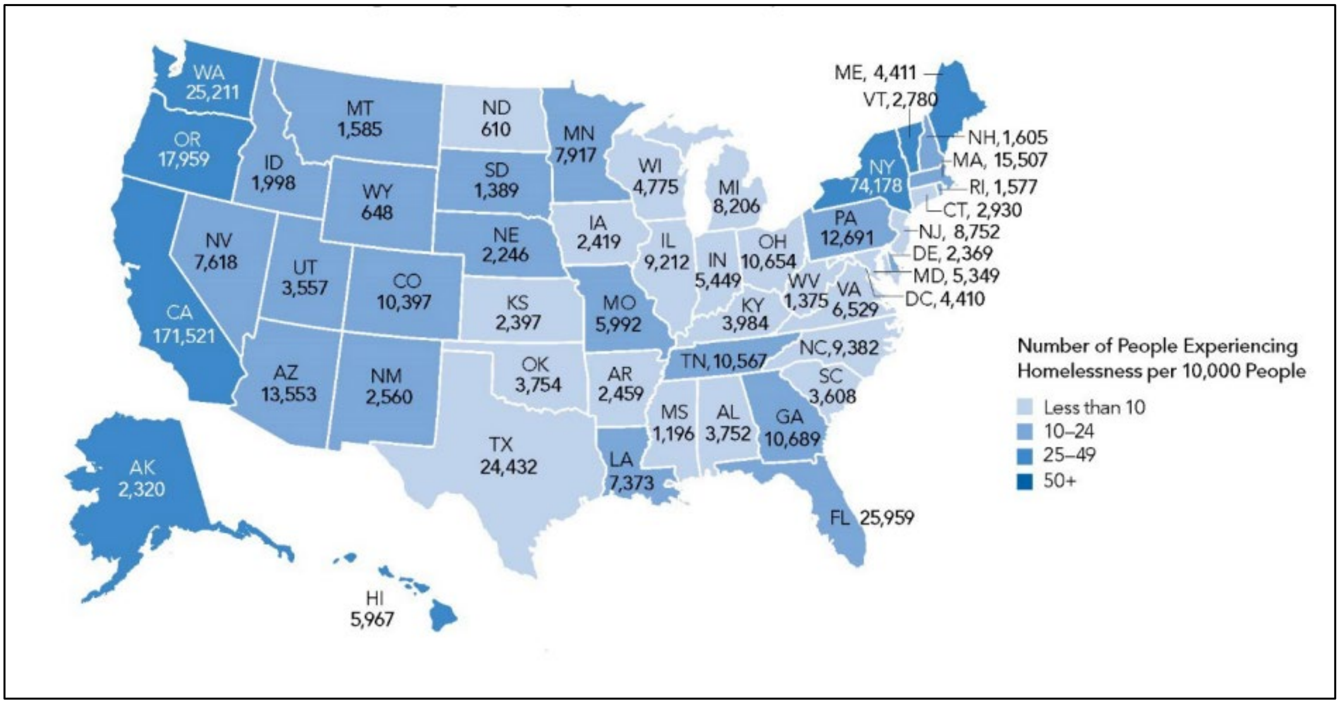
3.5.4 PERSONS WITH DISABILITIES OR WITH ACCESS AND FUNCTIONAL NEEDS

The 2020 U.S. Census estimates that over 42 million non-institutionalized Americans with disabilities or with access and functional needs live in the U.S. This population is more likely to have difficulty responding to a hazard event than the general population. State and local government is the first level of response to assist these individuals, and coordination of efforts to meet their access and functional needs is paramount to life safety efforts. It is important for emergency managers to distinguish between functional and medical needs in order to plan for incidents that require evacuation and sheltering. Knowing the percentage of the population with a disability allows emergency management personnel and first responders to have personnel available who can provide services needed by those with access and functional needs. According to the American Community Survey 2016 estimates, persons with disabilities make up approximately 12% of the total civilian non-institutionalized population of the State of Hawaiʻi (U.S. Census Bureau 2022). The likelihood of having a disability varies by age, with an estimated 3% of the population under 18 years old, to 8.7% of people 18–64 years of age, and 31.5% of those 65 and older.

3.5.5 PERSONS EXPERIENCING HOMELESSNESS

As of 2022, there are estimated to be 5,967 persons experiencing homelessness in the State of Hawaiʻi (see Figure 3-7) (U. S. Department of Housing and Urban Development 2022). This represents a decrease of 21% statewide from the 2017 estimates in the previous plan. The COVID-19 pandemic placed unprecedented levels of strain on the lives of all residents of Hawaiʻi, but those experiencing homelessness were disproportionately affected due to their lack of access to basic needs such as food, water, shelter, and medicine.

Figure 3-7. Persons Experiencing Homelessness, Estimates by State 2022



Source: U. S. Department of Housing and Urban Development 2022

According to the U.S. Department of Health and Human Services, people experiencing homelessness have limited resources and are likely to have previously experienced traumatic events. As a result, such persons may be more at risk to adverse physical and psychological reactions after a disaster event than the general population (U.S. Department of Health and Human Services 2021). In addition, many persons experiencing homelessness are unsheltered and may be particularly vulnerable to some hazard events due to inadequate shelters, exposure to the elements, and residing in high hazard risk areas, such as along creeks and streams. Persons experiencing homelessness may not be adequately alerted via established warning systems to seek adequate shelter.

The following sections provide information on the State of Hawaiʻi economy, including employment and industry income and tourism.

3.5.6 EMPLOYMENT AND INDUSTRY

After a natural hazard event, economic resiliency helps to drive and expedite recovery. It is essential to understand the major employers and economic sectors whose losses or inoperability would impact the community and its ability to recover from a disaster.

According to the 2021 Hawaiʻi State Data Book, there are 671,768 full-time employed civilians in the State of Hawaiʻi and a total of 751,000 full-time and part-time workers. The largest portion of employees (21.6%) are employed in the educational, health, and social services fields. Other notable fields include arts, entertainment, recreation, accommodation and food services (16.2%), retail (11.6%), and professional, scientific, management, administrative and waste management services (10.9%). High proportions of employment in retail, arts, entertainment, recreation, accommodation, and food services reflect the state's strong tourism economy (Hawaiʻi DBEDT 2022). These estimates do not include military populations. The U.S. Department of Defense estimates that there are 41,008 active-duty military in the state as of March 2022 (Hawaiʻi Defense Economy 2022).

The State of Hawaii's future growth will be primarily related to the rate of expansion of the economies of the United States mainland and Asia. These two economies are the sources of the State of Hawaii's tourism demand and the main export markets for the state's goods and services (Observatory of Economic Complexity 2022).

3.5.7 INCOME

In the United States, individual households are expected to use private resources to prepare for, respond to, and recover from disasters to some extent. This means that households living in poverty or experiencing financial difficulties are automatically disadvantaged when confronting hazards. A household that experiences financial difficulties may find it hard or impossible to invest in other areas that can increase safety and resilience. Necessary structural and mechanical improvements, modern technology to access information, vehicles to improve mobility and evacuation procedures, among other investments, may not be possible. Additionally, low-income residents typically occupy more poorly built and inadequately maintained housing. Mobile or modular homes, for example, are more susceptible to damage in earthquakes and floods than other types of housing. Furthermore, residents below the poverty level are less likely to have insurance to compensate for losses incurred from natural disasters. This means that residents below the poverty level or experiencing financial difficulties have a great deal to lose during an event and may be the least prepared to deal with potential losses.

The median household income for the State of Hawaiʻi in 2021 is $83,173, and as of September 2022, the unemployment rate in Hawaiʻi has significantly decreased to 3.4% (Hawaiʻi DBEDT 2022). Approximately 11.2% of residents are considered below the poverty line, 5.2% receive Supplemental Security Income, 3.4% receive cash public assistance, and 12.4% receive food stamps and SNAP benefits (U.S. Census Bureau 2022). Table 3-5 shows the median income and population below the poverty level in each county.

Table 3-5. Income Statistics in the State of Hawaiʻi by County

County	Median Household Income	Population Below Poverty Level in the Past 12 Months	
		Percent	Number
County of Kauaʻi	$86,287	9.1%	6,665
City and County of Honolulu	$92,600	8.6%	87,304
County of Maui [a]	$88,249	9.5%	15,633
County of Hawaiʻi	$68,399	13.8%	27,664
Total	**$83,884**	**10.25%**	**137,266**

Source: *American Community Survey 2021*

Note:

a. *Median household income estimates do not include the County of Kalawao, which is estimated to be $79,583. Population below poverty level does not include the County of Kalawao, which is estimated to be 20.9%.*

3.5.8 TOURISM

In addition to the resident population, the State of Hawaiʻi normally receives high volumes of tourists throughout the year that contribute to the needs for public infrastructure and services. Due to the COVID-19 pandemic, Hawaiʻi experienced some of the highest unemployment rates in the United States after a streak of historically low unemployment rates due to the sharp decrease in tourism. With virtually all flights canceled from March 2020 to mid-October 2020, the State of Hawaiʻi was drastically impacted and did not see relatively normal visitor rates return until June of 2021. The COVID-19 Delta variant would come along soon after, bringing new travel restrictions and further unpredictability in visitor rates. In 2021, Hawaiʻi welcomed nearly 6.8 million visitors, marking a 253% increase in visitor arrivals from 2020. Table 3-6 below shows the average daily visitors by island in 2021 (Hawaiʻi DBEDT 2022). Average daily visitors drastically increased statewide in 2021 compared to 2020, demonstrating up to a +183.1% positive change (Lānaʻi) in daily visitor rates when compared to the previous year.

Table 3-6. Average Daily Visitors by Island

County	Island	2021		
		Total	Domestic	International
Honolulu	Oʻahu	73,693	70,941	2,752
Maui	Maui	54,866	53,209	1,656
	Molokaʻi	500	498	2
	Lānaʻi	644	640	4
Kauaʻi	Kauaʻi	19,194	19,026	168
Hawaiʻi	Hawaiʻi	30,041	29,587	454
Total		**178,938**	**173,901**	**5,037**

Source: Hawaiʻi DBEDT 2022

Visitors to the state are not reflected in official population estimates, such as the U.S. Census' American Community Survey. The Island of Oʻahu has the greatest number of average daily visitors at 73,693; however, visitors contribute to the greatest increase in actual population in the County of Maui with a 36.2% increase. This is followed by the County of Kauaʻi at 34.5%, the County of Hawaiʻi at 16.0%, and the City and County of Honolulu at 10.2% (Hawaiʻi DBEDT 2022).

3.6 STATE ASSETS, COMMUNITY LIFELINES, AND CRITICAL FACILITIES

The following sections provide information on state assets, community lifelines, and critical facilities within the State of Hawaiʻi. The vulnerability of state assets, community lifelines, and critical facilities to the identified hazards of concern are discussed in Section 4 (Risk Assessment).

3.6.1 STATE BUILDINGS

The State of Hawaiʻi owns and/or leases buildings in all of its counties. Statewide, there are 6,095 state-owned or leased buildings with a total estimated replacement value of more than $26.1 billion (see Table 3-7). The majority of these facilities, roughly 67%, are located in the City and County of Honolulu. A breakdown of the number and replacement cost value of state-owned or leased buildings by state agency can be found in Section 4.1 (Risk Assessment Overview). The location of these buildings can be seen in Appendix D (Map Atlas).

Table 3-7. Number and Replacement Cost Value of State Buildings by County

County	Total Number of State Buildings [a]		Total Replacement Cost Value (structure and contents)	
	Number	Percent	Dollar Value	Percent
County of Kauaʻi	531	8.71%	$990,850,824	3.79%
City and County of Honolulu	3,472	56.96%	$17,393,945,915	66.59%
County of Maui	831	13.63%	$3,097,491,689	11.86%
County of Hawaiʻi	1,261	20.69%	$4,638,567,141	17.76%
Total	**6,095**	**100%**	**$26,120,855,568**	**100%**

Source: State of Hawaiʻi Risk Management Office 2017

3.6.2 STATE ROADS

The State of Hawaiʻi Department of Transportation Highways Division is charged with maintaining the state highway system, which amounts to more than 1,100 miles of road statewide. The length and percent of total state roads by county is shown in Table 3-8. Refer to Appendix D (Map Atlas), which includes a map of each island and transportation assets in each county, including the major roads under the state's jurisdiction.

Table 3-8. State Highway System by County

County	Total Length (Miles)	Percent of Total State Mileage
County of Kauaʻi	103.7	9.40%
City and County of Honolulu	374.9	33.97%
County of Maui	245.9	22.28%
County of Hawaiʻi	379.2	34.36%
Total	**1,103.70**	**100.00%**

Source: State of Hawaiʻi Department of Transportation 2022

3.6.3 COMMUNITY LIFELINES AND CRITICAL FACILITIES

In 2017, a collaborative planning effort was conducted with county, state, federal, private sector, and non-governmental organizations to address temporary emergency power planning requirements outlined in the *2015 Hawaiʻi Catastrophic Hurricane Plan*. The results of this effort were memorialized in the *Makani Pahili 2017 Emergency Power Prioritization Workshop Series Report* and included the definition and identification of critical facilities within the state. Critical facilities were defined as "those structures from which essential services and functions for victim survival, continuation of public safety actions, and disaster recovery are performed or provided" and more than 1,500 facilities statewide were identified. The database of identified facilities served as the basis for the community lifeline and critical facility assessment in this 2023 SHMP Update.

Each community lifeline identified in the state was assigned to one of seven community lifeline categories and critical facilities that could not be categorized by lifeline were listed as an additional critical facility category so that discussion and vulnerability could be aggregated. The facility type assigned to each category can be found in Appendix F (State Profile and Risk Assessment Supplement).

Table 3-9 shows the state's community lifelines and critical facilities by category and replacement cost value. Safety and Security accounts for over one-third (35%) of all community lifelines in the state. Table 3-10 shows the state's community lifelines and critical facilities by county. More than half (53%) of the state's community lifelines and critical facilities are located in the City and County of Honolulu. The general location of these facilities can be seen in Appendix D (Map Atlas).

Table 3-9. Community Lifelines and Critical Facilities by Category and Replacement Cost Value

Facility Category	Total Number of Community Lifelines	Total Replacement Cost Value (structure and contents)	Additional Critical Facilities	
			Count	Total Replacement Cost Value
Communications	188	$776,797,683		
Energy	89	$3,093,949,530		
Food, Water, Shelter	345	$11,847,189,588		
Hazardous Material	12	$436,474,800	106	$447,698,794
Health and Medical	193	$4,606,713,364		
Safety and Security	486	$38,164,188,232		
Transportation	56	$2,039,091,600		
Total	**1,369**	**$60,964,404,797**	**1,475**	**$61,412,103,591**

Source: HI-EMA 2017

Table 3-10. Community Lifelines and Critical Facilities by County

County	Total Number of Facilities [a]		Total Replacement Cost Value (structure and contents) [a]	
	County	Percent	Dollar Value	Percent
County of Kauaʻi	138	9.36%	$3,420,500,143	5.57%
City and County of Honolulu	783	53.08%	$22,973,873,078	37.41%
County of Maui	284	19.25%	$28,244,157,982	45.99%
County of Hawaiʻi	270	18.31%	$6,773,572,388	11.03%
Total	**1,475**	**100.00%**	**$61,412,103,591**	**100.00%**

Source: HI-EMA 2017
Note:
a. There is overlap between the state building and critical facility dataset, including 36 records in the County of Kauaʻi, 206 records in the City and County of Honolulu, 78 records in the County of Maui, and 59 records in the County of Hawaiʻi.

3.6.4 COMMERCIAL HARBORS

The State of Hawaiʻi has nine commercial harbors located on six islands that are vital to the economic well-being of the state. Almost all imported goods arrive in the state via island ports. Table 3-11 lists the commercial harbors by county and the tons of cargo that pass through each harbor where estimates are available. Honolulu Harbor serves as the distribution hub for the state, meaning that inter-island cargo distribution branches out from Honolulu Harbor (Hawaiʻi Department of Transportation n.d.).

Table 3-11. Commercial Harbors in the State of Hawaiʻi, 2021

County	Harbor	Waterborne Commerce (tons) [a]
County of Kauaʻi	Nāwiliwili	723,000
	Port Allen	88,000
City and County of Honolulu	Honolulu	9,596,000
	Barbers Point	3,717,000
County of Maui	Kahului	1,833,000
	Kaunakakai	83,000
	Kaumalapau	73,000
County of Hawaiʻi	Hilo	1,163,000
	Kawaihae	1,068,000

Source: Department of Business, Economic Development & Tourism 2021
Note:
a. Excludes cargo carried by Army and Navy Vessels and cargo in transit.

Harbors are not listed as community lifelines or critical facilities within the definition utilized for this 2023 SHMP Update; however, the facilities that make harbors operational (e.g., pump stations, support facilities, communications sites, etc.) are included in the community lifeline database.

3.7 LAND USE AND DEVELOPMENT

Element S7 and 44 CFR § 201.4(d): The risk assessment shall reflect changes in development, including a summary of recent development and potential or projected development in hazard-prone areas on state and local government risk assessments. Changes in development include changes in land use and the built environment, population demographics, vulnerability of state assets, and development that could impact jurisdictions most threatened by identified hazards.

Land use and development are major risk factors for natural hazards. Major areas of concern are where the built environment intersects hazard areas. Understanding how past, current, and projected development has or is likely to increase or decrease risk in hazard areas is key to understanding the state's overall risk to its hazards of concern. The following sections discuss changes in development over the performance period of the 2018 SHMP, current land use and development trends, and projected changes in development. Additional discussion on land use and development can be found in Section 5 (Capability Assessment) of the 2023 SHMP Update.

3.7.1 CHANGES IN DEVELOPMENT OVER THE PERFORMANCE PERIOD OF THE 2018 SHMP

The State of Hawaiʻi experienced changes in development over the performance period of the 2018 SHMP. Unfortunately, there is no statewide system that tracks where this development has occurred or its location in hazard areas. The current county local hazard mitigation plans were reviewed and do not report that significant changes in development have been occurring at the county level. Because there are no statewide systems for tracking changes in development, permits issued at the local level and changes in land use classification for taxable parcels are used to generally establish and discuss trends.

Number of Building Permits and New Residential Construction

According to the State of Hawaiʻi Data Book, between 2018 and 2021, there were estimated to be 77,996 building permits issued within the State of Hawaiʻi as shown in Table 3-12. Issuance of building permits decreased over the performance period of the 2018 SHMP by 26% (27,890 permits) over the previous 4-year period (2013 to 2016). The overall distribution of these permits by construction type (e.g., residential, commercial, etc.) is unknown. More than three-quarters of all building permits issued were issued by the City and County of Honolulu.

Table 3-12. Building Permits Issued by County, 2018 to 2021

County	Building Permits Issued [a]					
	2018	2019	2020	2021	Total	% of Total
County of Kauaʻi	232	176	161	167	736	0.9%
City and County of Honolulu	13,835	16,405	15,182	14,328	59,750	77.76%
County of Maui	1,232	1,307	1,039	1,351	4,929	6.3%
County of Hawaiʻi	3,514	3,186	3,042	2,839	12,581	16.2%
Total	**18,813**	**21,074**	**19,424**	**18,685**	**77,996**	**100%**

Source: DBEDT 2021
Note:
a. Includes residential, hotel, non-residential, and additions and alterations permits. Other permits, such as for demolitions, not included.

The American Community Survey (2017 to 2021) estimates that there are 556,937 housing units in the State of Hawaiʻi. More than half of these units are believed to have been built before 1980 (American Community Survey 2021). According to the 2021 State of Hawaiʻi Data Book, there were more than 17,000 new residential units constructed between 2018 and 2021. Approximately 52% of the total units were single-family construction. About 57% of units were issued in the City and County of Honolulu. In addition to new construction, there were estimated to be 1,781 housing units demolished between 2018 and 2021, amounting to an average annual demolition rate of 445 units (DBEDT 2021).

The American Community Survey (2017 to 2021) indicates that there are approximately 478,413 occupied housing units and 78,524 vacant housing units in the State of Hawaiʻi, amounting to an average household size of three persons per unit (American Community Survey 2021). The 2040 population projections indicate that the state's population is expected to increase by 255,415 persons over the next 17 years. Assuming the average household size, average demolition rate, and occupancy rate remain constant, approximately 85,138 new housing units would need to be constructed by 2040 in order to accommodate the projected population. This amounts to an approximate annual average construction rate of 5,008 units per year. Table 3-13 lists new private residential construction during the performance period of the 2018 SHMP.

Table 3-13. New Private Residential Construction by County, 2018 to 2021

County	New Private Residential Construction				
	2018	2019	2020	2021	Total
County of Kauaʻi	364	179	169	213	925
City and County of Honolulu	2,589	2,306	1,516	3,825	10,236
County of Maui [a]	840	654	526	940	2,960
County of Hawaiʻi	1,051	757	933	1,006	3,747
Total	**4,844**	**3,896**	**3,144**	**5,984**	**17,868**

Source: DBEDT 2021
Note:
a. Numbers include single-family units, duplex units, and apartment units. The number of duplex and apartment units were not available in 2019 or 2020 for the County of Hawaiʻi. Statistics for 2022 were not available at the time this plan was published.

3.7.2 CURRENT LAND USE AND DEVELOPMENT

The following sections discuss the state land use district classification system, county land use planning, and general building stock in the state. Additional information on land use and development is included in Section 5.

State Land Use Districts

The State Land Use Law (Chapter 205, Hawaiʻi Revised Statutes) is unique in the history of the State of Hawaiʻi land use planning. Originally adopted by the State Legislature in 1961, the Land Use Law establishes an overall framework of land use management within the state. The statewide land use classifications established in the State Land Use Law are administered by the Land Use Commission (LUC), which is composed of nine members appointed by the Governor and confirmed by the State Senate (one member appointed for each of the counties except the County of Kalawao and five members appointed at large). The State Land Use Law classifies the lands within the State of Hawaiʻi into one of four Districts: Urban, Rural, Agricultural, and Conservation (LUC 2018).

The Urban District generally includes lands characterized by “city-like” concentrations of people, structures, and services. This district also includes vacant areas for future development. Jurisdiction of this district lies primarily with the respective counties. Generally, lot sizes and uses permitted in the Urban District area are established by the respective county through ordinances or rules (LUC 2019).

Rural Districts are composed primarily of small farms intermixed with low-density residential lots with a minimum size of one-half acre. Jurisdiction over Rural Districts is shared by the Commission and county governments. Permitted uses include those relating or compatible to agricultural use and low-density residential lots. Variances can be obtained through the special use permitting process (LUC 2019).

The Agricultural District includes lands for the cultivation of crops, aquaculture, raising livestock, wind energy facility, timber cultivation, agricultural-support activities (i.e., mills, employee quarters, etc.), and land with significant potential for agricultural uses. Golf courses and golf-related activities may also be included in this district, provided the land is not in the highest productivity categories (A or B) of the Land Study Bureau’s detailed classification system. Uses permitted in the highest productivity agricultural categories are governed by statute. Uses in the lower-productivity categories—C, D, E, or U—are established by the Commission and include those allowed on A or B lands as well as those stated under Section 205-4.5, Hawai‘i Revised Statutes (LUC 2019).

Conservation Districts are composed primarily of lands in existing forest and water reserve zones and include areas necessary for protecting watersheds and water sources; scenic and historic areas; parks, wilderness, open space, and recreational areas; habitats of endemic plants, fish, and wildlife; and all submerged lands seaward of the shoreline. The Conservation District also includes lands subject to flooding and soil erosion. Conservation Districts are administrated by the State of Hawai‘i Board of Land and Natural Resources, and uses are governed by rules promulgated by the State of Hawai‘i Department of Land and Natural Resources (DLNR) Office of Conservation and Coastal Lands (OCCL) and Land Division (LUC 2019).

As of 2022, the Conservation and Agricultural District classifications account for the vast majority of land area in the County of Hawai‘i, 52% and 45%, respectively. In all four counties, conservation and agricultural land districts are predominant, with rural land use districts representing the smallest land area. Statewide, urban land use districts account for only 5% of the total land area; however, more than half the total acreage in the Urban District is in the City and County of Honolulu. Figure 3-8 through Figure 3-11 show the land use district classifications for each county. Table 3-14 summarizes the area of current land uses by county.

Section 4 (Risk Assessment) includes an assessment of each state land use district’s exposure to each hazard of concern with a defined spatial extent and location.

Figure 3-8. State Land Use District Classifications and Hawaiian Home Lands in the County of Kaua'i

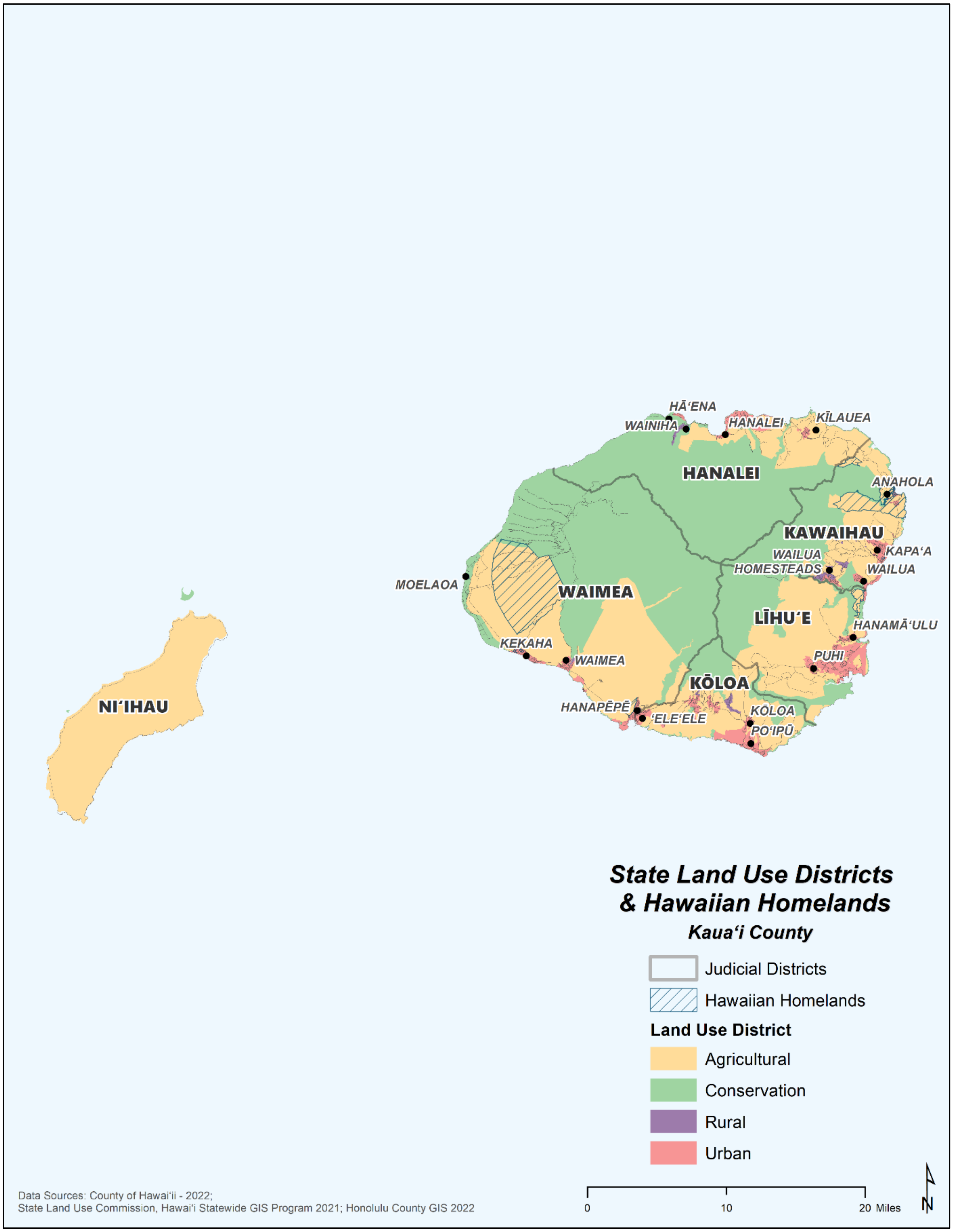


Figure 3-9. State Land Use District Classifications and Hawaiian Home Lands in the City and County of Honolulu

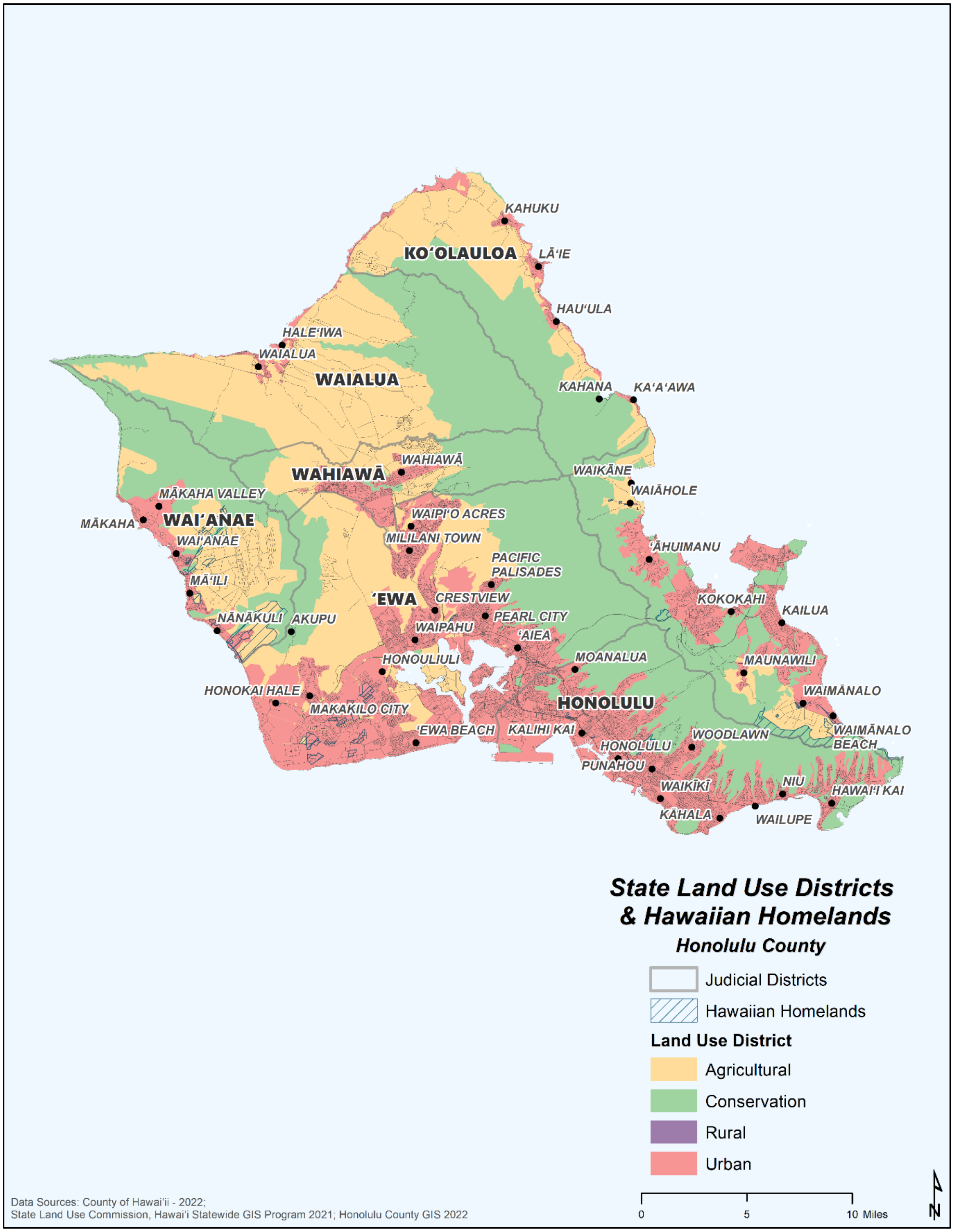


Figure 3-10. State Land Use District Classifications and Hawaiian Home Lands in the County of Maui

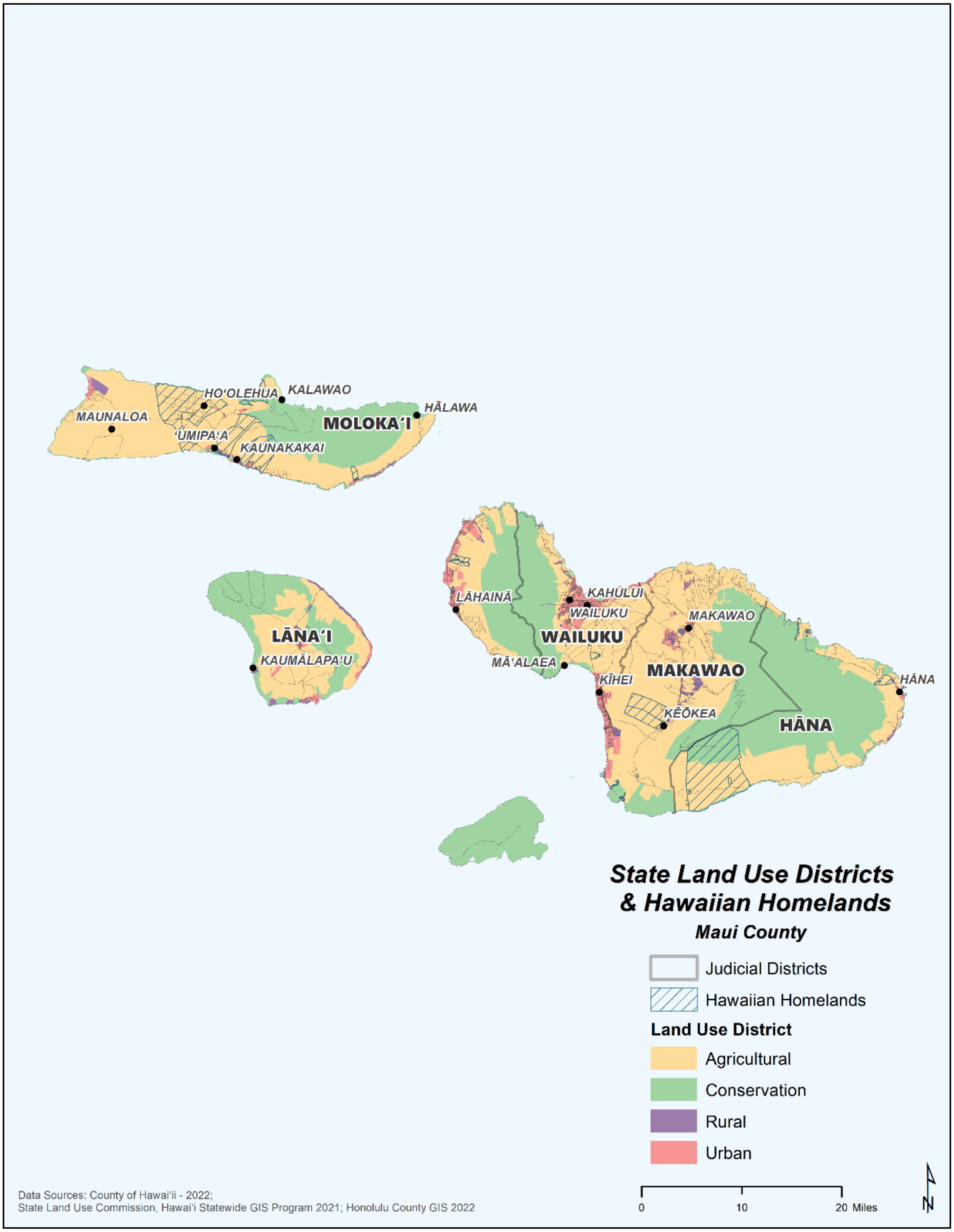


Figure 3-11. State Land Use District Classifications and Hawaiian Home Lands in the County of Hawaiʻi

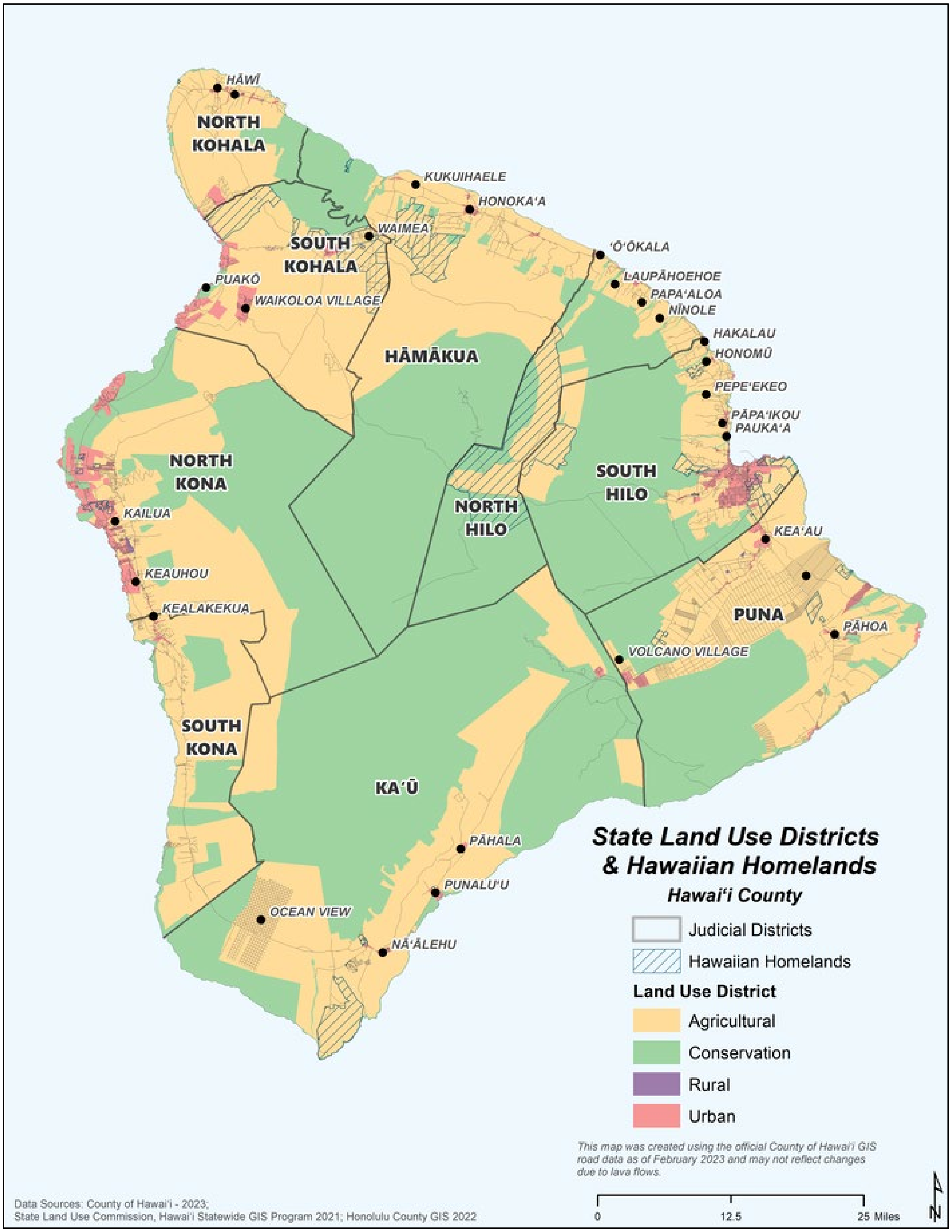


Table 3-14. State Land Use District Classification by County

County	Square Miles								
	Total Land Area	Agricultural		Conservation		Rural		Urban	
		Total	% of Total	Total	% of Total	Total	% of Total	Total	% of Total
County of Kaua'i	627.13	297.1	47.4%	304.3	48.5%	2.1	0.3%	23.6	3.8%
City and County of Honolulu	598.54	188.5	31.5%	247.6	41.4%	0.0	0.0%	162.5	27.1%
County of Maui	1248.10	637.7	51.1%	552.4	44.3%	12.8	1.0%	45.2	3.6%
County of Hawai'i	4038.18	1850.3	45.8%	2098.7	52.0%	1.4	0.0%	87.8	2.2%
TOTAL	**6511.95**	**2,973.60**	**45.7%**	**3202.9**	**49.2%**	**16.3**	**0.3%**	**319.1**	**4.9%**

Source: State Land Use Commission, Hawai'i Statewide GIS Program 2021; Honolulu County GIS 2022

County Land Use Planning

The counties in Hawai'i administer and enforce land uses in all state land use districts, aside from the Conservation District. County zoning generally establishes acceptable uses, density, and arrangement of urban, rural, and agricultural district lands but must be consistent with state policy laws and regulations. All counties have general plans and zoning codes (sometimes called land use ordinances). These plans and codes are updated and administered at the county level, and there is no statewide system for assessing whether county-level changes in zoning allow for increased development in hazard risk areas. Additional information on county land use planning tools can be found in Section 5 (Capability Assessment).

General Building Stock

Residential, commercial, industrial, and other structures in the state make up the state's general building stock. Understanding where structures are located, their value, and their potential for damage is a critical component of understanding the state's overall risk to the hazards of concern. Damages to the general building stock can have far-reaching consequences to recovery efforts and can help planners understand where mitigation efforts will be cost-effective and have the greatest potential for reducing risk to lives and property. General building stock and replacement cost value are listed in Table 3-15 for each county. The vulnerability assessment conducted for each hazard of concern in Section 4 includes an assessment of impacts to the state's general building stock.

Table 3-15. General Building Stock in the State of Hawai'i by County

County	Replacement Cost Value (structure and contents) [a]	
	Dollars	Percent of Total
County of Kaua'i	$24,246,497,228	6.51%
City and County of Honolulu	$239,152,051,766	64.19%
County of Maui	$50,796,693,140	13.63%
County of Hawai'i	$58,395,349,136	15.67%
Total	**$372,590,591,270**	**100.00%**

Source: NIYAM IT 2022; U.S. Army Corps of Engineers 2022
Note:
a. Replacement cost value does not include any development that has occurred in the state since 2010.

3.7.3 PROJECTED CHANGES IN DEVELOPMENT

Just as there is no statewide system for tracking where development occurred over the performance period of the 2018 SHMP, there is also no statewide system for tracking where development is likely to occur over the performance period of the 2023 SHMP Update. A review of available data in the state identified three spatial datasets that could be used to generally discuss where development may occur. The following sections provide information on these areas. The hazard exposure for each area is discussed in Section 4 (Risk Assessment).

Community Development Districts

The Hawaiʻi Community Development Authority (HCDA) establishes community plans in Hawaii's Community Development Districts. Districts are designated in order to plan for the future development of underutilized urban areas in the state (HCDA 2019). As of 2023, there are three community development districts in the state: Kakaʻako, Kalaeloa, and Heʻeia. All districts are located in the City and County of Honolulu and are a combined 7.4 square miles. These districts are described in the *Hawaiʻi Community Development Authority 2021 Annual Report* as follows (HCDA 2017); see detailed maps in Appendix D (Map Atlas):

- **Kakaʻako**—The Kakaʻako Community Development District consists of over 600 acres of land. HCDA's goal is to use sound planning to encourage use of Kakaʻako land supporting the legislative intent of a mixed-use district where residential, commercial, industrial, and public uses would complement each other. HCDA has improved infrastructure and public facilities in the district to attract development to increase housing opportunities for all segments of the community.
- **Kalaeloa**—The Kalaeloa Community Development District encompasses approximately 3,700 acres of land within the former Naval Air Station Barbers Point. The legislature designated the district in 2002 to facilitate the redevelopment of the area in accordance with the Barbers Point Naval Air Station reuse plan. The HCDA has been working on various projects to bring infrastructure improvements to the district, including projects to bring firm energy to Kalaeloa. Facilitating the redevelopment of Kalaeloa is a complex undertaking. There are several challenges to development because of the existing infrastructure and lack thereof. For example, there are 20 miles of roadways that do not meet city or state standards, drainage in parts of the district is inadequate and the electrical system is not reliable. The HCDA has partnered with the Hawaiʻi State Energy Office, U.S. Department of Energy, and Sandia National Laboratories to plan, analyze, and design a micro-grid to provide reliable energy throughout the 3,700-acre district and help the State of Hawaiʻi meet its clean energy goals. In 2021, the Authority approved the first Community-Based Renewable Energy project that will allow the Department of Hawaiian Home Lands (DHHL) beneficiaries and other community residents to benefit from solar power savings, although they may not be able to put solar on their own rooftops.
- **Heʻeia**—In 2011, Act 210 was signed into law establishing the Heʻeia Community Development District. The HCDA facilitates culturally appropriate agriculture, education, and natural resource restoration and management in alignment with the Honolulu Board of Water Supply's Koʻolaupoko Watershed Management Plan and the City and County of Honolulu's Koʻolaupoko Sustainable Communities Plan. In January 2010, the HCDA and Kākoʻo ʻŌiwi, a community-based nonprofit corporation entered into a 38-year lease. Kākoʻo ʻŌiwi's primary mission is to restore the Heʻeia wetlands into a working agricultural and cultural district. In November 2021, Kākoʻo ʻŌiwi completed the construction of ʻŌpūnui, a poi mill and

certified kitchen within the Heʻeia CDD. ʻŌpūnui affords Kākoʻo ʻŌiwi the ability to process kalo on-site and further secures its goal of providing farm-to-table produce for the community.

Enterprise Zones

The Enterprise Zones Partnership Program gives state and county benefits to companies in an effort to stimulate business activity, job preservation, and job creation in areas where they are most appropriate or most needed. Each county is able to select up to six zones that, after approval by the Governor, exist for 20 years. As of 2021, there are 20 zones statewide comprising more than 2,800 square miles (DBEDT 2021). Appendix D (Map Atlas) shows the location of the Enterprise Zones in each of the counties. Table 3-16 shows the square miles per county as well as the percent of the county's total land area.

Table 3-16. Area of Enterprise Zones by County

County	Total Land Area (Square Miles)	Enterprise Zones (Square Miles)	Percent of Total County Land Area
County of Kauaʻi	624.3	251.0	40.2%
City and County of Honolulu	598.6	297.3	49.7%
County of Maui	1176.3	1059.8	90.1%
County of Hawaiʻi	4039.6	1274.9	31.6%
Total	**6438.8**	**2883.0**	**44.8%**

Source: Community Economic Development Program, Department of Business, Economic Development, County Planning Departments 2021, U.S. Census Bureau 2021

Maui Development Projects

The County of Maui maintains a database of development projects on the Island of Maui that have come to the attention of the Department of Planning. These projects include three categories as defined below:

- **Committed**—These projects have inclusion in the Maui Island Plan Growth Boundaries and generally have conforming Community Plan and zoning entitlements.
- **Maui Island Plan and Community Plan**—These projects have inclusion in the Maui Island Plan Growth Boundaries and the appropriate urban or rural Community Plan designations but not the conforming zoning entitlements to proceed.
- **Maui Island Plan Only**—These projects do have inclusion in the Maui Island Plan Growth Boundaries but do not have the appropriate Community Plan designation nor zoning to proceed.

These projects are not a complete picture of development projects within the County of Maui and are at varying stages of development. Some of these projects may never be started or realized, or the project specifics may change over time. In total, the parcels on which these projects are located account for more than 27.6 square miles on the Island of Maui. See detailed maps in Appendix D (Map Atlas).

3.8 CULTURAL ASSETS

3.8.1 HAWAIIAN HOME LANDS

Hawaiian Home Lands are intended to provide for the economic self-sufficiency of Native Hawaiians through a homesteading program (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017). Consistent with Native Hawaiian culture, Hawaiian Home Lands include areas from mauka to makai (from the mountain to the sea). These lands are developed and distributed to Native Hawaiian beneficiaries by way of residential, agricultural, and pastoral leases for 99-year terms with lease payments of $1.00 per year. Some parcels are designated for income-producing purposes and are generally leased for industrial, retail, or other uses (DHHL 2020).

Hawaiian Home Lands account for only a small percent of the total land area statewide and in each county. There are approximately 337 square miles in the state, of which 57% (191 square miles) is in the County of Hawaiʻi. There are 103 square miles of Hawaiian Home Lands in the County of Maui, 32 square miles in the County of Kauaʻi, and 11 square miles in the City and County of Honolulu. The location of Hawaiian Home Lands in each county can be seen in Figure 3-8 through Figure 3-11.

3.8.2 OTHER CULTURAL ASSETS

There is a wide array of cultural assets located on the Hawaiian Islands. The State Historic Preservation Division maintains an inventory of more than 38,000 historic sites in the state, including historic and cultural resources. These cultural resources include architecturally significant buildings and sites where significant historic events occurred as well as sites that are culturally significant to Native Hawaiians, such as burial sites and fishponds. The Historic District covers 87% of the total cultural resource type land area and is the primary cultural resource district for each of the five Hawaiian Counties (see Table 3-17).

Table 3-17. Cultural Resources by Source Type in Square Miles by County

Cultural Resource Site Type	Area in square miles				
	County of Kauaʻi	City and County of Honolulu	County of Maui	County of Hawaiʻi	Statewide
Archaeology	17.5	17.3	24.9	31.1	90.9
Burial Sensitivity Area	1.1	0.1	0.5	0.3	2.1
Historic Building	0.4	1.2	0.5	0.6	2.7
Historic District	68.2	55.7	190.9	534.6	849.4
Historic Object	0.0	0.0	0.0	9.6	9.6
Historic Structure	1.0	0.9	1.4	17.5	20.7
Total	**88.3**	**75.2**	**218.1**	**593.7**	**975.4**

3.9 NATURAL RESOURCES

The following sections discuss the extent and location of select natural resources in the State of Hawaiʻi, including environmental resources and watershed partnerships. Areas where these resources, as well as those in conservation district lands discussed in Section 3.7.2, intersect with hazard risk areas as well as potential impacts are discussed in each of the vulnerability assessments presented in Section 4 (Risk Assessment).

3.9.1 ENVIRONMENTAL RESOURCES

The State of Hawaiʻi contains an array of onshore and offshore environmental resources, including many species that are native only to the Hawaiian Islands. Such resources are considered in hazard mitigation planning because they are impacted by natural hazard events and can influence the way that hazards impact the built environment. The following environmental resources are discussed for each hazard of concern in this 2023 SHMP Update:

- **Critical Habitat**—Critical habitat is the term used in the Endangered Species Act to define those areas of habitat that are known to be essential for an endangered or threatened species to recover and that require special management or protection. According to the U.S. Fish & Wildlife Service, there are 79 animal species and 424 plant species believed or known to occur within the state that are listed as endangered or threatened (U.S. Fish & Wildlife Service 2018). As of 2022, there is critical habitat in each of the state's counties, with critical habitats totaling more than 950 square miles. Critical habitat is not designated for every listed species.
- **Wetlands**—Wetlands provide a multitude of benefits, including habitat for fish and wildlife, groundwater recharge, flood reduction, water quality, food, and recreational opportunities. There are more than 3,600 square miles of wetlands in the state.
- **Parks and Reserves**—A large number of beloved parks and reserves in the Hawaiian Islands provide recreational opportunities, offer economic benefits, and provide for the protection of natural and cultural resources. Statewide, there are more than 2,700 square miles of land designated as a park, preserve, or reserve in the state; the County of Hawaiʻi contains over 2,000 square miles of parks and reserves.
- **Reefs**—The marine waters of the State of Hawaiʻi include coral and artificial reefs, which provide habitat to a diverse array of species, provide economic opportunities for fishers and tourism activities, and buffer adjacent shorelines from wave action preventing erosion. Statewide there are approximately 55 square miles of reefs in the state's offshore environment. The County of Maui has the largest share of the state's reef system with almost half of the total acreage of reefs located in the county's offshore environment.

Table 3-18 shows the total area of natural resources assessed in this plan by county. Locations of these environmental resources by county are available in Appendix D (Map Atlas).

Table 3-18. Square Miles of Environmental Resource Areas in the State of Hawaiʻi by County

Environmental Resource Area	Area in square miles				
	County of Kauaʻi	City and County of Honolulu	County of Maui	County of Hawaiʻi	Statewide
Critical Habitat [a]	89.9	120.9	293.1	446.6	950.6
Wetlands	599.9	505.8	1382.3	1148.8	3636.7
Parks and Reserves	225.6	120.5	408.6	2023.0	2777.7
Reefs [b]	4.5	15.7	26.0	8.6	54.8
Total [c]	**919.9**	**762.9**	**2110.0**	**3627.0**	**7419.8**

Source: U.S. Fish and Wildlife Service, Pacific Islands Office, 2022; U.S. Fish and Wildlife Service 2021; 2017; Hawaiʻi State Department of Land and Natural Resources, Division of Forestry and Wildlife 2022; NOAA raster nautical charts 2020; State of Hawaiʻi Department of Land and Natural Resources, Division of State Parks 2021

Notes:

a. Critical area mileage includes the combined area of coverage of individual critical habitat areas.

b. Reefs include artificial and coral reefs.

c. Total square miles may be over-reported as some environmental asset areas may overlap.

3.9.2 WATERSHED PARTNERSHIPS

According to the Hawaiʻi Association of Watershed Partnerships (HAWP), a watershed is an area of land, such as a mountain or valley, which collects rainwater into a common outlet. In the State of Hawaiʻi, the common outlet is ultimately the ocean. Some of the rain is absorbed by plants, some of it is absorbed underground, and the rest flows into surface rivers and streams. A critical component of a watershed's ability to collect rainwater is the existence of forests. Fog condensing on trees high up in watershed areas can increase rainfall collection and absorption by as much as 30% annually (HAWP 2012).

The Hawaiian equivalent of a watershed is the ahupuaʻa. In Hawaiian cultural tradition, an ahupuaʻa is a land division with the streams and valleys serving as boundaries. The size of the ahupuaʻa varies on different islands from as little as 100 acres to more than 100,000 acres. An ahupuaʻa includes the land from the mountains to the coast and the coastal ocean extending out to and including the coral reef (HAWP 2012).

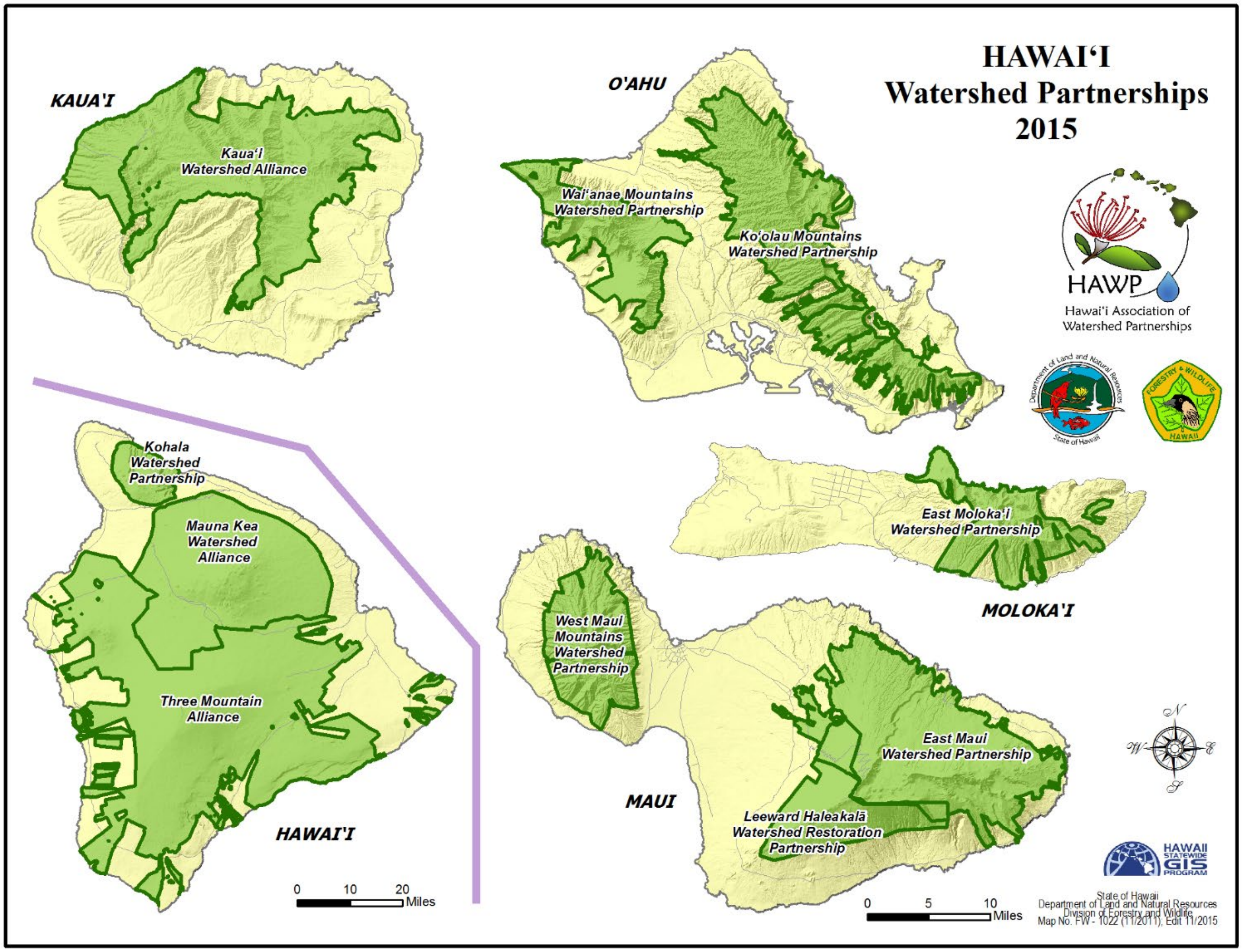
The State of Hawaiʻi has 12 Watershed Partnerships on five of its islands. Hawaii's forested watersheds provide habitat, groundwater recharge, and other ecosystem services upon which the residents of the State of Hawaiʻi rely. Watershed partnership areas are those areas where public and private landowners who are committed to the common value of protecting forested watersheds engage in collaborative management (HAWP 2015). More than 3,177 square miles of the state's land area are located in a watershed partnership. Table 3-19 shows the total area of each watershed partnership, and Figure 3-12 shows their locations.

Table 3-19. Watershed Partnerships in Square Miles by County

County	Watershed Partnership	Area (square miles)
County of Kauaʻi	Kauaʻi Watershed Alliance	225.61
	County Total:	**225.61**
City and County of Honolulu	Koʻolau Mountains Watershed Partnership	160.62
	Waiʻanae Mountains Watershed Partnership	73.59
	County Total:	**234.21**
County of Maui	East Maui Watershed Partnership	173.01
	East Molokaʻi Watershed Partnership	105.27
	Lanai Forest and Watershed Partnership	14.84
	Leeward Haleakalā Watershed Restoration Partnership	53.56
	Overlap East Maui Watershed Partnership and Leeward Haleakalā Watershed Restoration Partnership	13.72
	West Maui Mountains Watershed Partnership	73.94
	County Total:	**434.34**
County of Hawaiʻi	Kohala Watershed Partnership	115.81
	Mauna Kea Watershed Alliance	400.39
	Three Mountain Alliance	1,767.20
	County Total:	**2,283.4**
	State of Hawaiʻi Total:	**3,177.56**

Source: Native Ecosystem Protection & Management Program, Division of Forestry and Wildlife, Department of Land and Natural Resources 2020

Figure 3-12. Watershed Partnership Areas in the State of Hawai'i



Source: HAWP 2015

Section 4.1 Overview

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TABLES

FIGURES

[1] *Section Cover Photo: Cloud lei around Mauna Kea, Hawaiʻi Island. Photo by Megan Brotherton*

SECTION 4. RISK ASSESSMENT

4.1 OVERVIEW

2023 SHMP Update Changes

- For the 2023 SHMP Update, all information on the risk assessment can be found in Section 4 as well as in the referenced supporting appendices. The hazards of concern have been reorganized and new hazards added to align with HI-EMA's February 2022 Hazards and Vulnerabilities Overview and THIRA. The Flood section combines chronic coastal flooding and event-based flooding. Dam failure is the primary hazard in the Infrastructure Failure section. The new hazards for 2023 are cyber threat and terrorism.
- An enhancement to the 2023 SHMP Update risk assessment is the analysis of community lifelines defined by FEMA along with additional critical facilities.
- Assessments performed for the County of Maui also include the County of Kalawao.
- The total areas for each county was calculated using 2020 Census County Boundary downloaded from State of Hawaiʻi GIS Program Geospatial Data Portal.
- The enhanced risk assessment not only evaluates the population as a whole but also analyzes the location of socially vulnerable populations in relation to mapped hazards.
- In addition to assessing Hawaiian Home Lands, the 2023 SHMP adds six types of cultural resources (archaeology, burial sensitivity area, historic building, historic district, historic object, and historic structure) to the vulnerability assessment.
- The environmental resources evaluated were expanded. Reefs (both artificial and coral) are analyzed in their own category for all the natural hazards.
- Mitigation success stories were added to various sections in the risk assessment to demonstrate the progress on implementing effective mitigation strategies.

44 CFR §201.4(c)(2): States are required to undertake a risk assessment that provides "…the factual basis for activities proposed in the strategy portion of the mitigation plan. Statewide risk assessments must characterize and analyze natural hazards and risks to provide a statewide overview."

The risk assessment is a process by which the state determines which hazards are of concern and addresses the potential impacts of those hazards statewide. The risk assessment helps communicate vulnerabilities, develop priorities, and inform decision-making for the hazard mitigation plan and other emergency management efforts.

Risk Defined

For the purposes of the 2023 HMP Update, risk is the potential for damage or loss created by the interaction of hazards with assets such as people, buildings, infrastructure, and/or natural and cultural resources.

The risk assessment for the State of Hawai'i 2023 SHMP Update provides the factual basis for developing a statewide mitigation strategy. It makes the connection between vulnerability and the proposed hazard mitigation actions.

The HI-EMA envisions the 2023 SHMP Update to serve as a technical reference for local HMP updates. With that in mind, the 2023 SHMP Update included a comprehensive update to the 2018 SHMP risk assessment. The enhanced risk assessment not only evaluates state assets but also evaluates each county's vulnerability to the identified hazards so that results may be integrated into upcoming local HMP updates. This will reduce the work required to update the local HMP risk assessments so that an enhanced focus may be placed on strengthening other areas of the local plans. In addition, HI-EMA envisioned that the risk assessment be more easily understood by a person without a technical background, while paralleling the structure of the requirements outlined in 44CFR 201.4 and FEMA's State Mitigation Planning Policy Guide (April 2022) and State Mitigation Planning Key Topics Bulletins: Risk Assessment (June 2016). Mitigation capabilities and mitigation strategy elements are found in Section 5 (Capability Assessment) and Section 6 (Mitigation Strategy).

To maintain consistency with the 2018 SHMP, the 2023 SHMP Update divides the risk assessment for each hazard into two parts: (1) hazard profile and (2) vulnerability assessment. The following is the consistent outline for each hazard's risk assessment section (Sections 4.2 through 4.16):

- Hazard Profile
  - Identify and describe hazards
  - Location of the hazards and areas vulnerable to damage
  - Extent (i.e., strength or magnitude) of hazard
  - Previous occurrences of hazard
  - Probability of future hazard events, including climate change impacts
- Vulnerability Assessment
  - Assessment of state vulnerability and potential losses, including community lifelines
  - Assessment of local vulnerability and potential losses, including socially vulnerable populations
  - Future changes that may impact vulnerability

The 2023 SHMP Update risk assessment characterizes the impacts of hazards on both state assets and counties, allowing the state to compare potential loss and determine priorities for mitigation measures. To summarize vulnerability, the state ranked the identified hazards based on factors related to the risks faced. These risk factors include the probability of occurrence, impacts, spatial extent, warning time, and duration as per the FEMA State Planning Key Topics Bulletin: Risk Assessment (June 2016). The state also integrated adaptive capacity and changing future conditions into the hazard ranking to ensure these important factors are considered. Refer to Section 4.17 (Vulnerability Summary) for further details on the ranking methodology and results.

The results presented throughout the risk assessment are summarized geographically, from west to east, by county. County tabular results and maps presented throughout Sections 4.2 through 4.17 are in the following order: County of Kauaʻi, City and County of Honolulu, County of Maui, and County of Hawaiʻi. Where results were given by island in other plans and studies integrated into the 2023 SHMP Update, the cumulative results are presented by county.

4.1.1 IDENTIFICATION OF HAZARDS

Element S3, FMAG1, and 44 CFR §201.4I(2)(i): The risk assessment shall include an overview of the type and location of all natural hazards that can affect the state, including a current overview of all natural hazards that can affect the state, location of hazards, and previous occurrences of hazards.

The HI-EMA considered a full range of hazards that could affect the state for the 2023 SHMP Update. The process included a review of the February 2022 Hazards and Vulnerabilities Overview. To maintain consistency across state planning documents, this 2023 SHMP Update aligns hazard categories with the Hazards and Vulnerabilities Overview. Extensive outreach was conducted to subject matter experts to ensure the appropriate elements of each hazard were included and best-available data was used for the risk assessment, described further below. The Forum was briefed on the updated list of hazards of concern for additional input.

Disaster History

The State of Hawaii's disaster history, in combination with an understanding of the location and type of state built and natural assets, provides direction on the identification of hazards and their significance to the state. Of the 61 federal disasters declared in the State of Hawaiʻi from 1955 to December 2022, Hawaiʻi received 36 major disaster declarations (DR); 5 emergency declarations (EM); and 20 fire management assistance declarations (FM). Table 4.1-1 outlines each federal declaration that the State of Hawaiʻi has received since 1955. Declarations prior to 1964 do not contain county data as it is not available (FEMA 2022). Additional details regarding declarations during the performance period of the plan are discussed further in Sections 4.2 through 4.16.

Table 4.1-1. Federal Major Disaster, Emergency, and Fire Declarations

Date Declared	Incident Type	Disaster Number	Counties Affected
April 1, 1955	Volcano	DR-32	Not Reported
March 16, 1957	Tidal Wave	DR-71	Not Reported
August 16, 1959	Hurricane Dot	DR-94	Not Reported
January 21, 1960	Earthquakes & Volcanic Disruptions	DR-96	Not Reported
May 25, 1960	Tidal Waves	DR-101	Not Reported
April 24, 1963	Heavy Rains & Flooding	DR-152	Not Reported
September 13, 1968	Heavy Rains & Flooding	DR-251	Maui
May 16, 1973	Earthquake	DR-383	Hawaiʻi
May 7, 1974	Heavy Rains & Flooding	DR-433	Honolulu, Kauaʻi

Date Declared	Incident Type	Disaster Number	Counties Affected
December 7, 1975	Earthquake, Seismic Waves & Volcanic Eruption	DR-490	Hawaiʻi
March 7, 1979	Severe Storms & Flooding	DR-573	Hawaiʻi
February 6, 1980	Severe Storms, High Surf & Flooding	DR-613	Maui
April 22, 1982	Heavy Rains & Flooding	DR-656	Maui
November 27, 1982	Typhoon Iwa	DR-671	Honolulu, Kauaʻi
March 3, 1983	Hawaiʻi Kīlauea	FM-2044	Not Reported
January 8, 1988	Severe Storms, Mudslides & Flooding	DR-808	Honolulu
May 18, 1990	Lava Flow, Kīlauea Volcano	DR-864	Hawaiʻi
September 12, 1992	Hurricane Iniki	DR-961	Hawaiʻi, Honolulu, Kalawao, Kauaʻi, Maui, and Niihau (Census County Division)
November 18, 1996	Severe Storms and Flooding	EM-3122	Honolulu
November 26, 1996	Prolonged and Heavy Rains, High Surf, Flooding, Land/Mud Slide	DR-1147	Honolulu
February 18, 1998	Hawaiʻi Wildfire	FM-2195	Not Reported*
March 15, 1998	Puna District Wildfire	FM-2196	Not Reported*
August 24, 1998	Molokai Fire 98	FM-2236	Not Reported*
March 20, 2000	Puuaakapu Ranch Lot Fire	FM-2293	Hawaiʻi
November 9, 2000	Severe Storms and Flooding	DR-1348	Hawaiʻi, Maui
May 18, 2003	Hi - Waikoloa Village– Fire - 05/18/2003	FM-2468	Hawaiʻi
September 14, 2004	Kawaihae Road Fire Hawaiʻi	FM-2556	Hawaiʻi
February 1, 2005	Severe Storms and Flash Flooding	DR-1575	Honolulu
August 2, 2005	Lalamilo Fire	FM-2573	Hawaiʻi
August 4, 2005	Akoni Pule Highway Fire	FM-2574	Hawaiʻi
August 15, 2005	Nanakuli Brush Fire	FM-2576	Honolulu
August 19, 2005	Waikele Fire	FM-2577	Honolulu
May 2, 2006	Severe Storms, Flooding, Landslides, and Mudslides	DR-1640	Honolulu, Kauaʻi
September 2, 2006	Ma'alaea Fire	FM-2673	Maui
October 17, 2006	Earthquake	DR-1664	Hawaiʻi, Honolulu, Kauaʻi, and Maui
June 28, 2007	Olowalu Fire	FM-2701	Maui
August 14, 2007	Waialua Fire	FM-2720	Honolulu
August 17, 2007	Kohala Mountain Road Fire	FM-2722	Hawaiʻi
October 28, 2007	Puako Fire	FM-2740	Hawaiʻi
February 6, 2008	Severe Storms, High Surf, Flooding, and Mudslides	DR-1743	Hawaiʻi, Kauaʻi, and Maui
January 5, 2009	Severe Storms and Flooding	DR-1814	Honolulu and Kauaʻi
August 31, 2009	Kaunakakai Fire	FM-2834	Maui
June 9, 2010	Maalaea Fire	FM-2844	Maui
April 8, 2011	Tsunami Waves	DR-1967	Hawaiʻi, Honolulu, and Maui
April 18, 2012	Severe Storms, Flooding, and Landslides	DR-4062	Kauaʻi and Maui
September 12, 2014	Tropical Storm Iselle	DR-4194	Hawaiʻi and Maui
November 3, 2014	Puʻu ʻŌʻō Volcanic Eruption and Lava Flow	DR-4201	Hawaiʻi
October 6, 2016	Severe Storms, Flooding, Landslides, and Mudslides	DR-4282	Maui
May 8, 2018	Severe Storms, Flooding, Landslides and Mudslides	DR-4365	Honolulu and Kauaʻi
May 11, 2018	Volcanic Eruption and Earthquakes	DR-4366	Hawaiʻi
August 22, 2018	Hurricane Lane	EM-3399	Hawaiʻi, Honolulu, Kauaʻi, and Maui

Date Declared	Incident Type	Disaster Number	Counties Affected
September 12, 2018	Tropical Storm Olivia	EM-3404	Hawai'i, Honolulu, Kaua'i, and Maui
September 27, 2018	Hurricane Lane	DR-4395	Hawai'i, Kaua'i, and Maui
October 23, 2019	Kahana Ridge Fire	FM-5294	Maui
March 13, 2020	COVID-19	EM-3431	Hawai'i, Honolulu, Kaua'i, and Maui
April 1, 2020	COVID-19	DI-4510	Hawai'i, Honolulu, Kaua'i, and Maui
July 9, 2020	Severe Storms and Flooding	DR-4549	Kaua'i
July 25, 2020	Hurricane Douglas	EM-3529	Hawai'i, Honolulu, Kaua'i, and Maui
May 13, 2021	Severe Storms, Flooding, and Landslides	DR-4604	Maui
February 15, 2022	Severe Storms, Flooding, and Landslides	DR-4639	Honolulu and Maui
August 1, 2021	Mana Road Fire	FM-5404	Hawai'i

Source: FEMA 2023
** For this event, as per the FEMA website, no additional information was filed for this event*

Local HMP Risk Assessment Roll-Up

Element S6, HHPD2, and 44 CFR § 201.4(I2)(ii) and 201.4(c)(2)(iii): The risk assessment shall include an overview and analysis of jurisdictions' vulnerability to the identified hazards and the potential losses, including jurisdictions most threatened by the identified hazards and most vulnerable to damage and loss from hazard events with respect to populations, structures, infrastructure, and community lifelines. Additionally, potential losses to the identified vulnerable structures based on estimates in the local risk assessments as well as the state risk assessment should be included.

All local HMP risk assessments were reviewed, not only to consider data sources for the 2023 SHMP Update but to summarize losses across the state for each hazard. The local plan roll-up, however, proved challenging because all four local HMPs and specifically their risk assessments differ in structure, data used, and analysis methods. Therefore, the 2023 SHMP Update risk assessment not only included an evaluation of state asset vulnerability but also assessed the vulnerability to the population and built environment (buildings and land use), environmental resources, and cultural assets summarized by county. These results provide a technical resource for the next round of local HMP updates and will lend to a smoother local plan roll-up for the State of Hawai'i 2028 SHMP update. The evaluation of the local risk assessment data is included in each hazard profile.

The hazards identified in each local HMP were reviewed to determine the presence of each hazard on a county-by-county basis and to ensure that the 2023 SHMP Update incorporates information from local risk assessments. Table 4.1-2 lists the hazards identified during each county's local mitigation planning efforts, alongside the state's 2018 and 2023 SHMP Update hazards of concern.

Table 4.1-2. Summary of Hazards of Concern Captured in State and Local Hazard Mitigation Plans

Hazard	2023 SHMP	2018 SHMP	Local HMPs			
			County of Kaua'i (2021)	City and County of Honolulu (2020)	County of Maui (2020)	County of Hawai'i (2020)
Climate Change and Sea Level Rise	◆	◆	◆	◆	*	◆

Hazard	2023 SHMP	2018 SHMP	Local HMPs			
			County of Kauaʻi (2021)	City and County of Honolulu (2020)	County of Maui (2020)	County of Hawaiʻi (2020)
Chronic Coastal Flood	◆ Flood	◆	◆ High Surf, Coastal Flood, Erosion	◆ Coastal Erosion, High Surf	◆ Coastal Erosion, High Surf	◆ High Surf, Storm Surge, Coastal
Cyber Threat	◆					◆ Other Hazards of Interest
Dam Failure	◆ Infrastructure Failure	◆	◆	◆	◆ Dam and Reservoir Failure	◆
Drought	◆	◆	◆ Heat, Drought	◆	◆ Drought, Extreme Heat	◆
Earthquake	◆	◆	◆	◆	◆	◆
Event-Based Flood	◆ Flood	◆	◆ Inland Flooding	◆ Coastal, Inland	◆	◆
Extreme Cold					◆	
Hazardous Materials	◆	◆	**	◆	◆	
Health Risks	◆	◆	**		◆	◆ Other Hazards of Interest
High Wind Storms	◆	◆	◆ Tropical Cyclones, high winds combined	◆	◆	◆
Hurricane	◆	◆	◆ Tropical Cyclones, high winds combined	◆ Tropical Cyclones, Hurricane Storm Surge, Scour	◆ Hurricane, Tropical Storm, Kona Storms	◆ Tropical Cyclone
Infrastructure Failure	◆					
Landslide and Rockfall	◆	◆	◆ Landslide	◆ Landslide, Debris Flows, Rockfall	◆ Landslide, Mudflows, Rockfall, Slurry	◆
Tsunami	◆	◆	◆	◆	◆	◆
Terrorism	◆					◆ Other Hazards of Interest
Volcanic Hazards	◆	◆		◆ Vog	◆ Lava Flow, Debris Flow, Ash, Vog	◆
Wildfire	◆	◆	◆	◆	◆	◆

Sources: County of Kauaʻi, 2021; City and County of Honolulu 2020; County of Maui 2020; County of Hawaiʻi 2020

* *The County of Maui did not include climate change as a stand-alone hazard; however, climate change impacts are discussed throughout the plan.*

** *Hazardous materials and health and medical may have been included as critical facilities in the local HMPs and therefore estimated potential impacts discussed in all hazard sections.*

Table 4.1-3 compares the risk assessment terminology and ranking for each county HMP. The basis of the risk assessment and ranking for counties varied according the factors chosen by each jurisdiction. For example, the local plans assessed "asset" or "property" exposure and vulnerability. While community lifelines may have been part of the asset or property list, they were not specifically indicated as part of the analysis. The County of Maui performed a ranking for socially vulnerable populations for each Community Planning Area which did not factor in with their overall priority risk index to rank the hazards. The City and County of Honolulu and the counties of Kauaʻi and Hawaiʻi did not specifically include socially vulnerable populations in the hazard ranking criteria. The following list summarizes the basis for each county's risk ranking methodology:

Kauaʻi County used a risk ranking methodology based on:

- Probability of occurrence
- Weighted impact to people based on the percentage of the total population exposed to the hazard event
- Weighted impact to property based on the percentage of the total property value exposed to the hazard event (includes tax assessor real property data)
- Weighted impact to the economy based on the percentage of the total property value vulnerable to the hazard event

City and County of Honolulu used a damage assessment ranking by average annual loss (AAL) estimates based on:

- Probability of occurrence
- Magnitude and severity
- Asset exposure and vulnerability
- Consequences

Maui County used a priority risk index (PRI) to rank hazards based on:

- Probability
- Impact
- Spatial Extent
- Warning Time
- Duration

For Maui County, a separate social vulnerability ranking was performed for each Community Planning Area based on:

- Household composition
- Socioeconomic status
- Information Access Vulnerability
- Housing Characteristics
- Access to Lifelines

Hawaiʻi County used a risk ranking methodology based on:

- Probability of occurrence
- Weighted impact to people based on the percentage of the total population exposed to the hazard event
- Weighted impact to property based on the percentage of the total property value exposed to the hazard event (includes tax assessor real property data)
- Weighted impact to the economy based on the percentage of the total property value vulnerable to the hazard event

Table 4.1-3. Risk Assessment and Ranking Used in County HMPs

Hazard	County of Kaua'i Risk Ranking	City and County of Honolulu Damage Assessment Ranking	County of Maui Hazard Ranking	County of Hawai'i Risk Ranking
Climate Change and Sea Level Rise	High	Not ranked	Not included as a stand-alone chapter	Medium
Chronic Coastal Flood	High	$3 Million / Year	High	Medium
Cyber Threat	Not included	Not included	Not included	Not ranked
Dam Failure	Low	Less than $1 Million / Year	Moderate	Low
Drought	Not ranked	Not ranked	Moderate	Low
Earthquake	Low	$21 Million / Year	Moderate	High
Event-Based Flood	High	$41 Million / Year	High	High
Extreme Cold	Not included	Not included	Low	Not included
Hazardous Materials	Included in the critical facilities of each hazard	Less than $0.10 Million / Year	Low	Not included
Health Risks	Included in the critical facilities of each hazard	Not ranked	Moderate	Not ranked
High Wind Storms	High	Not ranked	High	High
Hurricane	High	$410 Million / Year	High	High
Infrastructure Failure	Not included	Not included	Not included	Not included
Landslide and Rockfall	Medium	$1 to $5 Million / Year	High	High
Tsunami	Medium	$81 Million / Year	High	Low
Terrorism	Not Included	Not included	Not included	Not ranked
Volcanic Hazards	Not included	Not ranked	Moderate	High
Wildfire	High	$1 Million / Year	High	High

2023 SHMP Update Hazards of Concern

Based on this review, all hazards of concern in the 2018 SHMP are included in the 2023 SHMP Update. There are no commonly recognized natural hazards that have been omitted from the plan. However, changes have been made to the grouping and/or renaming of existing hazards; further, additional elements to existing hazards were included to capture a more current snapshot of risk. Two additional non-natural hazards were included to align the 2023 SHMP with the state's *2022 Hazards and Vulnerabilities Overview* and the *2022 Threat and Hazard Identification and Risk Assessment* (THIRA). The hazards of concern evaluated for the 2018 SHMP and 2023 SHMP Update are presented in Table 4.1-3 in alphabetical order for this update. The order of the listing does not indicate the hazards' relative severity. Each hazard section contains a subsection that discusses the potential changes in future probability and impacts resulting from climate change and the impacts of the hazard to the socially vulnerable population.

4.1.2 ASSET INVENTORIES

National, state, and county resources were reviewed to identify best-available data to update the risk assessment. To protect individual privacy and the security of critical facilities, information on properties assessed is presented in aggregate, without details about specific individual properties.

STATE ASSETS

Element S5 44 CFR § 201.lc)(2)(ii) and 201.4(c)(2)(iii): The risk assessment shall address the vulnerability of state assets located in hazard areas and estimate the potential dollar losses to these assets, including state-owned and operated critical facilities, buildings, infrastructure, and community lifelines. The assessment should include a summary of the potential impacts to state assets from each of the identified hazards.

FEMA requires the state to identify its assets which may include state-owned or operated buildings, infrastructure and critical facilities. For the 2023 SHMP Update, the State of Hawaiʻi assessed the vulnerability of the following types of state assets: state-owned and leased buildings; state roads; and critical facilities identified by the state and others, which includes local and state-owned critical facilities and infrastructure.

State Buildings

The State Risk Management Office provided a list of 6,634 state buildings to utilize for the risk assessment. The data set did not have attribution to determine the number of owned versus leased buildings; this data will be referred to as state buildings in the 2023 SHMP Update. The list of facilities was geocoded to generate a spatial layer with the attributes needed for the analyses. Not all facilities had sufficient location data for geocoding. Of the total 6,634 facilities, 6,095 had sufficient data to be successfully geocoded and included in the spatial analyses reported in Sections 4.2 through 4.16. The data set included various structural attributes used for the analyses, including 2017 replacement cost values from the State of Hawaiʻi Risk Management Office, the agency that owns or leases the building, use description, year built, number of stories, and square footage. For buildings missing values for these attributes and for additional attributes required for the FEMA Hazus analyses, default values were used.

Table 4.1-4. Hazards Evaluated in 2018 and 2023

2018 SHMP Hazards	2023 SHMP Hazards
Climate Change and Sea Level Rise	Climate Change and Sea Level Rise ▪ Increased Surface Air Temperature ▪ Decline in Overall Precipitation ▪ Increase in Rain Intensity ▪ Sea Level Changes ▪ Increased Sea Surface Temperatures ▪ Ocean Acidification
(not included)	Cyber Threat (new hazard to align with the state's Hazards and Vulnerabilities Overview and THIRA)
Drought	Drought
Earthquake	Earthquake
Chronic Coastal Flood Event-Based Flood	Flood ▪ Event-Based Coastal Flooding ▪ Inland Flooding ▪ Passive Flooding ▪ Annual High Wave Flooding ▪ Coastal Erosion ▪ Tidal Flooding/King Tides (combines chronic coastal and event-based flooding to align with the state's Hazards and Vulnerabilities Overview and THIRA)
Hazardous Materials	Hazardous Materials ▪ Fixed-Site Hazardous Materials ▪ In-Transit Hazardous Materials
Health Risks	Health Risks ▪ COVID-19 ▪ Vector-Borne Disease ▪ Water-Borne Disease ▪ Pandemic Flu ▪ Bioterrorism
Hurricane	Hurricane
Dam Failure	Infrastructure Failure (includes dam failure to align with the state's Hazards and Vulnerabilities Overview and THIRA)
Landslide and Rockfall	Landslide and Rockfall
(not included)	Terrorism (new hazard to align with the state's Hazards and Vulnerabilities Overview and THIRA)
Tsunami	Tsunami
Volcanic Hazards	Volcanic Hazards ▪ Lava Flows ▪ Vog ▪ Bench Collapse ▪ Methane Explosions
Wildfire	Wildfire
High Wind Storm	Windstorm ▪ Trade Winds ▪ Kona Winds

Structures without replacement cost values were updated using RSMeans 2022 data. RSMeans is the industry-standard cost-estimate model for replacement cost. Therefore, replacement costs could vary significantly from actual values; however, this is a suitable methodology for planning. Replacement cost value does not include land value and may underestimate the total loss. Appendix F provides information on Hazus and the default values.

The analysis of state buildings is categorized according to the agency that uses the structure. Total building counts and replacement cost values for each agency are shown in Table 4.1-4. Individual hazard sections show the number and value of the buildings that may be impacted by the hazard.

Table 4.1-5. Summary of State Buildings by Agency

	State Building	
Agency	Count	Total Replacement Cost Value
Dept of Accounting & General Services	66	$953,963,738
Dept of Agriculture	70	$147,607,399
Dept of Attorney General	15	$108,425,480
Dept of Budget & Finance	16	$28,968,679
Dept of Business, Economic Development & Tourism	25	$645,480,379
Dept of Commerce & Consumer Affairs	2	$40,197,360
Dept of Defense	69	$267,352,836
Dept of Education	4,090	$10,598,205,739
Dept of Hawaiian Home Lands	12	$110,427,352
Dept of Health	44	$387,068,440
Dept of Human Resources Development	1	$5,973,872
Dept of Human Services	130	$480,212,294
Dept of Labor & Industrial Relations	22	$90,076,209
Dept of Land & Natural Resources	90	$101,441,821
Dept of Public Safety	154	$440,774,415
Dept of Taxation	1	$7,174,162
Dept of Transportation	68	$2,935,208,214
Hawaiʻi State Ethics Commission	1	$984,533
Hawaiʻi Health Systems Corporation	106	$1,230,852,871
Hawaiʻi Housing Finance & Development Corporation	86	$360,851,671
Hawaiʻi Public Housing Authority	273	$982,981,701
Hawaiʻi State Legislature	2	$48,555,381
Hawaiʻi State Public Library System	53	$525,584,082
Judiciary	41	$534,877,354
Legislative Reference Bureau	1	$2,996,162
Office of Hawaiian Affairs	11	$54,125,645
Office of the Auditor	2	$1,921,180
Office of the Governor	1	$2,996,162
Office of the Lieutenant Governor	2	$4,588,849
Office of the Ombudsman	1	$1,818,060
Research Corporation of the University of Hawaiʻi	3	$4,189,026
University of Hawaiʻi	637	$5,014,974,503
Total	**6,095**	**$26,120,855,568**

Source: State of Hawaiʻi Risk Management Office 2017; RSMeans 2022

State Roads

The State of Hawaiʻi Department of Transportation's state route inventory, downloaded from the State of Hawaiʻi GIS Program Geospatial Data Portal, was used to determine the state road exposure to spatially delineated hazards. The spatial layer displays the state routes for the main Hawaiian Islands as of 2022. Economic impact of hazard events on road infrastructure has not been monetized, although exposure is identified and discussed. Appendix D (Map Atlas) includes maps of each island that depict the major transportation assets, highways, and airports located throughout the state.

Community Lifelines and Critical Facilities

Community lifelines are the most fundamental services of a community. FEMA developed the community lifelines construct to increase effectiveness in disaster operations, and during initial response, priority efforts should focus on stabilizing community lifelines.

Figure 4.1-1. Community Lifeline Categories

Source: (FEMA 2020)

For the risk assessment, HI-EMA provided a list of facilities deemed as critical. This list was compiled for the *Makani Pahili 2017 Emergency Power Prioritization Workshop Series Final Report*. This data set was used as the community lifeline inventory, which includes both local and state-owned buildings, critical facilities, and infrastructure. The facilities were assigned to community lifeline categories, as summarized in Table 4.1-5. The category "Additional Critical Facilities" are facilities that are also deemed critical by participants in the emergency power prioritization workshop series (i.e., community and civic centers, gyms, parks, warehouses, and home improvement stores); however, they did not fit seamlessly into a community lifeline category. Individual hazard sections show the category and number of lifelines and additional critical facilities may be impacted by the hazard.

Table 4.1-6. Summary of Community Lifelines and Critical Facilities by Category

Category	Count	Total Replacement Cost Value
Communications	188	$776,797,683
Energy	89	$3,093,949,530
Food, Water, Shelter	345	$11,847,189,588
Hazardous Material	12	$436,474,800
Health and Medical	193	$4,606,713,364
Safety and Security	486	$38,164,188,232
Transportation	56	$2,039,091,600
Additional Critical Facilities	106	$447,698,794
Total	**1,475**	**$61,412,103,591**

Source: HI-EMA 2017; FEMA 2020; RSMeans 2022

LOCAL ASSETS

Element S6, HHPD2, and 44IR § 201.4(c)(2)(ii) and 201.4(c)(2)(iii): The risk assessment shall include an overview and analysis of jurisdictions' vulnerability to the identified hazards and the potential losses, including jurisdictions most threatened by the identified hazards and most vulnerable to damage and loss from hazard events with respect to populations, structures, infrastructure, and community lifelines. Additionally, potential losses to the identified vulnerable structures based on estimates in the local risk assessments as well as the state risk assessment should be included.

In addition to assessing the vulnerability of state assets, a key component to the risk assessment is to evaluate potential losses to jurisdictions in the state. The State of Hawaiʻi 2023 SHMP Update risk assessment included a vulnerability assessment for the counties utilizing statewide population, building, environmental resource, and cultural asset spatial data sets. Estimated exposure and potential impacts to these assets are reported in each hazard section. In addition, economic impacts are discussed qualitatively for each hazard. Privately-owned agriculture and ranching structures were not included in the risk assessment; however, it should be acknowledged that if such structures are impacted by hazards, community lifelines and supply chains could be disrupted.

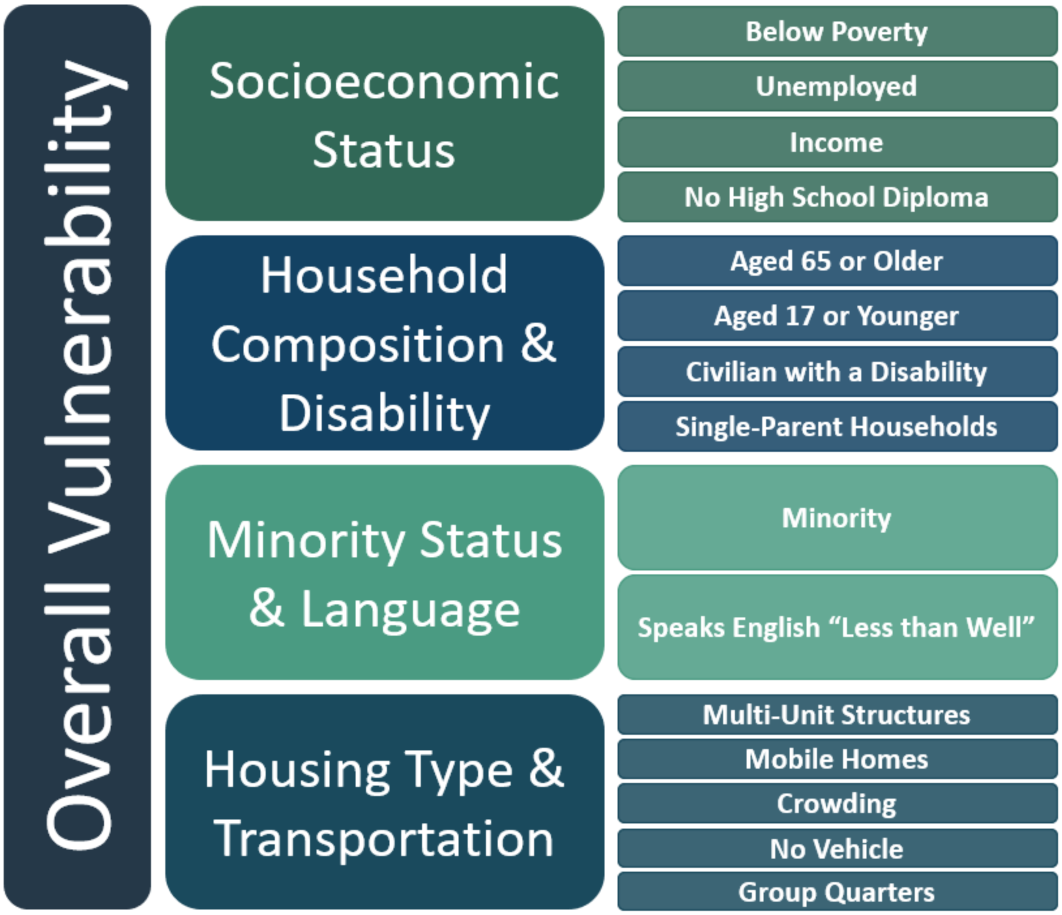
Each county is divided into judicial districts for election, taxation, education, city, county, and all other purposes (State of Hawaiʻi n.d.). Hazard mapping developed for the 2023 SHMP includes the judicial district boundaries to provide a higher resolution of vulnerability and to inform local decision-making.

Socially Vulnerable and Total Populations

Research has shown that some populations are at greater risk from hazard events because of decreased resources or physical abilities. Risk to the entire residential population is analyzed for each of the hazards. For the SHMP Update, the Social Vulnerability Focus Group identified the 2018 statewide Social Vulnerability Index (SVI) published by the Centers for Disease Control and Prevention (CDC) to be used to estimate risk to socially vulnerable populations. The SVI is a combination of 15 social factors that contribute to social vulnerability as shown in Figure 4.1-2. Index values are based on a percentile ranging from 0 to 1, with higher values indicating greater vulnerability. For this analysis, Census tracts with an overall SVI ranking of 0.8 or greater were categorized as highly vulnerable tracts with socially vulnerable populations. This aligns with FEMA's current annual Hazard Mitigation Assistance (HMA) evaluation scoring for high social vulnerability.

The SVI data is available by Census tract level and was clipped to areas of residential parcels only. Total population was adjusted for each census tract using the countywide percentage change calculated between the 2018 5-year American Community Survey (ACS) population shown in the SVI data and the 2020 5-year ACS countywide population totals compiled from the Census Bureau. Hazard risk to the population was estimated by overlaying the hazard areas to the processed census tracts. The percentage area of the tracts within each hazard boundary was used to estimate the number of persons at risk to each hazard. The socially vulnerable population makes up more than 20% of the state's total residents, which excludes visitors and tourists. Refer to Table 4.1-6 for a summary of these statistics. Figure 4.1-3 through Figure 4.1-6 depict low, medium, and high social vulnerability areas in each county.

Figure 4.1-2 CDC Social Vulnerability Indicators



Source: (U.S. Department of Health & Human Services 2022)

Table 4.1-7. Population Statistics by County

County	Total Population	Socially Vulnerable Population	Percent of Total Population
County of Kauaʻi	71,949	11,149	15.5%
City and County of Honolulu	979,682	224,567	22.9%
County of Maui	167,093	35,284	21.1%
County of Hawaiʻi	201,350	45,257	22.5%
Total	**1,420,074**	**316,257**	**22.3%**

Source: CDC 2018; ACS 5-year 2020 Population Estimates

Figure 4.1-3. County of Kaua'i Social Vulnerability Ranking

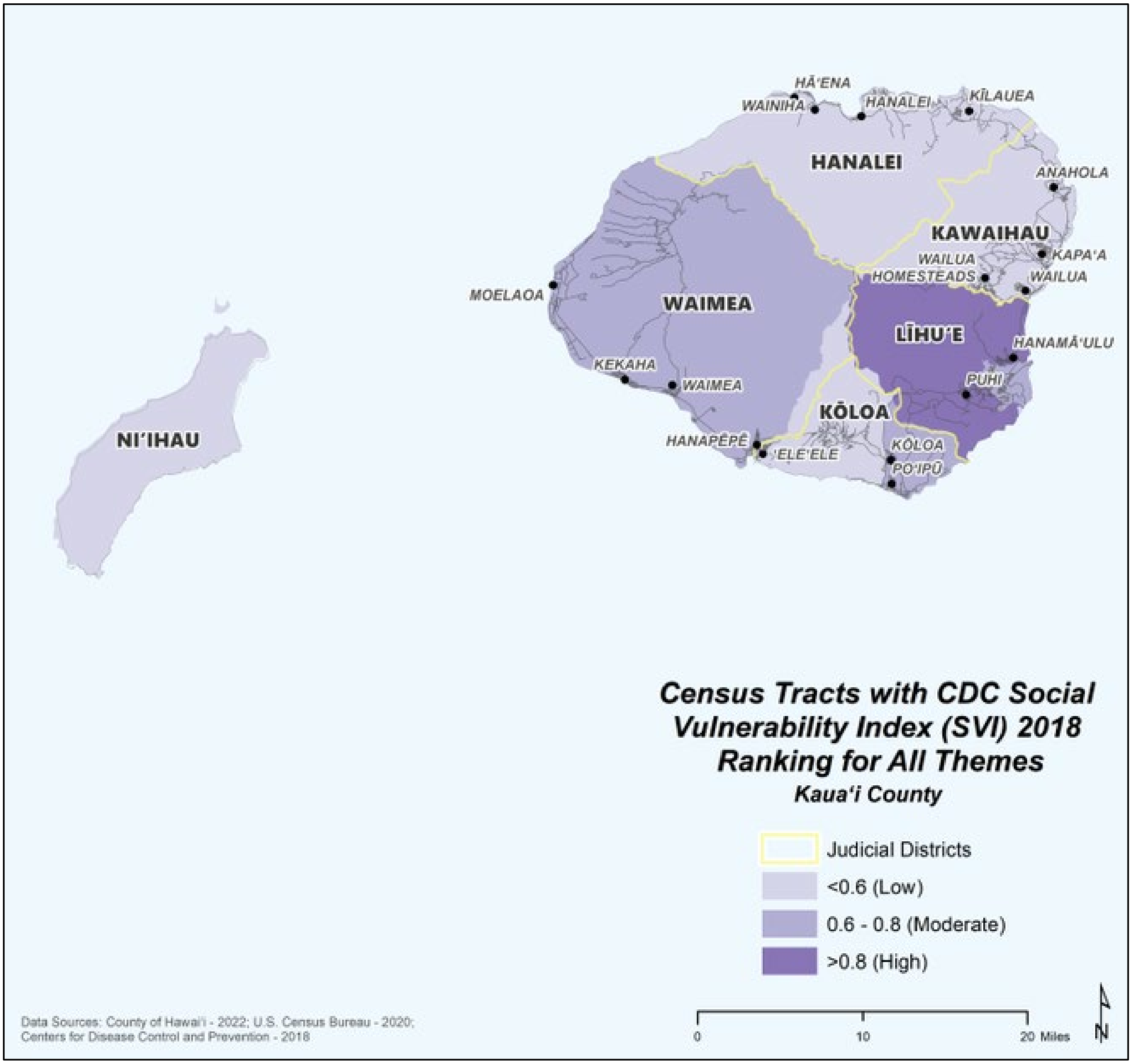


Figure 4.1-4. City and County of Honolulu Social Vulnerability Ranking

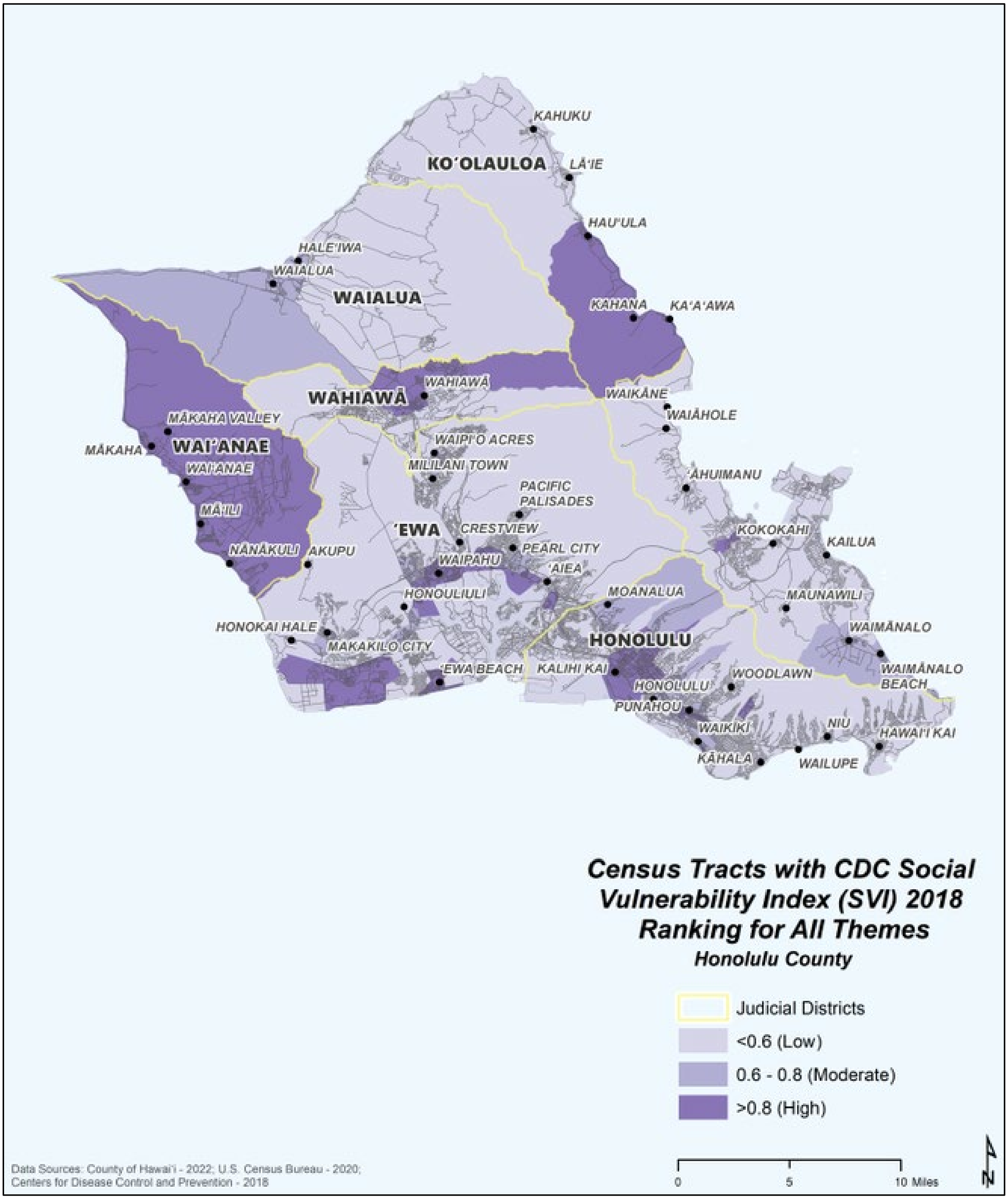


Figure 4.1-5. County of Maui Social Vulnerability Ranking

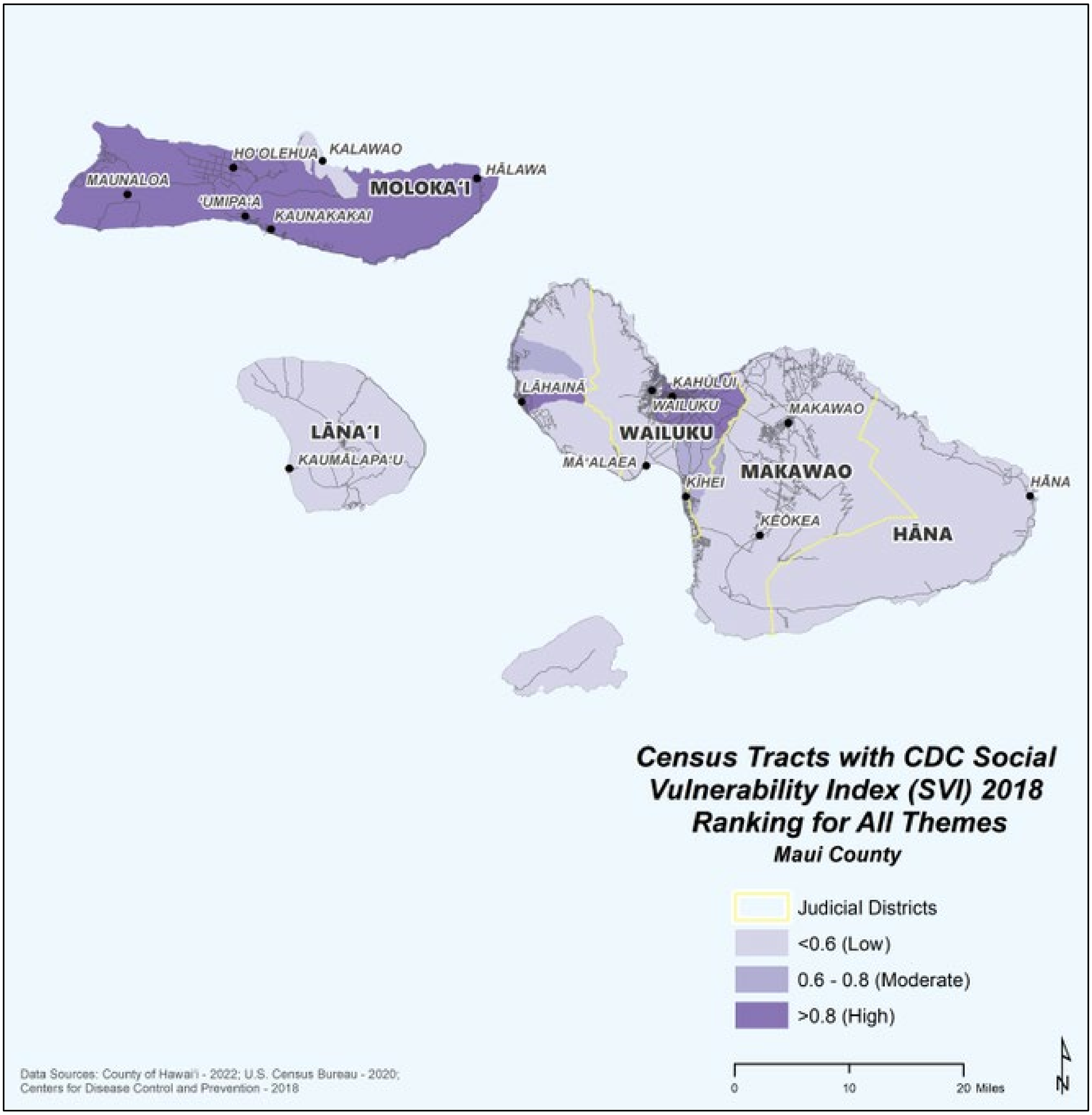
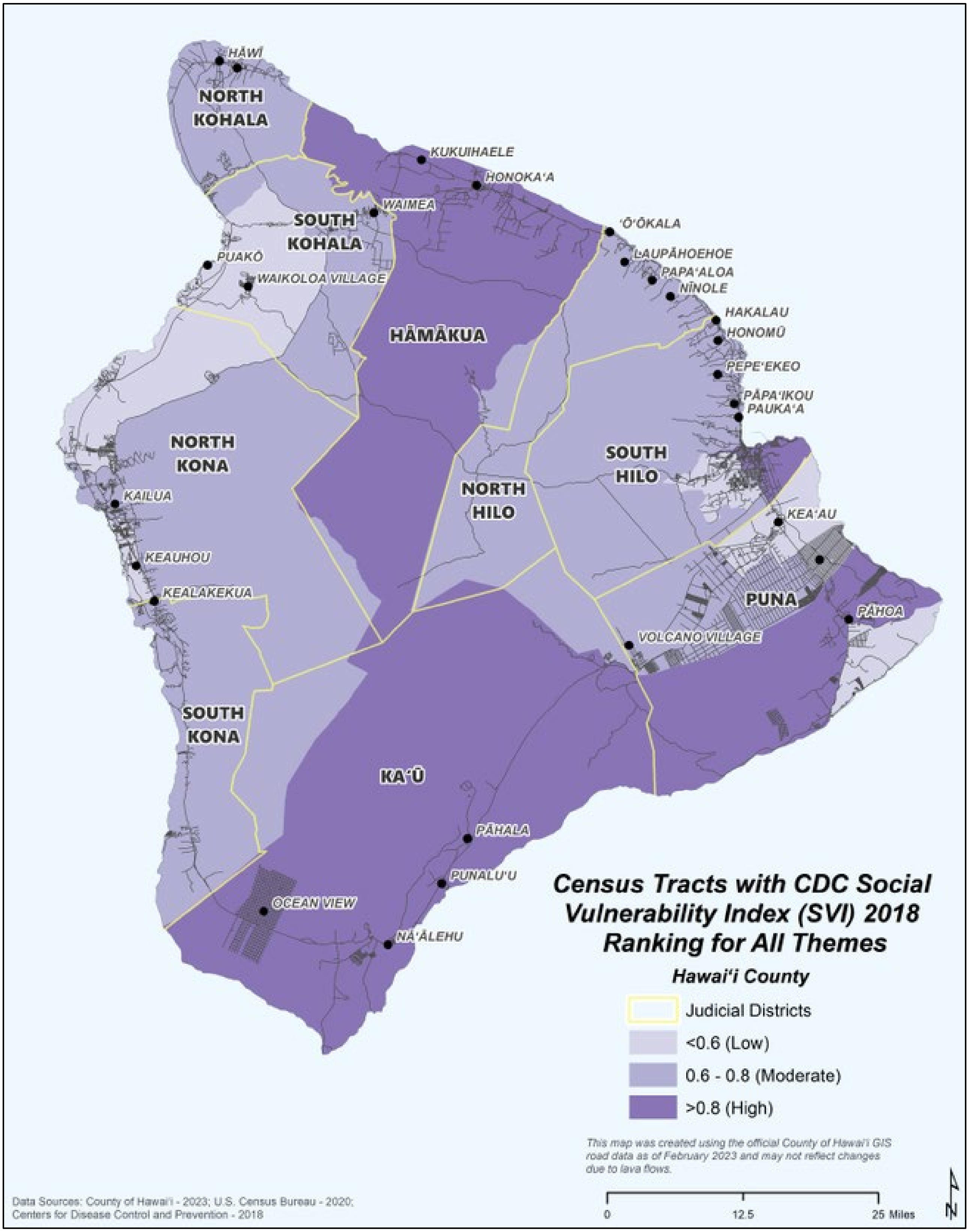


Figure 4.1-6. County of Hawaiʻi Social Vulnerability Ranking



General Building Stock

To assess the built environment, a 2022 structure level general building stock inventory data set created by Niyam IT for HI-EMA was used for the risk assessment. This building data used the U.S. Army Corp of Engineers 2021 National Structure Inventory and was modified for the state to remove structures impacted by the 2018 Kīlauea Eruption. The structures contained attributes compatible for Hazus modeling and were updated with RSMeans 2022 values for the replacement cost valuation. The spatial hazard layers were overlaid with the building inventory in GIS to determine the replacement cost value located in the impact area of the hazard. When Hazus was utilized to evaluate the earthquake, flood, hurricane, and tsunami events, the potential loss to the building stock was estimated.

Environmental Resources

The state contains an abundant array of onshore and offshore environmental assets, including many species that are endemic only to the Hawaiian Islands. The HI-EMA identified the following assets to include in the risk assessment based on the availability of spatial data: critical habitats (or habitats that are known to be essential for an endangered or threatened species), wetlands, parks and reserves, reefs, and watersheds. The spatial hazard layers were overlaid with the environmental resources in GIS to determine which environmental resources are located in the impact area of the hazard. Refer to Section 3 (State Profile) for a more detailed description of these assets in the state.

Cultural Assets

Cultural asset information in the State of Hawaiʻi is managed by the Hawaiʻi State Historic Preservation Division in the Hawaiʻi Department of Land and Natural Resources (DLNR). The location of cultural resources was provided by DLNR and include archaeology sites, burial sensitivity areas, historic buildings, historic districts, historic objects, and historic structures. Additionally, the 2021 Hawaiian Homelands spatial data was used to assess cultural assets at risk to impacts from the natural hazards evaluated. The spatial hazard layers were overlaid with the cultural asset data in GIS to determine the area of land located in the impact area of the hazard.

4.1.3 CHANGES THAT IMPACT VULNERABILITY

Element S7 and 44 CFR § 201.4(d): The risk assessment shall reflect changes in development, including a summary of recent development and potential or projected development in hazard-prone areas on state and local government risk assessments. Changes in development include changes in land use and the built environment, population demographics, vulnerability of state assets, and development that could impact jurisdictions most threatened by identified hazards.

In addition to summarizing the current vulnerability, the State of Hawaiʻi has identified three factors of change that can affect the State's vulnerability to hazards: (1) changes in population; (2) changes in development, and (3) other identified conditions as relevant and appropriate, including the impacts of climate change. Identifying these changes and integrating them into the risk assessment ensures they are considered when developing the mitigation strategy to reduce these vulnerabilities in the future.

As summarized in Section 3 (State Profile), the State of Hawaiʻi has experienced changes in development over the performance period of the 2018 SHMP; and new development, population demographic changes, and increases in visitors/tourists are anticipated in the future. There is no statewide system that tracks where this development has occurred or is anticipated to occur. Therefore, it proves challenging to conduct a statewide assessment to determine whether development has occurred in hazard areas.

For example, more than 600 residences were inundated with lava during the 2018 Kīlauea eruption on Hawaiʻi Island. Many of the displaced residents built homes in other areas within the County of Hawaiʻi, but that shift in development was not tracked. Additionally, over 32 miles of public and private roads were inundated. While many of the roads have not been rebuilt yet, State Routes 132 and 137 have been reopened.

While there were no changes in the number of state-owned and/or leased buildings and critical facilities assessed in the 2023 SHMP Update compared to the 2018 SHMP, the replacement cost value of these structures did increase; therefore, the risk and vulnerability of these structures increased. In addition, different general building inventories were used in the 2018 SHMP than the 2023 SHMP Update making it impossible to conduct a side-by-side comparison analysis to determine changes in vulnerability. However, using a structure-level general building stock data set in the 2023 SHMP Update did indicate that the replacement cost value of structures at risk to hazards in the state are greater than what was analyzed in the 2018 SHMP.

Development continues to occur in the state. Any new development that has occurred since 2021 is not reflected in the reported general building stock risk assessment results. Generally speaking, damages and losses as a result of hazard events are generally associated with older existing infrastructure and buildings rather than new development. This is because building codes and land use regulations, described in Section 5 (Capability Assessment), limit development in hazard areas or require construction to meet higher standards within hazard areas. This provides a reduction of risk in areas where new development or redevelopment is occurring.

In an attempt to understand if projected new development may be impacted by hazards, an exposure analysis was conducted using three data sets that were available in spatial formats to generally assess and discuss where development may occur; 1) Hawaiʻi Community Development Authority's Community Development Districts; 2) Enterprise Zones and 3) Maui Development Projects; refer to Section 3 (State Profile). The spatial hazard layers were overlaid with the projected development areas to determine the area of land located in the impact area of the hazard. These results are reported at the end of each hazard section (Sections 4.2 through 4.15). A qualitative discussion regarding other factors of change is also included, as appropriate.

Because the state is currently experiencing the impacts of the changing climate today, climate change continues to be a stand-alone hazard of concern included in the SHMP. Climate change and associated impacts are discussed in Section 4.2 (Climate Change and Sea Level Rise).

4.1.4 HAZARD-SPECIFIC DATA AND METHODOLOGIES

Element S3, FMAG1, and 44 CFR § 201.4(c)(2)(i) and 204.51(d)(2): The risk assessment shall include an overview of the type and location of all natural hazards that can affect the state, including information on previous occurrences of hazard events, probability of future events, range of observed and anticipated intensities of hazards, using maps where appropriate.

To assess vulnerability, three different levels of analysis were used depending upon the data available for each hazard as described below. In addition, location and potential loss estimates documented in the four local HMPs were also integrated into each hazard section, when available. Table 4.1-7 summarizes the types of analyses performed for each hazard followed by a discussion of each approach.

- **Historic Occurrences and Qualitative Analysis** – This analysis includes an examination of historic impacts to understand potential impacts of future events of similar size. In addition, potential impacts and losses are discussed qualitatively using best-available data and professional judgment.
- **Exposure Assessment** – This analysis involves overlaying available spatial hazard layers, or hazards with defined extent and locations, with assets in GIS to determine which assets are located in the impact area of the hazard. The analysis highlights which assets may be affected by the hazard. If the center of each asset is located in the hazard area, it is deemed exposed and potentially vulnerable to the hazard.
- **Loss estimation** — The Hazus modeling software was used to estimate potential losses for the event-based flood, earthquake, hurricane, and tsunami hazards. In addition, an examination of historic impacts and an exposure assessment was conducted for these spatially-delineated hazards. Refer to Appendix F (State Profile and Risk Assessment Supplement) for more information on FEMA's Hazus model.

Table 4.1-8. Summary of Risk Assessment Analyses

Hazard	Data Analyzed						
	State Buildings	State Roads	Community Lifelines and Critical Facilities	Population	General Building Stock	Environmental Resources	Cultural Assets
Climate Change and Sea Level Rise	E	E	E	E, H	E, H	E	E
Cyber Threat	Q	Q	Q	Q	Q	Q	Q
Drought	Q	Q	Q	Q	Q	Q	Q
Earthquake	E, H	E	E, H	E, H	E, H	E	E
Flood	E, H	E	E, H	E, H	E, H	E	E
Hazardous Materials	Q	Q	Q	Q	Q	Q	Q
Health Risks	Q	Q	Q	Q	Q	Q	Q
Hurricane	E, H	E	E, H	E, H	E, H	E	E
Infrastructure Failure	E	E	E	E	E	E	E
Landslide and Rockfall	E	E	E	E	E	E	E
Terrorism	Q	Q	Q	Q	Q	Q	Q
Tsunami	E, H	E	E, H	E, H	E, H	E	E
Volcanic Hazards	E	E	E	E	E	E	E
Wildfire	E	E	E	E	E	E	E
Windstorm	Q	Q	Q	Q	Q	Q	Q

E – Exposure analysis; H – Hazus analysis; Q – Qualitative analysis

Note: The four local HMPs were also consulted and potential losses summarized in hazard location and vulnerability assessment subsections when available.

Extensive outreach was conducted at the early stages of the 2023 SHMP Update process to collaborate with hazard SMEs to obtain the best-available data and methodologies to assess risk (refer to Section 2 and Appendix A – Planning Process Documentation). The following summarizes the data and analysis conducted to evaluate each hazard of concern. Sections 4.2 through 4.15 summarize the vulnerability assessment results. Appendix F (State Profile and Risk Assessment Supplement) includes all data generated as a result of the risk assessment in further detail (e.g., by state agency). Appendix D (Map Atlas) includes additional maps gathered or generated to support the risk assessment.

Climate Change and Sea Level Rise

Element S4 and 44 CFR § 201.4(c)(2)(i): The risk assessment shall include an overview of the probabilities of future hazard events, including considerations of changing future conditions such as climate change (e.g., long-term weather patterns, average temperature, and sea levels) on the type, location, and range of anticipated intensities of identified hazards.

The climate change and sea level rise hazard is limited to the discussion and analysis of key indicators of the changing climate and sea level rise. A qualitative assessment was conducted for the climate change indicators presented: rising air temperatures; decreased rainfall and stream flow; increased rain intensity; increased sea level and sea surface temperatures; and acidification of the ocean.

Sea level rise data compiled for the *2017 Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report* was used to assess exposure. Three modeled hazards (passive flooding, annual high wave flooding, and coastal erosion) were combined to define the projected extent of chronic flooding called the Sea Level Rise Exposure Area (SLR-XA). The SLR-XA for the islands of Hawaiʻi, Molokaʻi, and Lānaʻi is based on modeling passive flooding only.

To assess the chronic coastal flood hazard (defined as SLR-XA with 1.1 feet of sea level rise discussed in Section 4.2) with sea level rise, the SLR-XA with 3.2 feet of sea level rise was utilized (SLR-XA-3.2).

Key Terms in the 2023 HMP Update to Assess Flood and Sea Level Rise Vulnerability

- **SLR-XA** – Depicts the area exposed to potential chronic coastal flooding and land loss based on modeling passive flooding, annual high wave flooding, and coastal erosion.
- **Chronic Coastal Flood** – Three chronic flooding hazards were modeled: passive ‘bathtub’ flooding, annual high wave flooding and coastal erosion (a.k.a. SLR-XA). The SLR-XA with 1.1 feet of sea level rise, or chronic coastal flooding, is currently happening in the State and was assessed in Section 4.6 (Flood).
- **SLR-XA-3.2** – The SLR-XA with 3.2 feet of sea level rise, representing chronic coastal flooding and sea level rise, was assessed in Section 4.2 (Climate Change and Sea Level Rise).
- **Event-Based Flood** – The 1% annual chance flood event as depicted on the FEMA Flood Insurance Rate Maps, also known as the Special Flood Hazard Area (inclusive of V- and A-zones) was assessed in Section 4.6 (Flood).
- **1% CFZ-3.2** – The 1% annual coastal flood zone with 3.2 feet of sea level rise, was assessed to examine potential impacts to event-based flooding with SLR (Section 4.2 - Climate Change and Sea Level Rise).

To assess event-based coastal flooding with sea level rise, the 1% coastal flood zone with 3.2 feet of sea level rise (1%CFZ-3.2) was utilized (Tetra Tech Inc. and Sobis Inc. 2017). Refer to Appendix F for more details on the generation of the 1%CFZ-3.2.

When assessing impacts from the SLR-XA-3.2, permanent loss of the structure and land is assumed. The most accurate way to estimate this loss is to utilize the combined value of the structure and the land using tax assessor data. However, the asset data used in this analysis did not contain structure or land values from the tax assessor. Therefore, to estimate impacts and potential losses for the state, assets located within the hazard area are considered at risk and vulnerable to the hazard area.

Cyber Threat

To assess the vulnerability of the state to cyber threat and its associated impacts, a qualitative assessment was conducted. Refer to Section 4.3 for more information about this hazard of concern.

Drought

To assess the vulnerability of the state to drought and its associated impacts, a qualitative assessment was conducted. Refer to Section 4.4 for more information about this hazard of concern.

Earthquake

ShakeMap data prepared by the U.S. Geological Survey (USGS) and probabilistic earthquake data in Hazus version 5.1 were used to assess the earthquake hazard. The evaluation of the following historic events utilizing the current environment provides an understanding of potential loss if the event were to happen today.

- The Kalapana 1975 M7.7 scenario with an epicenter approximately 26 miles south-southeast of Hilo. This scenario represents the Kalapana M7.2 earthquake on November 29, 1975.
- The Kaʻū M8.0 scenario with an epicenter approximately 4 miles northwest of Pāhala. This scenario represents the Kaʻū District M7.9 earthquake on April 3, 1868.
- The Lānaʻi M7.0 scenario with an epicenter approximately 13 miles north-northwest of Lānaʻi City. This scenario represents the Lānaʻi M6.8 earthquake on February 20, 1871.
- The NE Maui M7.0 scenario with an epicenter approximately 31 miles northeast of Kahului. This scenario represents the Maui M6.5 earthquake on January 23, 1938.
- The standard Hazus 100-year probabilistic event.

A Level 2 analysis was performed in Hazus version 5.1 to estimate potential losses as a result of each scenario using the Advanced Engineering Building Module (AEBM) Hazus model (Section 4.5); refer to Appendix F (State Profile and Risk Assessment Supplement) for further details on Hazus and Level 2 analyses. The statewide general building stock data was used to update the aggregate building stock data within Hazus. The state-owned and/or leased facilities and critical facilities were uploaded in the Hazus AEBM model to update structure-level data.

The National Earthquake Hazard Reduction Program (NEHRP) soils and landslide susceptibility data were also integrated into the Hazus model. NEHRP soils D and E were identified as areas potentially more vulnerable to damage; these areas were used as the hazard extent for the exposure analysis.

- NEHRP soils data for the County of Hawaiʻi was provided by AECOM.
- NEHRP soils data for the County of Maui was originally compiled by Tetra Tech for the 2015 Maui County Hazard Mitigation Plan. The NEHRP soils data were generated using the USGS Geologic Map of the State of Hawaiʻi data and the County of Maui Probable Site Classes map in the 2013 Hawaiʻi State Mitigation Plan. Data was recreated from static sources, as GIS data files were unavailable. This methodology has resulted in a rather coarse resolution that is limited in applicability to planning purposes.
- The area of NEHRP soil classifications for the Counties of Kauaʻi and City and County of Honolulu are unknown at this time.
- Landslide susceptibility data for the County of Hawaiʻi was provided by the Pacific Disaster Center. Landslide susceptibility data categorized for use in Hazus was not available for the other counties.

Flood

Event-Based Flood

The National Flood Hazard Layer Digital Flood Insurance Rate Map (DFIRM) data, effective February 26, 2021, with the latest Letter of Map Amendment January 4, 2021, was used to assess exposure from the 1 percent annual chance flood event. Table 4.1-8 summarizes the effective dates of each county's DFIRM. Additionally, depth grids for each county were updated with the following data:

- **County of Kaua'i:** The effective countywide DFIRM from February 26, 2021, and National Oceanic and Atmospheric Administration's (NOAA) 2013 3-meter coastal Digital Elevation Model (DEM).
- **City and County of Honolulu:** The effective statewide DFIRM from September 29, 2017, with the latest Letter of Map Amendment January 4, 2017, NOAA's 2013 3-meter coastal DEM, and USGS' 2016 1-meter and 10-meter DEM.
- **County of Maui:** The effective statewide DFIRM from September 29, 2017, with the latest Letter of Map Amendment January 4, 2017, NOAA's 2013 3-meter coastal DEM, and USGS' 2016 1-meter and 10-meter DEM.
- **County of Hawaiʻi:** The effective countywide Digital Flood Insurance Rate Map (DFRIM) from September 29, 2017, with the latest Letter of Map Amendment June 28, 2019, NOAA's 2013 3-meter coastal DEM, and USGS 2016 10-meter DEM.

Table 4.1-9. FEMA Digital Flood Insurance Rate Maps Effective Dates

County	DFIRM Effective Date	Letter of Map Ammendment (LOMA) Effective Date
County of Kauaʻi	2/26/2021	-
City and County of Honolulu	11/5/2014	1/4/2021
County of Maui	11/4/2015	6/22/2020
County of Hawaiʻi	9/29/2017	3/19/2021

Source: FEMA Map Service Center

In Hazus, the default general building stock inventory was updated with the structure level general building stock to estimate potential loss to buildings. A Level 2 user-defined analysis was performed for state buildings and critical facilities. To estimate damage that would result from a flood, Hazus uses pre-defined relationships between flood depth at a structure and resulting damage, with damage given as a percent of total replacement value. Curves defining these relationships have been developed for damage to structures and for damage to typical contents within a structure. By inputting flood depth data and known property replacement cost values, dollar-value estimates of damage were generated. New development has not been factored into the inventory assessed in the 2023 SHMP Update, so the limitations of the flood analysis are recognized.

Chronic Coastal Flood

To assess the state's risk to the chronic coastal flood hazard, the SLR-XA with 1.1 feet of sea level rise inundation developed for the *Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report* was used for the state asset exposure analyses (refer to Section 4.6). The SLR-XA with 1.1 feet of sea level rise depicts the area exposed to potential chronic coastal flooding and land loss based on modeling passive flooding, annual high wave flooding, and coastal erosion with sea level rise for the Islands of Maui, Oʻahu, and Kauaʻi. The SLR-XA for the Islands of Hawaiʻi, Molokaʻi, and Lānaʻi is based on modeling passive flooding only. In addition, the *Sea Level Rise Vulnerability and Adaptation Report* quantitative results were integrated into the chronic coastal flood vulnerability assessment for estimated potential loss to population and the general building stock.

When assessing impacts from the SLR-XA-1.1, permanent loss of the structure and land is assumed. The most accurate way to estimate this loss is to utilize the combined value of the structure and the land using tax assessor data. To estimate loss to the general building stock, the assessed value of both the structure and the land was utilized and reported in Section 4.6 (Flood) as per the *Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report*. However, this tax data (structure and land value) was not available to report permanent loss to state assets (state buildings and critical facilities). Therefore, to report the required potential impact to state assets, the replacement cost value of state buildings and critical facilities is listed, and the limitations of this are acknowledged.

Hazardous Materials

The hazardous materials hazard is limited to the discussion and analysis of fixed site and in-transit hazard material releases. A qualitative assessment was conducted for the hazardous materials hazard. Refer to Section 4.7 for more information about this hazard of concern.

Health Risks

The health risks hazard is limited to the discussion and analysis of the following: COVID-19, infectious diseases (dengue fever, chikungunya, zika, rat lungworm, Legionnaires' disease, leptospirosis), waterborne disease, pandemic flu (including H5N1 or avian flu and H1N1 or swine flu) and bioterrorism. A qualitative assessment was conducted for the health risks hazard (Section 4.8). Risks to human health that occur as a result of natural hazard events are discussed throughout Sections 4.2 through 4.15.

Hurricane

A Level 2 analysis was performed in Hazus version 5.1 to assess hurricane exposure and vulnerability for one statewide scenario (500-year mean return period hurricane wind event). An aggregate general building stock analysis was performed using the updated general building stock data. The default critical facilities were replaced in the Hazus model with the updated critical facilities.

Hurricane storm surge (SLOSH) data provided by the NOAA was used for the exposure analysis. The data is the maximum of maximums (MOM) for each hurricane category 1 through 4; the MOM provides a worst-case snapshot for a particular storm category. This data was created by running multiple analysis runs for hurricanes approaching from different directions and retaining the highest value at a given location. The storm surge inundation is from wave action and does not include freshwater inundation. An exposure assessment was conducted, and results were generated for all category hurricanes. For the purposes of the 2023 SHMP Update risk assessment, assets located in the Category 4 storm surge inundation area are reported in Section 4.9 to align with the *2015 Hawaiʻi Catastrophic Hurricane Plan* and Hazus analysis performed. Exposure assessment results for Category 1 through 3 are reported in Appendix F (State Profile and Risk Assessment Supplement).

The two data sets referenced above (Hazus and SLOSH data) are not directly connected. The wind data was used to determine general building stock losses, displaced households, and shelter needs. The storm surge data was used to determine the estimated risk of state buildings, critical facilities, population, general building stock, environmental resources, and culture assets to the hazard.

Infrastructure Failure

Statewide dam failure inundation area data was provided by the DLNR. For the 2023 SHMP Update, the total number of state assets located in all spatially-delineated high hazard dam failure inundation areas was examined. Assets located in the high hazard dam failure inundation areas are considered at risk to impacts from dam failure. However, it is highly unlikely that all dams would fail at the same time.

Landslide and Rockfall

The landslide and rockfall hazard section is limited to discussion and analysis of landslides (inclusive of all types of soil/rock movement and debris flow) and rockfalls. Landslide susceptibility data for the County of Hawaiʻi was provided by the Pacific Disaster Center. A categorical slope risk map was prepared using an adaptation of the slope hazard methodology given in the FEMA 2007 HAZUS-MH MR3 Technical Manual. The approach involved the interactions of three primary slope hazard input criteria simplified to low, medium and high hazard susceptibility (State of Hawaiʻi HMP 2013).

Hazus version MR4 provides susceptibility categories combining slope angle, soil type, and soil moisture with an assigned yield acceleration to each category. The combined susceptibility categories when mapped represent zones of potential landslide triggering under different levels of ground shaking. The following summarizes the criteria used to spatially categorize landslide susceptibility into high, moderate, or low areas in the County of Hawaiʻi (State of Hawaiʻi HMP 2013).

- Slope
    - Low Susceptibility – Slope less than 20 degrees
    - Moderate Susceptibility – Slope of 20 to 40 degrees
    - High Susceptibility – Slope greater than 40 degrees

- Geology
  - Low Susceptibility - Fresh volcanic rock at shallow depths
  - Moderate Susceptibility – Clay-rich surficial soils, weathered rock
  - High Susceptibility – Weak soft soils, ash deposits, mapped historic talus (rockfall deposits)
- **Soil Moisture** – Soil moisture assignments are derived from NOAA rainfall mapping of the island since regional groundwater and soil moisture data are unavailable island wide. Areas receiving more than 2,000 mm annual precipitation are considered to have wet soil; these areas are located primarily on the windward side of the island. In addition, coastal areas below elevation 200 feet are considered wet due to potential groundwater seepage gradients from higher elevations, except in the arid Kona coast areas.

For the landslide exposure analysis, the Hazus values provided in the Pacific Disaster Center (PDC) source data were categorized into three landslide susceptibility areas described below.

- **Low** – Hazus susceptibility type values 1 through 3
- **Moderate** – Hazus susceptibility type values 4 through 6
- **High** – Hazus susceptibility type values 7 through 10

This landslide susceptibility data has not been generated for the County of Kauaʻi, City and County of Honolulu, and County of Maui. To determine the areas at greatest risk to landslide for these three counties, slope was calculated using a USGS 10-meter DEM. Areas of slope were assigned low, moderate, and high landslide susceptibility categories to align with the slope categories for the County of Hawaiʻi. This data is considered suitable for planning purposes only.

A statewide spatial analysis was conducted using the high landslide susceptibility areas available to determine exposure and vulnerability to the landslide hazard. A qualitative assessment was conducted for the rockfall hazard. Refer to Section 4.11 for more information about this hazard of concern.

Terrorism

To assess the vulnerability of the state to terrorism and its associated impacts, a qualitative assessment was conducted. Refer to Section 4.12 for more information about this hazard of concern.

Tsunami

The Standard Evacuation Zone (SOEST) historic tsunami inundation scenario (400-year), extreme evacuation zone Great Aleutian Tsunami (GAT) inundation scenario (1,500-year), and the American Society of Civil Engineers (ASCE) design level inundation scenario (3,500-year) was provided by the Hawaiʻi Emergency Management Agency (HI-EMA) and Niyam IT for the 2023 SHMP Update. In addition, HI-EMA and Niyam IT ran the Hazus version 5.1 tsunami model for these tsunami inundation scenarios to estimate potential economic losses (i.e., building, content, wage, income, relocation, and lost rent payments) in the state. A statewide spatial analysis was also conducted using the SOEST, GAT, and ASCE inundation areas to determine the state assets at risk to impacts from the tsunami hazard. Refer to Section 4.13 for more information about this hazard of concern.

Volcanic Hazards (Lava Flow and Vog)

The volcanic hazard is limited to the discussion and analysis of the lava flow and vog hazards. There are spatially-delineated lava flow zones for the Counties of Hawaiʻi and Maui. In collaboration with the volcanic SME, specific zones were selected to assess risk to the lava flow hazard. The following defines all zones for each county and which were selected for the exposure analysis reported in Section 4.14.

Lava flow hazard zones data for the County of Hawaiʻi was provided by the Hawaiʻi Statewide GIS Program. In collaboration with the volcanic SME, zones 1 through 4 were selected to assess lava flow risk for the County of Hawaiʻi. The hazard zones are defined as follows.

- Zone 1 – Includes summits and rift zones of Kīlauea and Mauna Loa, where vents have been repeatedly active in historic time.
- Zone 2 – Areas adjacent to and downslope from Zone 1. 15 to 25 percent of Zone 2 has been covered by lava since 1800, and 25 to 75 percent has been covered within the last 750 years. The relative hazard within Zone 2 decreases gradually as one moves away from Zone 1.
- Zone 3 – Areas less hazardous than Zone 2 because of greater distance from recently active vents and/or because of topography. One to 5 percent of Zone 3 has been covered since 1800, and 15 to 75 percent has been covered within the past 750 years.
- Zone 4 – Includes all of Hualālai, where the frequency of eruptions is lower than that for Kīlauea or Mauna Loa. Lava coverage is proportionally smaller, about 5 percent since 1800, and less than 15 percent within the past 750 years.
- Zone 5 – Includes the area on Kīlauea currently protected by topography.
- Zone 6 – Includes two areas on Mauna Loa, both protected by topography.
- Zone 7 – Includes the younger part of dormant volcano Mauna Kea; 20% of this area was covered by lava in the past 10,000 years.
- Zone 8 is the remaining part of Mauna Kea; only a small percentage of this area has been covered by lava in the past 10,000 years.
- Zone 9 is the Kohala Volcano, which last erupted over 60,000 years ago.

Lava flow hazard zones data for County of Maui was provided by USGS. In collaboration with the volcanic SME, zones 1 and 2 were selected to assess lava flow risk for the County of Maui. This decision was based on the 2006 paper by D.R. Sherrod and others, which suggests that Maui Zone 1 is roughly equivalent to Hawaiʻi Island Zone 3, Maui Zone 2 is roughly equivalent to Hawaiʻi Island Zone 4, and Maui Zone 3 is roughly equivalent to Hawaiʻi Island Zone 6 (Sherrod, 2006). These comparisons are not explicitly stated in the paper, but Dr. Sherrod affirms how Maui lava flow hazard zone numbers compare to Hawaiʻi Island lava flow hazard zone numbers, which were established by Mullineaux and others (1987). In other words, no place on Maui has volcanic hazards equivalent to Lava Flow Hazard Zones 1 and 2 on Hawaiʻi Island.

The hazard zones are defined as follows.

- Zone 1 – Encompasses the lower- and middle-altitude reaches of the southwest and east rift zones, Haleakala Crater itself, and an area on the northern flank of the east rift zone—all areas where eruptions have occurred frequently in the past 1500 years. At least five eruptive events, each encompassing several lava flows, have occurred in each of the designated areas. The attention drawn to Zone 1 hazards presumes that the volcano's short-term future will be similar to that of the past 1,500 years.

- Zone 2 – Encompasses the volcano's flanks downslope of the southwest and east rift zone axes, chiefly areas where lava has encroached at least once in the past 13,000 years. Included are some areas that have never been inundated during the past 50,000–100,000 years but that lie within the topographic boundaries of lava sheds for vents that could be expected to form along the rift zone axes.
- Zone 3 – Demarcates downslope reaches centered low on the Kaupo and Koʻolau lava fans. These areas, although within potentially active lava sheds, have become sheltered by topographic buildup during the past 40,000 years that now would deflect new lava toward the margins of the fans.
- Zone 4 – Encompasses those flanks shielded from lava during the past 100,000 years or for which the sparse eruptive products found are the consequence of off-rift cinder cones from random, infrequent eruptive events. Corresponds to essentially no hazard under most lava inundation conditions.

A qualitative discussion is also included regarding vog and potential impacts in the state. Refer to Section 4.14.

WILDFIRE

Communities at Risk from Wildfire (CAR) data were provided by the Hawaiʻi Wildfire Management Organization (HWMO). These data are based on HWMO's 2013 statewide Wildfire Hazard Assessment (WHA), which collected quantitative field data and qualitative firefighting capacity data of 36 hazard characteristics that contribute to wildland fire risk in developed communities. The Division of Forestry and Wildlife (DOFAW) personnel reviewed the WHA and then made adjustments to better reflect consistency across CAR maps, which communicate risk levels based on staff experience. Tetra Tech assigned high, moderate and low fire risk categories to the communities delineated in the CAR data using the "DOFAW 2013: Communities at Risk from Wildfire" map published by HWMO as a reference. High, moderate, and low categories were used for the exposure analysis. For the purposes of this risk assessment, an asset is considered potentially vulnerable to wildfire if it is located in a high-risk community. The CAR data focuses on communities or developed areas. Therefore, the wildfire risk to state assets located outside of these communities could not be determined.

HWMO provided the following disclaimer with the CAR data:

- "HWMO will not bear any responsibility for the consequences of using this data set, which are entirely the responsibility of the user. Therefore, the data does not indicate the full range of realistic fire threat, nor does it offer actual quantification of the potential exposure of homes to the ignition, spread, and intensity of wildfires or embers produced by wildfires. Although the data set and subsequent analyses may indicate general wildfire risk for a given area, the actual risk to homes and property can deviate based on the characteristics of the site around an individual home, community, or natural resource area."

An exposure assessment was conducted generating results for the high, moderate, and low wildfire risk areas. For the purposes of the 2023 SHMP Update risk assessment, assets located in the high wildfire risk area are deemed exposed and vulnerable to the wildfire hazard of concern. Refer to Section 4.15 for more information about this hazard of concern. Results for the low and moderate landslide risk areas are reported in Appendix F (State Profile and Risk Assessment Supplement). The wildfire risk rankings used for analysis focus on communities and developed areas. Therefore, assets located outside these areas have not been evaluated, and it cannot be assumed they are not at risk. The results reported in Section 4.15 may underestimate the state's exposure and vulnerability to wildfire.

WIND STORM

Data showing defined geographical extents of terrain-related amplification of wind speeds were not available to evaluate the high wind storm hazard. A qualitative assessment on the high wind component of the trade winds and kona storm events is presented in Section 4.16.

DATA SOURCES

A list of sources for the data used in this risk assessment are outlined in Table 4.1-9.

LIMITATIONS

The spatial hazard data used in this plan was generated by multiple agencies and organizations. Due to differing processes of data generation between these entities, spatial layer boundaries may not accurately align with the coastline.

The worst-case scenarios used are for planning purposes only, and may not represent the actual worst-case a geographic area may experience. Loss estimates, exposure assessments, and hazard-specific vulnerability evaluations rely on the best-available data and methodologies. Uncertainties are inherent in any loss estimation methodology and arise in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. The reader is urged to use caution when interpreting these results as each hazard event is unique, and climate change projections may change over time as technology and science advances. Uncertainties also result from the following:

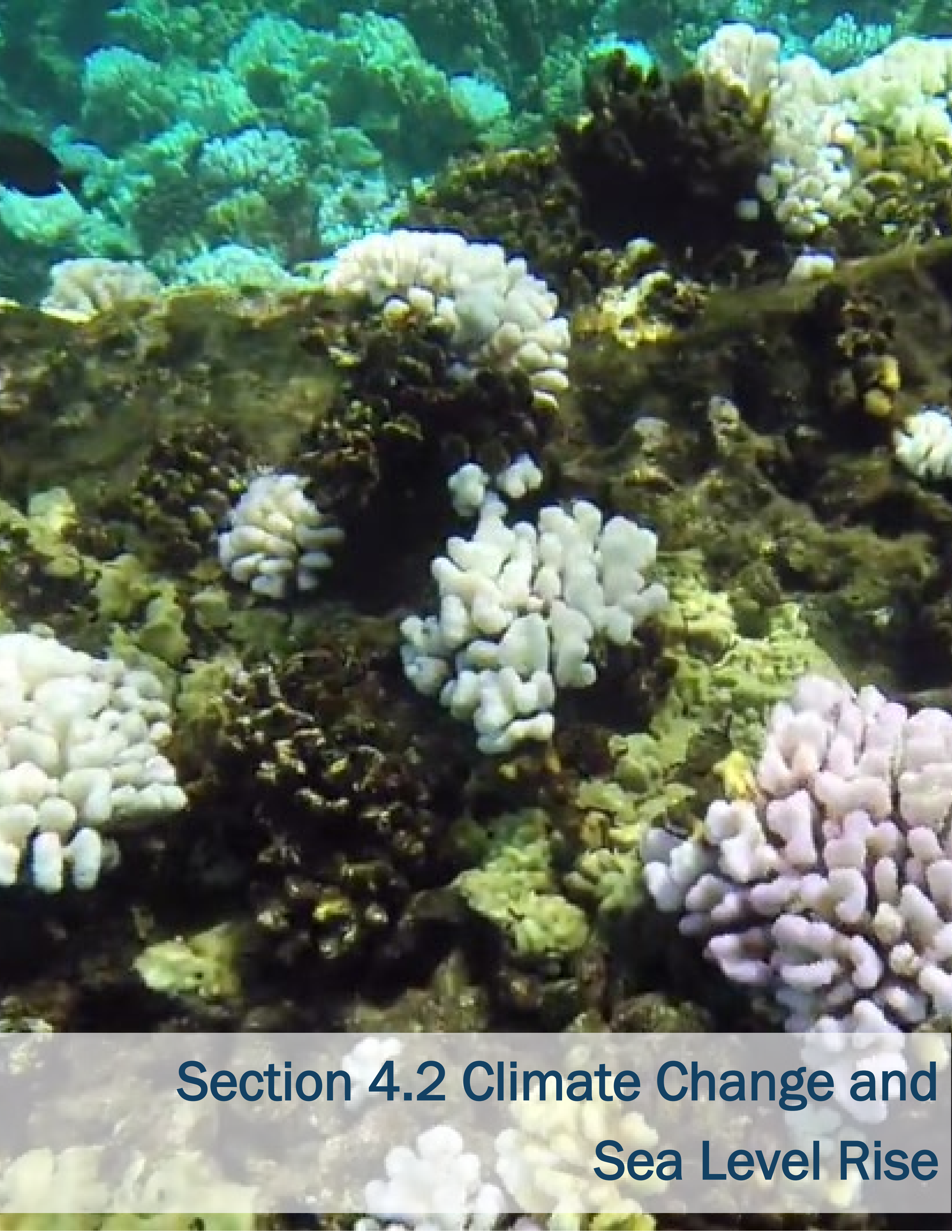
- Approximations and simplifications necessary to conduct a study
- Incomplete or outdated inventory, demographic, or economic parameter data
- The unique nature, geographic extent, and severity of each hazard event
- Mitigation measures already employed
- The amount of advance notice residents have to prepare for a specific hazard event

These factors can affect loss estimates by a factor of two or more. Therefore, potential exposure and loss estimates are approximate and should be used only to understand relative risk. Over the long term, the State of Hawaiʻi will continue to collect additional data, and update and refine existing inventories, to assist in estimating potential losses.

Potential economic loss is based on the present value of the state buildings and general building stock utilizing best-available data. The state acknowledges significant impacts may occur to critical facilities and infrastructure (such as roads, airports, harbors, utilities) as a result of these hazard events causing great economic loss not only to one island but potentially cascading impacts throughout the state. However, monetized damage estimates to critical facilities and infrastructure and economic impacts were not quantified and require more detailed loss analyses. In addition, economic impacts to industries such as tourism and the real estate market were not analyzed.

Table 4.1-10. Data Sources for Data Used in the 2023 SHMP Update

Name of Data	Name of Source	Year of Data Update
State-Owned and/or Leased Facilities	State Risk Management Office	2017
Critical Facilities and Lifelines	Hawai'i Emergency Management Agency	2017
General Building Stock	Hawai'i Emergency Management Agency; Niyam IT	2022
State Roadways	State of Hawai'i Department of Transportation	2022
Judicial Districts	County of Hawai'i; Statewide Office of Planning	2021
Socially Vulnerable Population	Centers for Disease and Prevention; American Community Survey	2018; 2020
Critical Habitat	U.S. Fish and Wildlife Service; Pacific Islands Office	2022
Wetlands	U.S. Fish and Wildlife Service	2021
Parks	Hawai'i Department of Land and Natural Resources; Division of State Parks	2021
Coral Reefs	National Oceanic and Atmospheric Administration	2020
Reserves	Hawai'i Department of Land and Natural Resources, Division of Forestry and Wildlife	2022
Artificial Reefs	Hawai'i SHMP	2018
Hawaiian Homelands	Hawai'i State Department of Hawaiian Homelands	2021
Hawai'i Community Development Authority Community Development Districts	Hawai'i Community Development Authority	2021
Maui Development Projects	Maui County Planning Department	2016
Enterprise Zones	Community Economic Development Program; County Planning Departments	2021
Watershed Partnerships	Hawai'i Department of Land and Natural Resources	2020
Cultural Resources	Hawai'i Department of Land and Natural Resources	2022
Statewide 1-Percent Annual Chance Flood Event	Federal Emergency Management Agency	2021
Countywide 1-Percent Annual Chance Flood Event	Federal Emergency Management Agency	2014; 2015; 2017; 2021
10-Meter Digital Elevation Model	United States Geological Survey	2016
1-Meter Digital Elevation Model	United States Geological Survey	2016
3-Meter Digital Elevation Model	National Oceanic and Atmospheric Administration	2013
Chronic Coastal Flooding	Hawai'i Climate Change Mitigation and Adaptation Commission	2017
High Hazard Dam Inundation Areas	Hawai'i Department of Land and Natural Resources	2021
NEHRP Soils	AECOM; United States Geological Survey	2013
Landslide Susceptibility	Pacific Disaster Center; United States Geological Survey	2017; 2016
Storm Surge (SLOSH) Categories 1-4	National Oceanic and Atmospheric Administration	2017
SLRA-XA 3.2 Feet Sea Level Rise	Hawai'i Emergency Management Agency	2017
1%CFZ 3.2 Feet Sea Level Rise	Hawai'i Emergency Management Agency; Tetra Tech Inc. and Sobis Inc.	2017
Tsunami Inundation Areas	Hawai'i Emergency Management Agency; Niyam IT	2022
CAR Wildfire Risk	Hawai'i Wildfire Management Organization	2013
Volcanic Hazard Zones	Hawai'i Statewide GIS Program; United States Geological Survey	2017; 1992/2006



Section 4.2 Climate Change and Sea Level Rise

Climate Change and Sea Level Rise

The Hawaiian Islands are highly exposed to the effects of climate change and sea level rise. The State has seen a decline in total rainfall, but increases in sea level, sea surface temperature, and acidification of ocean water over the last three or more decades. The statistics below represent the Sea Level Rise Exposure Area (SLR-XA) 3.2 feet.

CHANGES SINCE 2018

+0

Declared Disasters

+0

Events

COUNTIES MOST VULNERABLE

Kauaʻi Honolulu Maui Hawaiʻi

SOCIALLY VULNERABLE POPULATION

0.5%

Of Total Population

7,127

Persons

HAZARD RANKING

Low Medium High

COMMUNITY LIFELINES

33

Total

Food, Water, Shelter

Greatest

CLIMATE PROJECTIONS

Warmer, more acidic ocean will drive changes in circulation and biologic activity

Climate change can lead to a decrease in precipitation, streamflow, and groundwater levels and increase the number of and duration of droughts

Coastline erosion alters the habitats of endemic Hawaiian species and may displace residents and business owners

SQUARE MILES

54

State Buildings

32

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[1] *Section Cover Photo: Bleached coral from increased sea temperatures. Photo courtesy of DLNR*

SECTION 4. RISK ASSESSMENT

4.2 CLIMATE CHANGE AND SEA LEVEL RISE

2023 SHMP Update Changes

- New and updated statistics and figures from federal, state, academic, and local agencies are incorporated.
- Discussion of how climate change and sea level rise impact socially vulnerable populations and community lifelines is incorporated.
- In Environmental Resources, reefs (both artificial and coral) are analyzed in their own category.
- Six types of cultural resources (archaeology, burial sensitivity area, historic building, historic district, historic object, and historic structure) are added to the vulnerability assessment.

4.2.1 HAZARD PROFILE

Climate is defined as long-term averages and variations in weather measured over a period of time. A change in the state of the climate can be identified by changes in the mean and/or variability of its properties that persist for an extended period of time, typically decades or longer. Key drivers and indicators of the changing climate include rising carbon dioxide in the atmosphere, rising air and sea temperatures, rising sea levels and upper-ocean heat content, changing ocean chemistry and increasing ocean acidity, changing rainfall patterns, decreasing base flow in streams, changing wind and wave patterns, changing extremes, and changing habitats and species distributions (Department of Land and Natural Resources 2016).

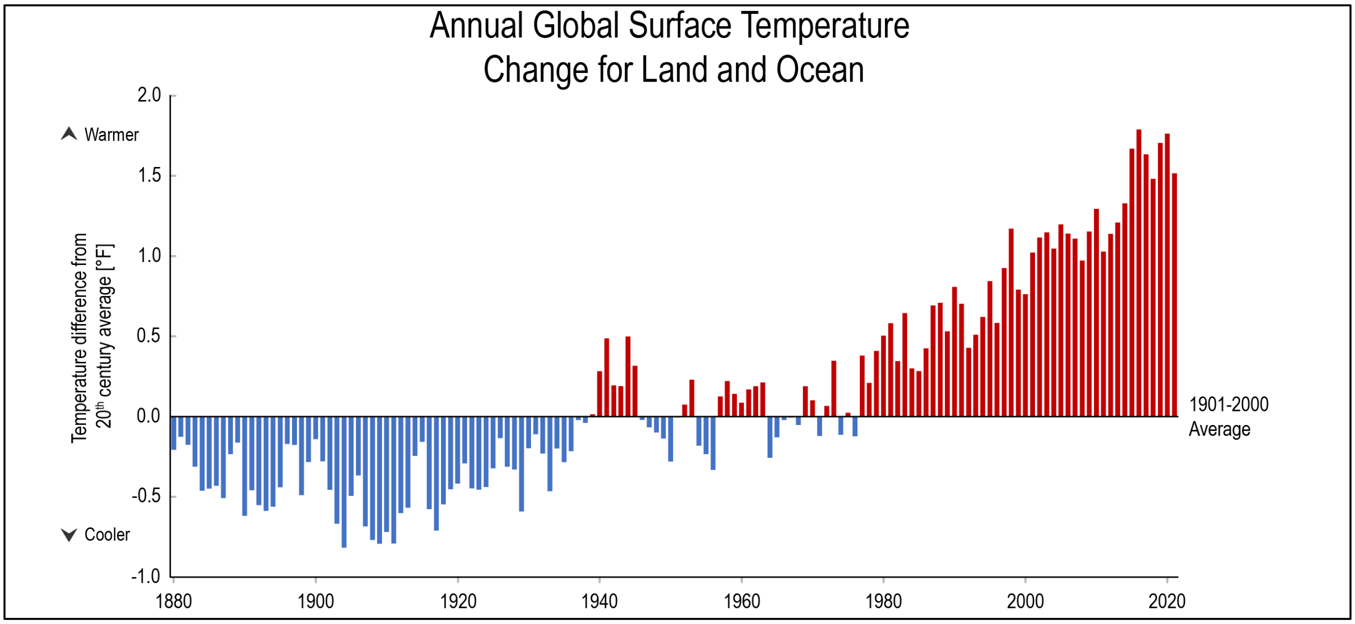
This section provides general information on the climate change hazard with an enhanced discussion on sea level rise. For an analysis of how climate change impacts natural hazards, see each natural hazard profile in this plan.

HAZARD DESCRIPTION

Climate Change

Since 1880, global average surface air temperatures have increased 1.82 degrees Fahrenheit (˚F) (NASA 2022). Figure 4.2-1 shows the number of degrees between the 1880s and the 2020s that the average global temperature for each year differs from the baseline, or average global temperature calculated during the last century (1901–2000).

Figure 4.2-1. Global Temperature Change



Source: (U.S. Global Change Research Program 2021)

The Intergovernmental Panel on Climate Change (IPCC) stated in its Sixth Assessment Report that "It is unequivocal that the increase of CO_2, methane, and nitrous oxide in the atmosphere over the industrial era is the result of human activities and that human influence is the principle driver of many changes observed across the atmosphere, ocean, cryosphere, and biosphere." It continues, "Since systematic scientific assessments began in the 1970s, the influence of human activity on the warming of the climate system has evolved from theory to established fact (IPCC 2021)." Sixteen of the last 17 years having been the warmest ever recorded.

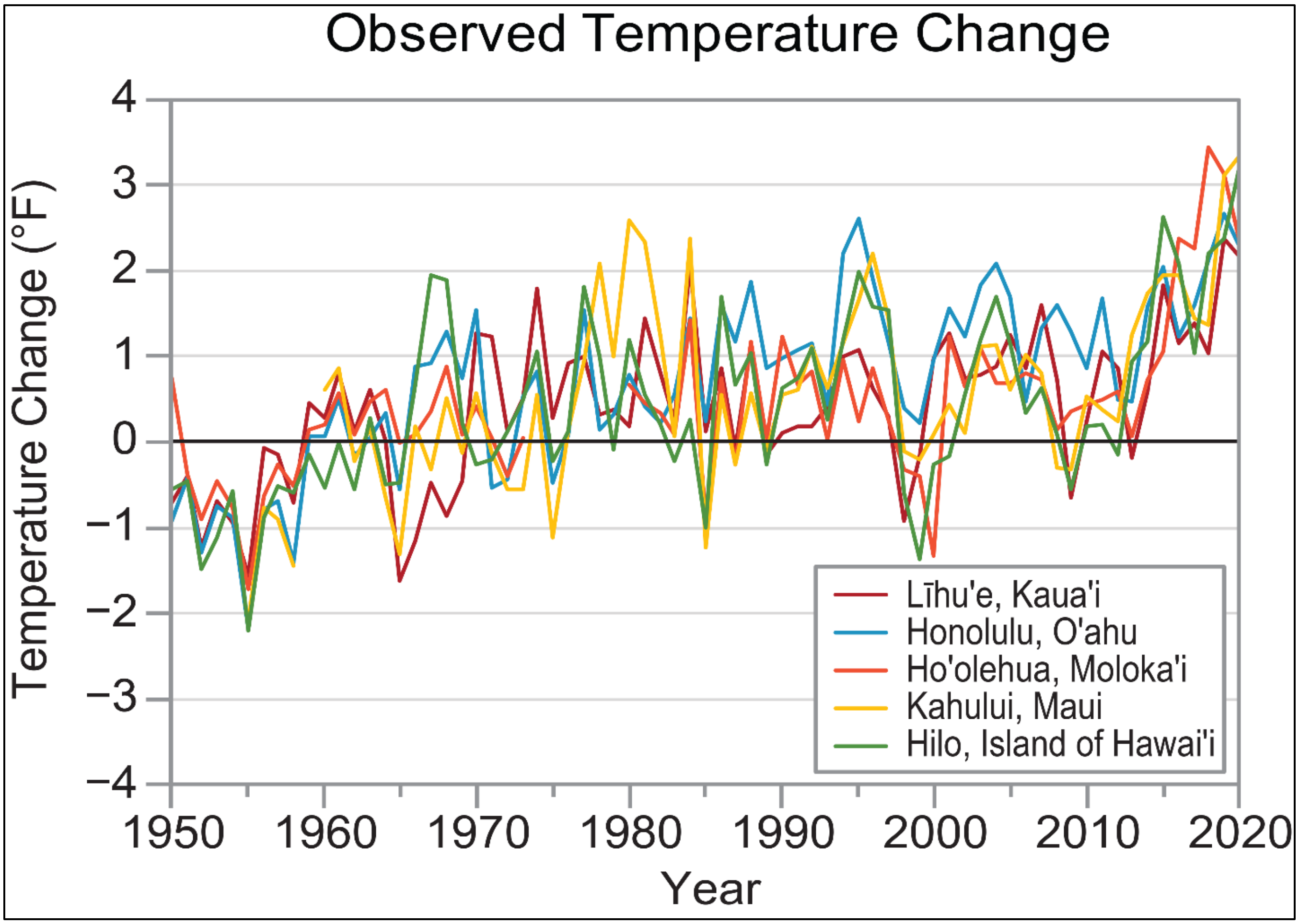
In the State of Hawaiʻi, climate is changing in ways that are consistent with the influence of global warming. The State of Hawaiʻi has experienced rising air temperatures, changing rain intensity, rainfall and stream flow changes, increased sea level and sea surface temperatures, and acidification of the ocean.

- **Surface Air Temperature**. Figure 4.2-2 shows temperature changes across Hawaiʻi since 1950. The lines on the graph show observed changes (compared to the 1951–1980 average; horizontal black line) in annual near-surface air temperature for five long-term reporting stations in Hawaiʻi from 1950 to 2020. Temperatures across the islands have risen by about 2°F since 1950, with a sharp increase in warming over the last decade (NOAA 2022). As average air temperatures rise, heat disorders among the population also increase.
- **Rain Intensity**. Historical extreme rainfall trends vary among studies conducted throughout the state. Some studies show a decrease in daily rainfall intensity while other studies indicate that consecutive wet and dry days are both increasing statewide. What was considered a rare storm event in 1960 with nearly 12 inches of daily precipitation was considered common in 2009 (City and County of Honolulu Climate Change Commission 2023). Intense rain events may lead to more flash flooding, damage to infrastructure, runoff, and sedimentation.
- **Rainfall and Stream Discharge**. The State of Hawaiʻi has seen an overall decline in rainfall in the last 30 years, with widely varying precipitation patterns on each island. Projections show that the State of Hawaiʻi will see

more drought and heavy rain events. A decline in overall precipitation totals have caused a decrease in stream base flow, which may reduce aquifer recharge and freshwater supplies. This may also negatively impact aquatic and riparian ecosystems and agriculture.

- **Sea Level**. Refer to the following subsection for information on sea level changes in the State of Hawaiʻi.
- **Sea Surface Temperature**. At Station ALOHA, marine researchers at the University of Hawaiʻi and cooperating institutions have measured an increase of sea surface temperature of 0.22°F per decade. With climate change, this rate is likely to increase, potentially exposing coral reefs and other marine ecosystems to negative impacts related to increased temperatures, including coral bleaching. Increasing air surface temperatures due to increasing sea surface temperatures may further impact the population as mentioned above.

Figure 4.2-2. Observed Hawaiʻi Surface Air Temperature Change



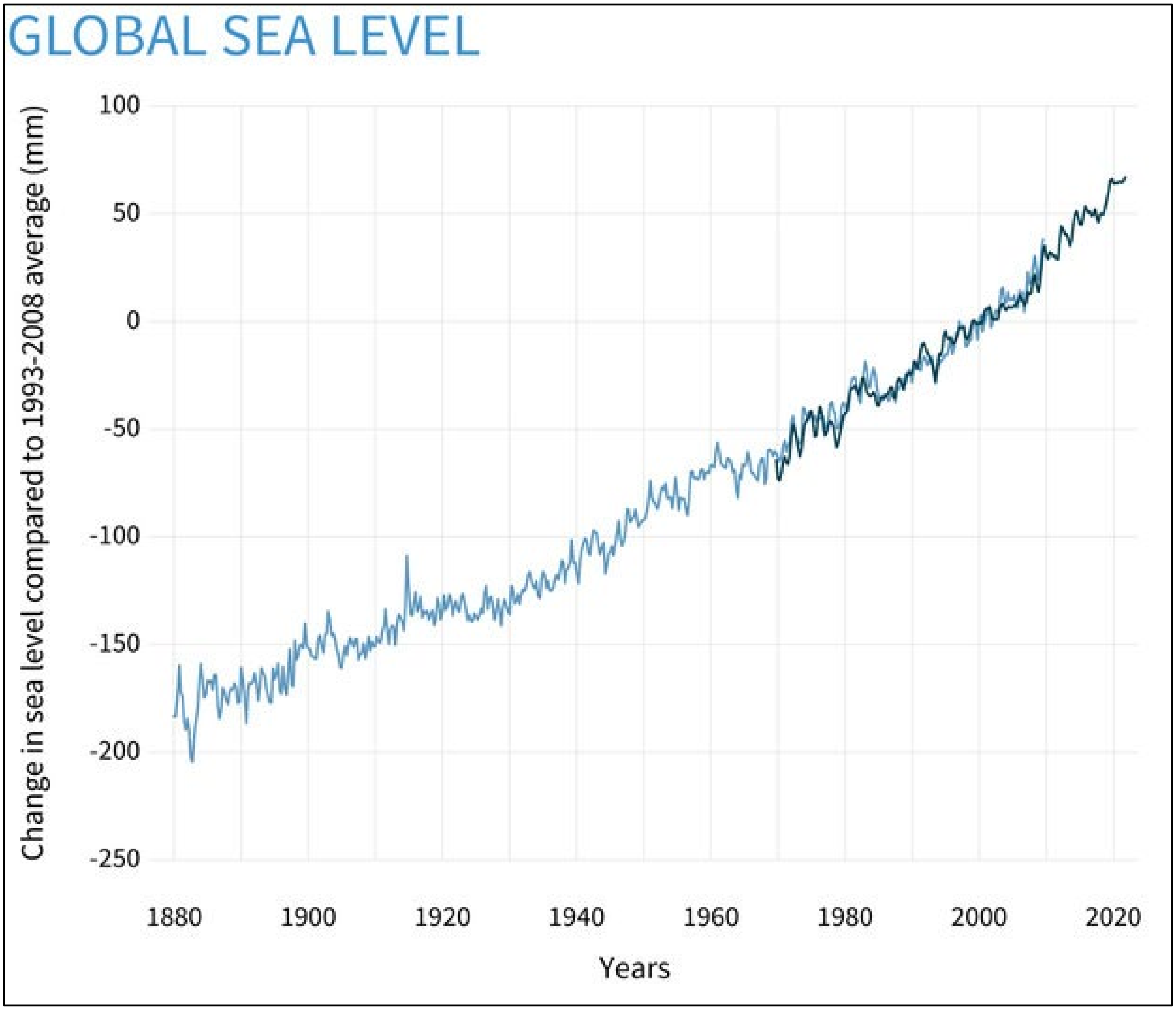
Source: (NOAA 2022)

- **Ocean Acidification**. Rising carbon dioxide in the atmosphere is taken-up (dissolved) in seawater, causing the pH of the ocean to drop or acidify with negative impacts to organisms that make calcium carbonate shells, such as calcareous plankton, corals, and mollusks. Measurements at Station ALOHA over the last 20 years have documented that the surface ocean around the State of Hawaiʻi has grown more acidic (University of Hawaiʻi at Mānoa Sea Grant College Program 2014) (Fletcher 2010).

Sea Level Rise

Global mean sea level rise has been observed over the last century in tide station data from around the world and, more recently, in satellite-based ocean height measurements. The rate of global sea level rise has accelerated over the past century, as seen in Figure 4.2-3, and global mean sea level has risen by 8 to 9 inches since 1880. In 2017 and 2020, the Honolulu Harbor Tide gauge recorded its highest daily mean water levels over the previous 112 years. The record high sea levels included a combination of global sea level rise, peak astronomical tides, wave setup, and migration of warm waters brought by winds and currents (DLNR OCCL 2022).

Figure 4.2-3. Global Sea Level Since 1880

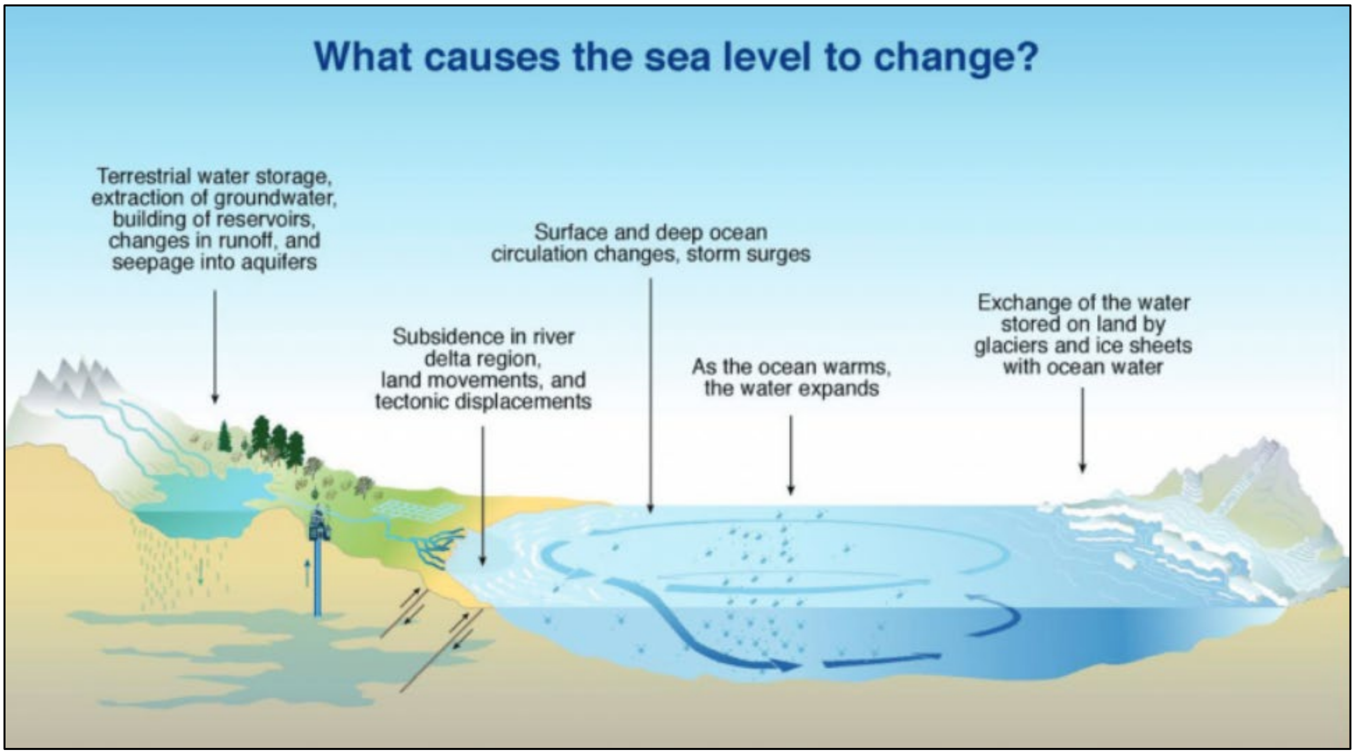


Source: (Lindsey 2022)

Note: The light blue line shows seasonal (3-month) sea level estimates from Church and White (2011). The darker line is based on University of Hawaiʻi Fast Delivery sea level data.

There are two types of sea level rise: global and relative (local). Global sea level rise refers to the increase currently observed in the average global sea level trend. This is primarily attributed to changes in ocean volume due to ice melt and thermal expansion. The melting of glaciers and continental ice masses can contribute significant amounts of freshwater input to the earth's oceans. In addition, observed increase in global ocean temperature causes an expansion of seawater, increasing ocean volume (NASA 2020). Refer to Figure 4.2-4 for an illustration of what causes sea level to change.

Figure 4.2-4. Causes of Sea Level Change



Source: (NASA 2020)

Relative (or local) sea level is affected by global sea level fluctuations, changes in land elevation, winds, and ocean circulation. It refers to the height of the water as measured along the coast relative to a specific point on land. Tide stations measure local sea level rise. Water measurements at the tide stations are referenced to stable vertical points on the land, and a known relationship is established. Measurements at any given tide station include both global sea level rise and vertical land motion (subsidence, glacial rebound, or large-scale tectonic motion). Since the heights of both the land and water change, the land-water interface can vary spatially and temporally and must be defined over time. Depending on the rates of vertical land motion relative to changes in sea level, observed local sea level trends may differ from the average rate of global sea level rise and vary from one location to the next. Relative, local sea level change should be considered in hazard assessment and adaptation planning, including coastal mapping, marine boundary delineation, coastal zone management, coastal engineering, sustainable habitat restoration design, and the general public enjoying their favorite beach (NOAA 2022).

Rising sea level and projections of stronger and more frequent El Niño events and tropical cyclones in waters surrounding the State of Hawaiʻi all indicate a growing vulnerability to coastal flooding and erosion (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017) (EPA 2016). Changing sea levels can affect human activities in coastal areas. Rising sea level inundates low-lying wetlands and dry land, erodes shorelines, contributes to coastal flooding, and increases the flow of salt water into estuaries and nearby groundwater aquifers. Coastal areas become more vulnerable to damage from storms as well (EPA 2016).

Location

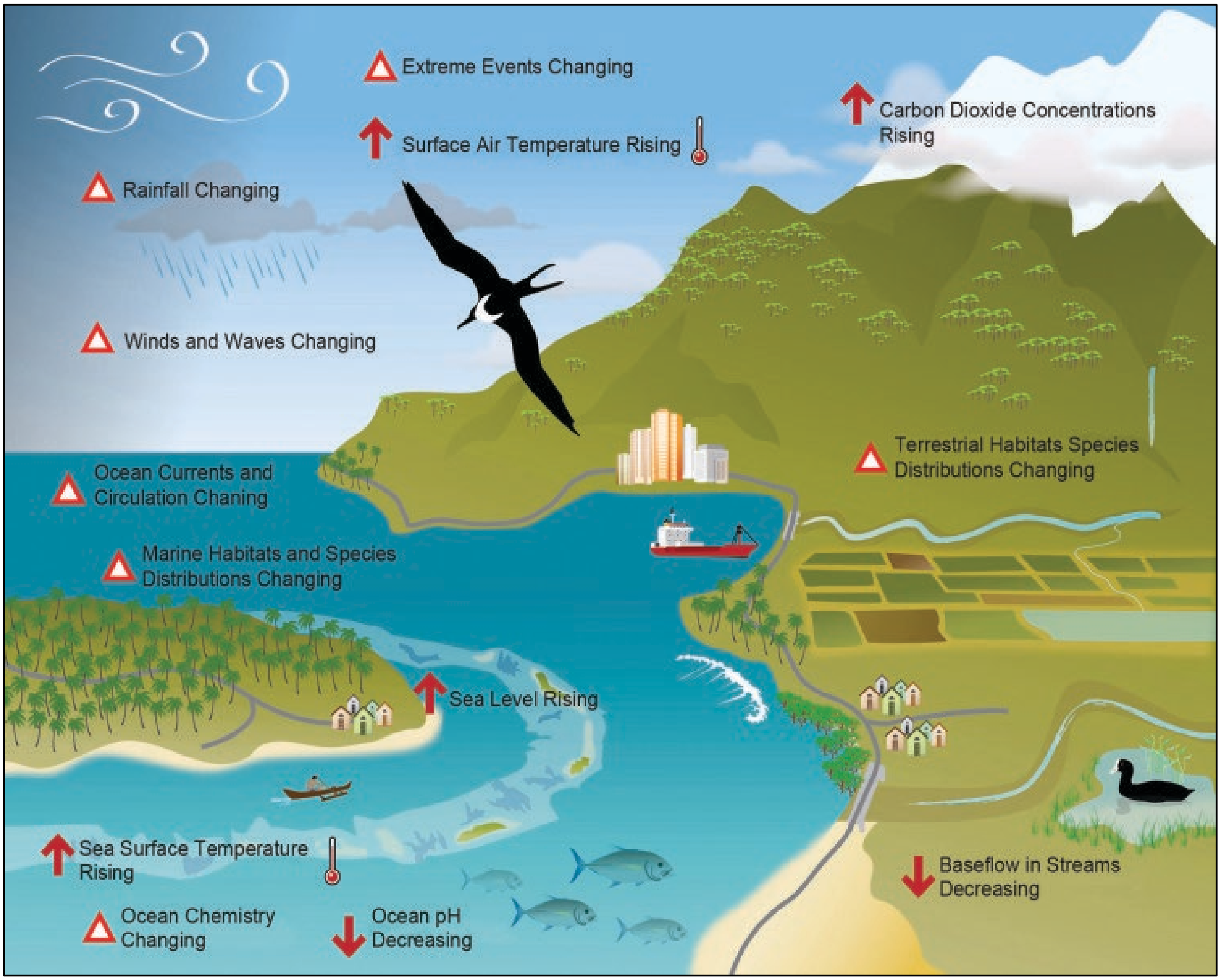
The State of Hawaiʻi is experiencing climate change and sea level rise impacts in unique, region-specific ways. Climate change and sea level rise can impact marine ecosystems, coasts and the built environment, terrestrial ecosystems, freshwater resources, and human health. Some of these impacts have already been observed, while others are projected to manifest in the coming years (U.S. Global Change Research Program 2018)

Climate change will increasingly be felt from the upper reaches of each island to the sea and throughout the entire archipelago, including the main Hawaiian Islands and Northwestern Hawaiian Islands. Figure 4.2-5 shows the key indicators of climate change in the Hawaiian Islands and the relative location of these changes.

The local relative rates of sea level rise vary among the Hawaiian Islands due to varying rates of subsidence along the volcanic island chain and possibly, in part, due to oceanic variability. As seen in Figure 4.2-6, the relative rate of sea level rise on the Island of Hawaiʻi is almost twice the rate on the Island of Kauaʻi. This is due to the fact that the Island of Hawaiʻi is slowly subsiding as it gains mass from active volcanoes, resulting in a higher relative rate of sea level rise while the Islands of Kauaʻi and Oʻahu, which are older islands, are relatively stable (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017) (NOAA 2022).

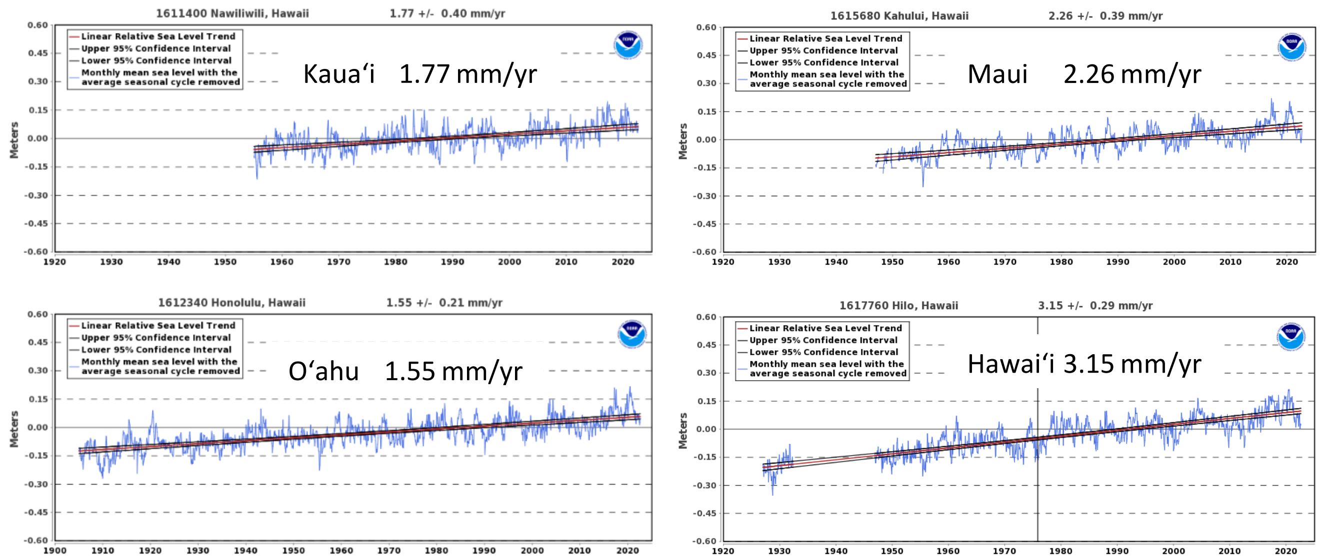
Modeling was conducted using the best available data and methods to determine the potential future exposure of the State of Hawaiʻi to multiple coastal hazards as a result of sea level rise (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017). In a 2022 update to an interagency report looking at the latest peer-reviewed science on sea level rise projections, findings included that a 3.2 feet of sea level rise will happen by 2100 in an “intermediate” (mid-range) scenario (Sweet, et al. 2022) for the contiguous United States. However, the “intermediate” scenario for Hawaiʻi is estimated at 3.9 feet of sea level rise by 2100 (DLNR OCCL 2022). As noted in the 2017 *Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report* and discussed in the chronic coastal flood section of this plan (Section 4.6 Flood), current or near-term exposure to coastal hazards is assessed using the Sea Level Rise Exposure Area with 1.1 feet of sea level rise (SLR-XA-1.1). To assess mid- to late century sea level rise on chronic coastal flooding, the Sea Level Rise Exposure Area with 3.2 feet of sea level rise (SLR-XA-3.2) is used for the 2023 SHMP Update, which is the best available exposure data. These maps may be seen on the Hawaiʻi Sea Level Rise Viewer located at: hawaiisealevelriseviewer.com.

Figure 4.2-5. Indicators of Climate Change in the Pacific Islands Region



Source: (V. W. Keener 2012)

Figure 4.2-6. Observed Mean Sea Level Rise Trends and Rates of Rise in the Hawaiian Islands



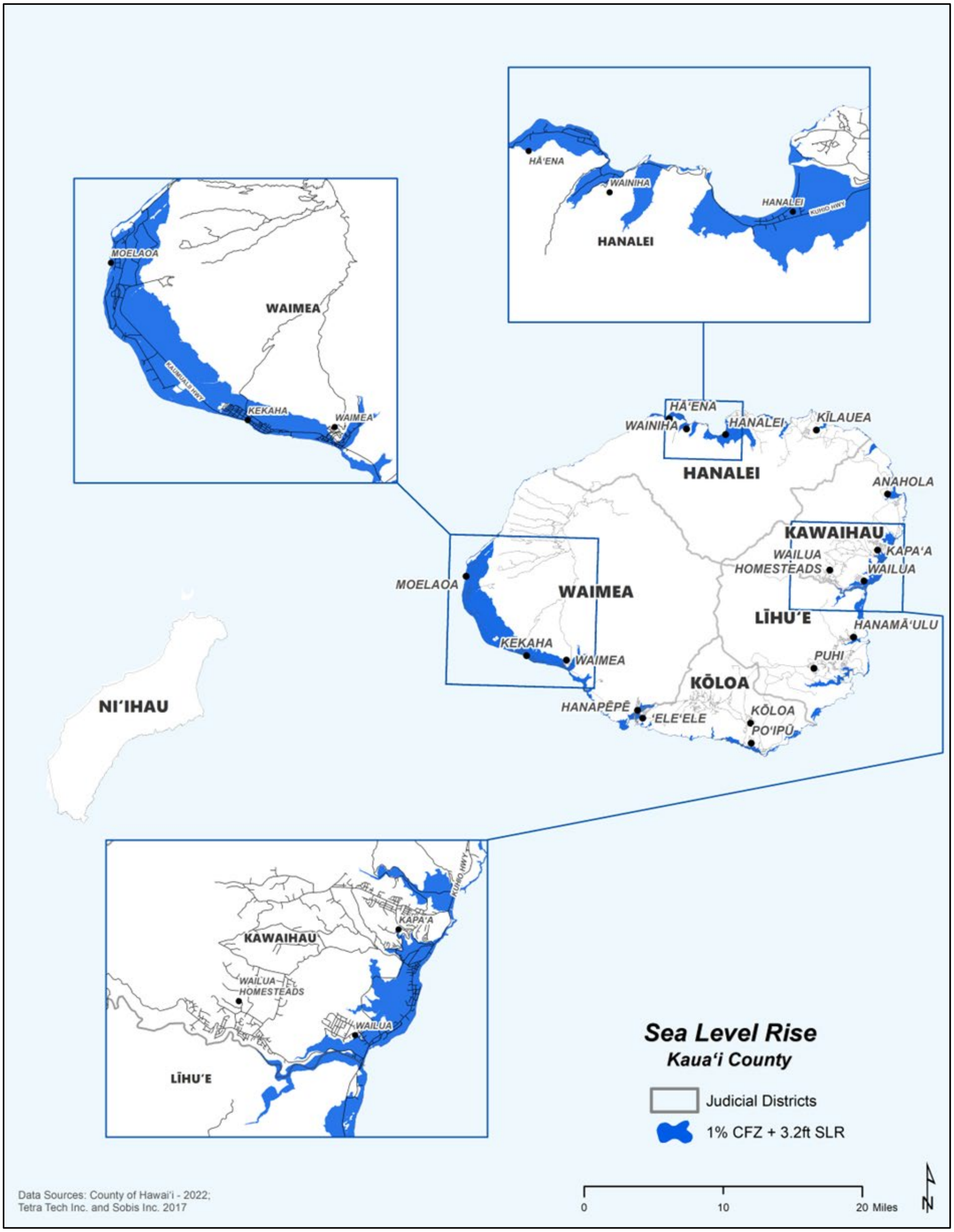
Source: (NOAA Tides & Currents 2022)

Key Terms

- **SLR-XA** – The Sea Level Rise Exposure Area represents the area exposed to chronic coastal flooding and land loss based on modeling of passive flooding, annual high wave flooding and coastal erosion (refer to Section 4.0 for further details).
- **Chronic Coastal Flood** – The SLR-XA with 1.1 feet of sea level rise (SLR-XA-1.1) approximates current or near-term exposure to chronic coastal flooding discussed in Section 4.2.
- **SLR-XA-3.2** – The SLR-XA with 3.2 feet of sea level rise was used to assess mid- to late century exposure to chronic coastal flooding.
- **Event-Based Flood** – The 1% annual chance flood as depicted on the FEMA Flood Insurance Rate Maps, also known as the Special Flood Hazard Area (inclusive of V- zones, or wave velocity zones with waves 3 feet or greater, and A-zones or flooded areas not subject to waves greater than 3 feet), was assessed in Section 4.7.
- **1%CFZ-3.2** – The 1% annual chance coastal flood zone with 3.2 feet of sea level rise was used to assess mid- to late century event-based coastal flooding.

The 1% annual chance coastal flood zone (referred to as the 1%CFZ) will expand with sea level rise meaning that more land area will be exposed to damaging wave impacts from a 100-year flood event. The 1%CFZ with 3.2 feet of sea level rise (1%CFZ-3.2) was utilized to assess mid- to late century sea level rise on coastal event-based flooding. The event-based flood hazard discussed in Section 4.6 assesses the entire Special Flood Hazard Area (V- and A-zones). Sea level rise effects on event-based flooding only includes the coastal flood zones. The 1%CFZ-3.2 areas are shown in Figure 4.2-7 through Figure 4.2-10.

Figure 4.2-7. 1% Annual Chance Coastal Flood Event with 3.2-feet of Sea Level Rise (1%CFZ-3.2) for the County of Kaua'i



Note: Ni'ihau was not modeled

Figure 4.2-8. 1% Annual Chance Coastal Flood Event with 3.2-feet of Sea Level Rise(1%CFZ-3.2) for the City and County of Honolulu

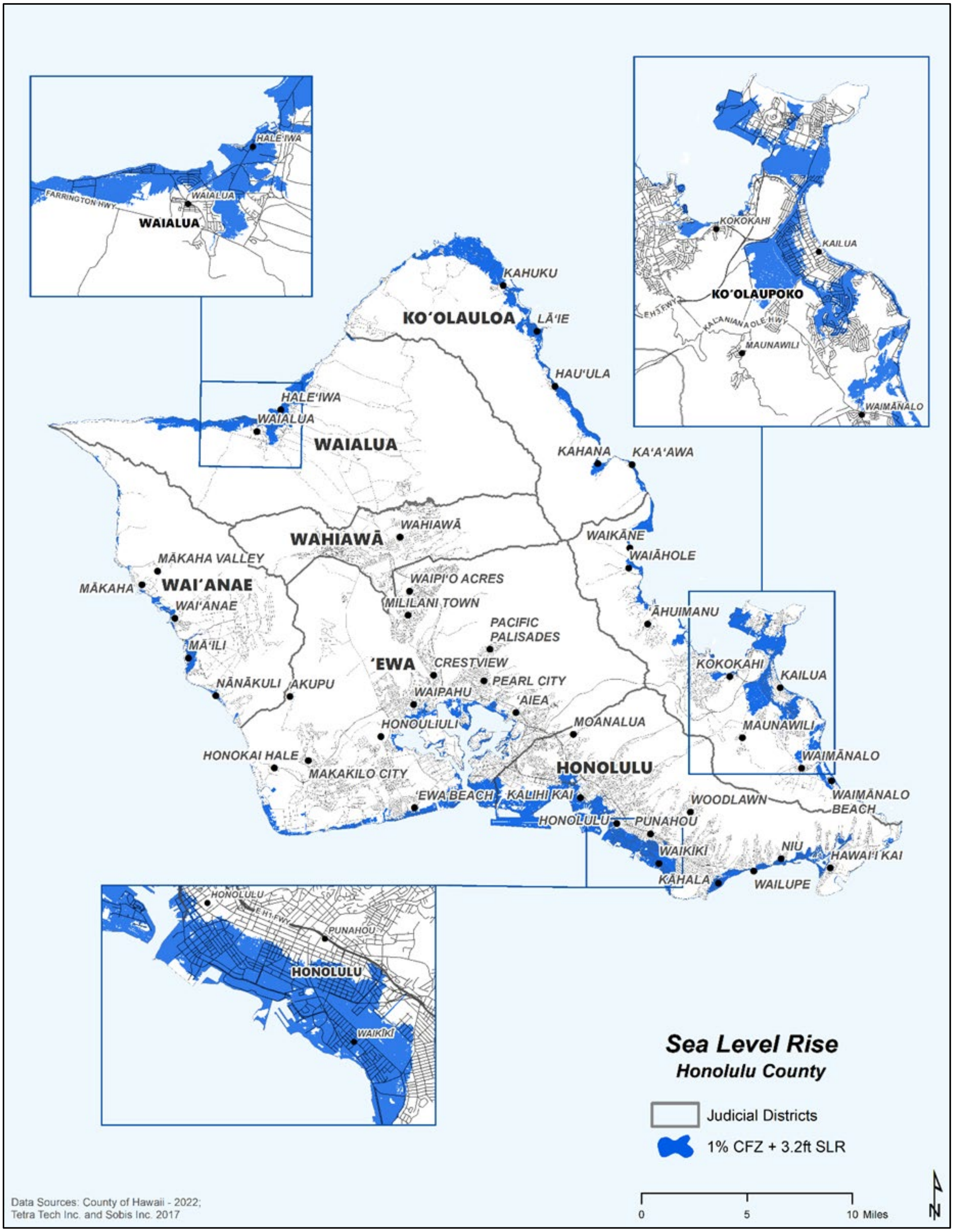
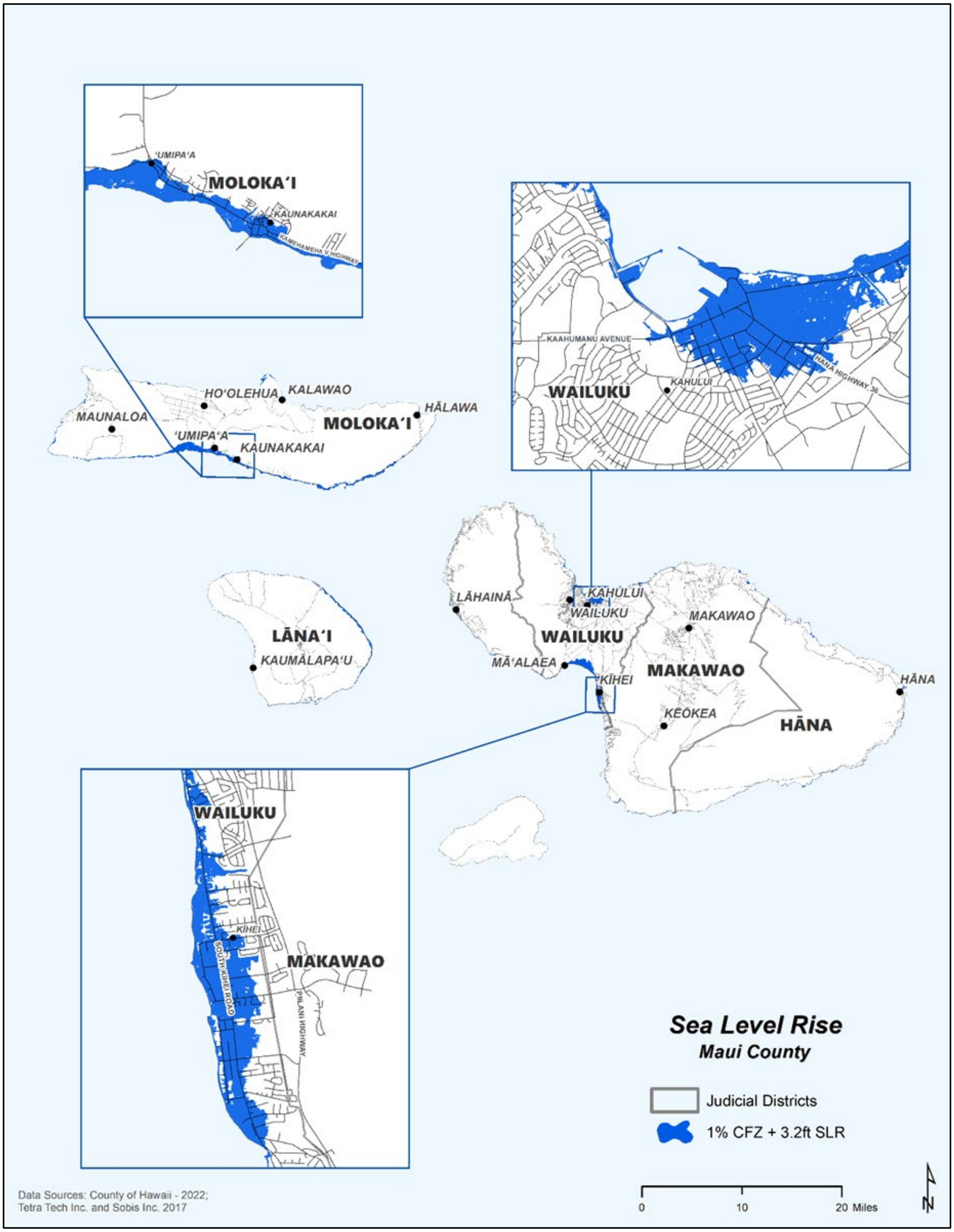


Figure 4.2-9. 1% Annual Chance Coastal Flood Event with 3.2-feet of Sea Level Rise (1%CFZ-3.2) for the County of Maui



Note: Kahoʻolawe was not modeled

Figure 4.2-10. 1% Annual Chance Coastal Flood Event with 3.2-feet of Sea Level Rise (1%CFZ-3.2) for the County of Hawai'i

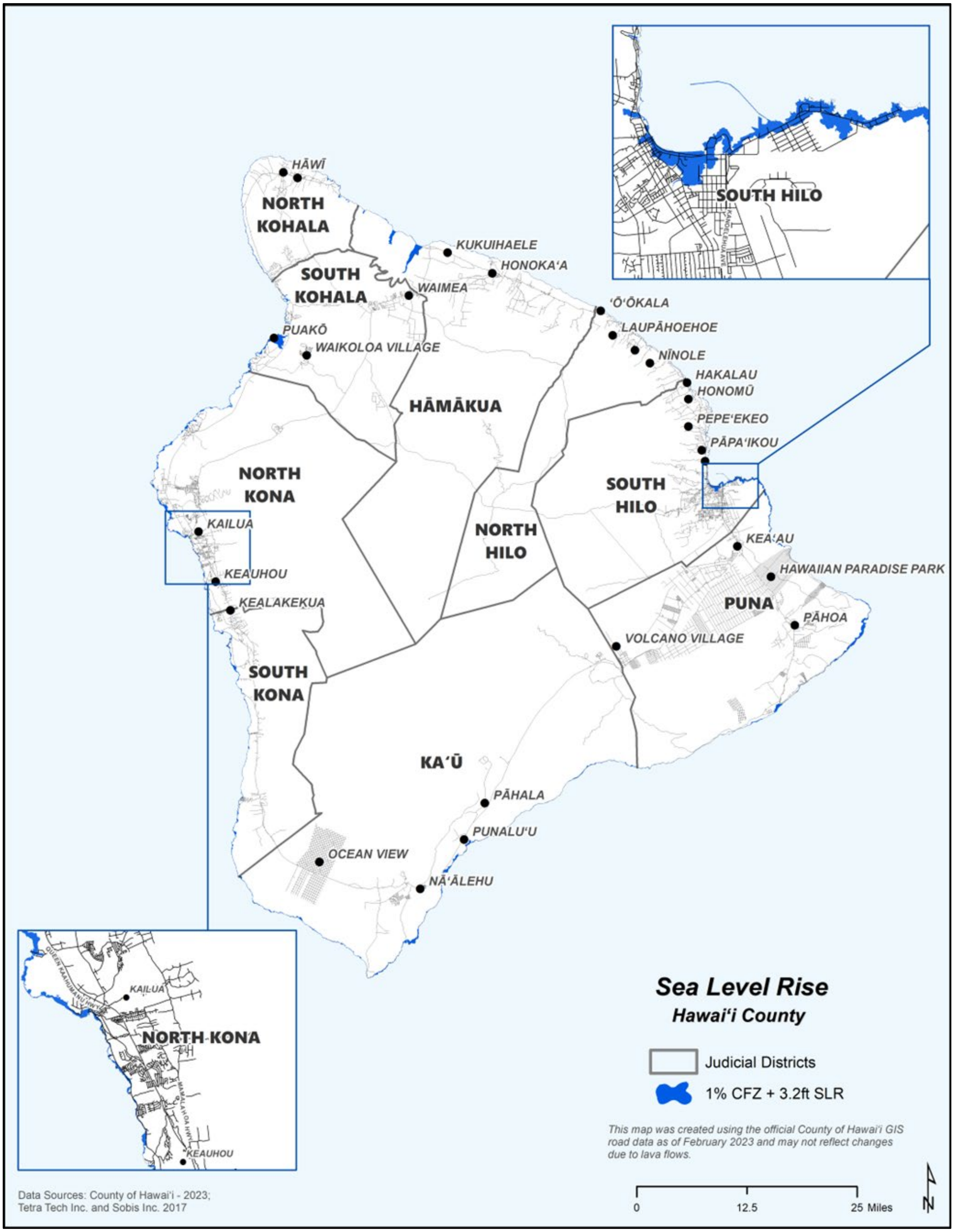


Table 4.2-1 shows the estimated square miles of potential land loss/impact due to 3.2 feet of sea level rise for each county. The state's total potential lost area due to chronic coastal flooding with sea level rise will amount to an estimated 0.5 percent of the state's total land area; however, it comprises of some of the most developed and valued land. When examining the 1% annual chance coastal flood event with 3.2 feet of sea level rise, 1.7 percent of the state's land will be impacted. The City and County of Honolulu, with its expansive coastal plains, will have the most land unusable due to sea level rise, followed by the Counties of Kauaʻi and Maui.

Table 4.2-1. Sea Level Rise Hazard Areas by County

County	Area				
	Total Area (square miles)	SLR-XA-3.2 (square miles)	SLR-XA-3.2 as % of Total Area	1%CFZ-3.2 (square miles)	1%CFZ-3.2 Area as % of Total Area
County of Kauaʻi	624.3	8.8	1.4%	32.8	5.3%
City and County of Honolulu	598.6	13	2.2%	41.2	6.9%
County of Maui	1,176.3	7.8	0.7%	15.7	1.3%
County of Hawaiʻi	4,039.6	4.3	0.1%	19.4	0.5%
Total	**6,438.8**	**33.9**	**0.5%**	**109.1**	**1.7%**

Source: *Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017; Tetra Tech Inc. and Sobis Inc. 2017, U.S. Census Bureau 2021*

EXTENT

Climate Change

Increasing temperatures, and in some areas, reduced rainfall will stress native plants and animals, especially in high-elevation ecosystems with increasing exposure to invasive species, increasing the risk of extinctions and wildfire (see Section 4.15 Wildfire). Increasing temperatures will significantly impact the population due to the health risks of heat stress and heat emergencies, the increase of vector-borne diseases, and increased wildfire and wildfire smoke hazards. Marine heatwaves will become more frequent, extensive, and intense (IPCC 2019). Freshwater supplies are already constrained and will become more limited on many Hawaiian Islands (Keener, et al. 2018). In areas where precipitation does not increase, freshwater supplies will be adversely affected as the air temperature rises.

Sea Level Rise

Rising sea levels, coupled with high water levels caused by storms, will incrementally increase coastal flooding and erosion, damaging coastal ecosystems, infrastructure, and agriculture, and negatively affecting tourism (Keener, et al. 2018). As noted earlier, the latest peer-reviewed science on Hawaiʻi sea level rise projections and finds that 3.9 feet of sea level rise will happen by 2100 in an "intermediate" (mid-range) scenario (DLNR OCCL 2022).

Sea level is measured by two main methods: tide gauges and satellite laser altimeters. Tide gauge stations from around the world have measured the daily high and low tides for over a century. Using data from these stations, scientists can calculate a global average of change. Since the early 1990s, sea level has been measured from space using laser altimeters. This method determines the height of the sea surface by measuring the return speed and intensity of a laser pulse directed at the ocean. The higher the sea level, the faster and stronger the return signal

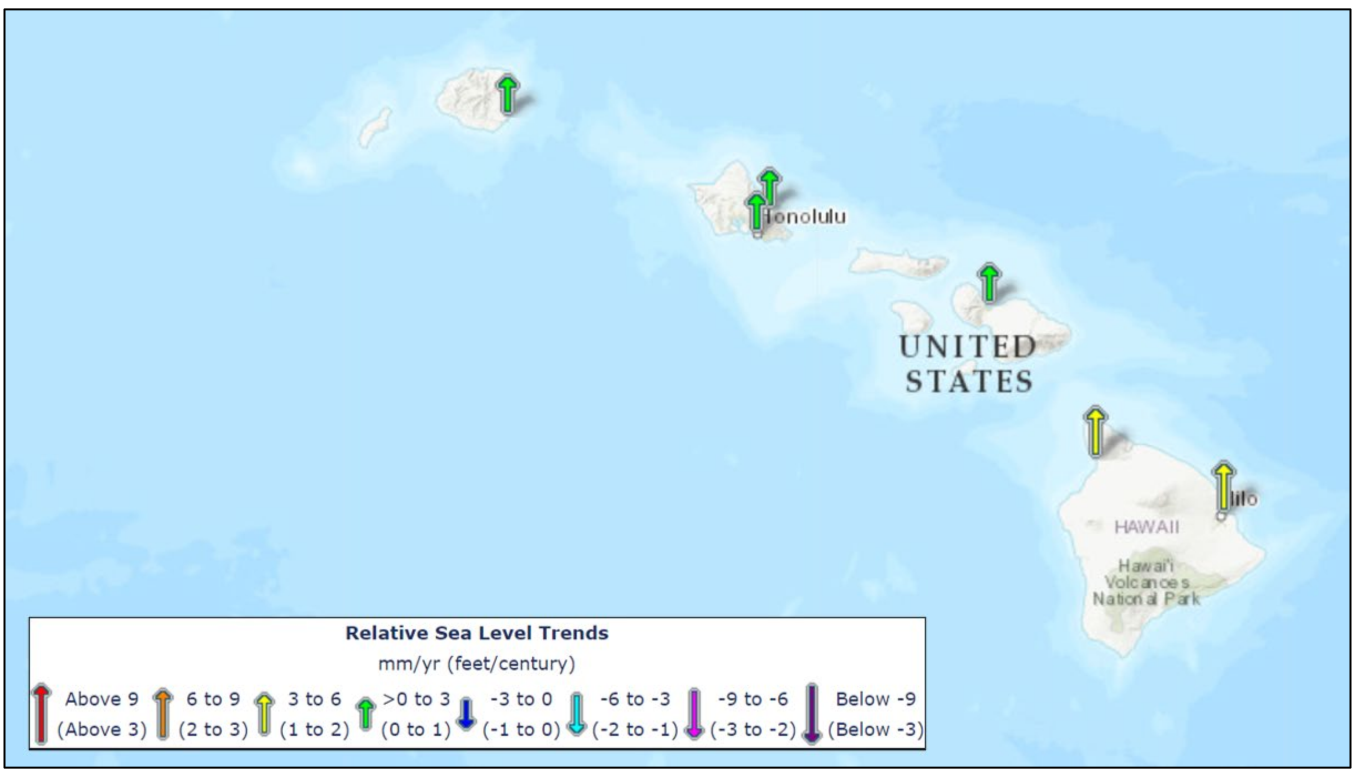
(NASA Earth Observatory 2020). Figure 4.2-11 illustrates the regional trends in sea level rise from local tide gauges for the State of Hawaiʻi. The arrows represent the direction and magnitude of change. Sea level trends in the State of Hawaiʻi are on the rise and range between 1.55 to 3.87 millimeters per year (mm/yr). Table 4.2-2 lists these changes for the State of Hawaiʻi by station. These rates are based on linear trends (a best-fit straight line). Global sea level rise is accelerating. Extrapolating these local linear trends decades into the future would underestimate future sea level rise based on scenarios in the *Global and Regional Sea Level Rise Scenarios for the United States* (Sweet, et al. 2022). Acceleration is expected and may already be occurring around Hawaiʻi but has not been measure due to shorter-term variability in the individual tide gauge records.

Table 4.2-2. Linear Mean Sea Level Trends and 95% Confidence Intervals

Station Name	First Year	Year Range	Mean Sea Level Trend (millimeter per year)	+/- 95% Confidence Interval	Equivalent To
Nāwiliwili	1955	66	1.77	0.40	0.58 feet in 100 years
Mokuoloʻe	1957	64	1.69	0.52	0.55 feet in 100 years
Honolulu	1905	116	1.55	0.21	0.51 feet in 100 years
Kahului	1947	74	2.26	0.39	0.74 feet in 100 years
Kawaihae	1988	33	3.87	1.13	1.27 feet in 100 years
Hilo	1927	94	3.15	0.29	1.03 feet in 100 years

Source: (NOAA Tides & Currents 2022)

Figure 4.2-11. Sea Level Trends in the State of Hawaiʻi



Source: (NOAA Tides & Currents 2022)

Previous Occurrences and Losses

Disaster and Emergency Declarations

No FEMA, USDA, or State of Hawaiʻi disaster declarations or proclamations for climate change and sea level rise have been issued relevant to Hawaiʻi or any of its counties.

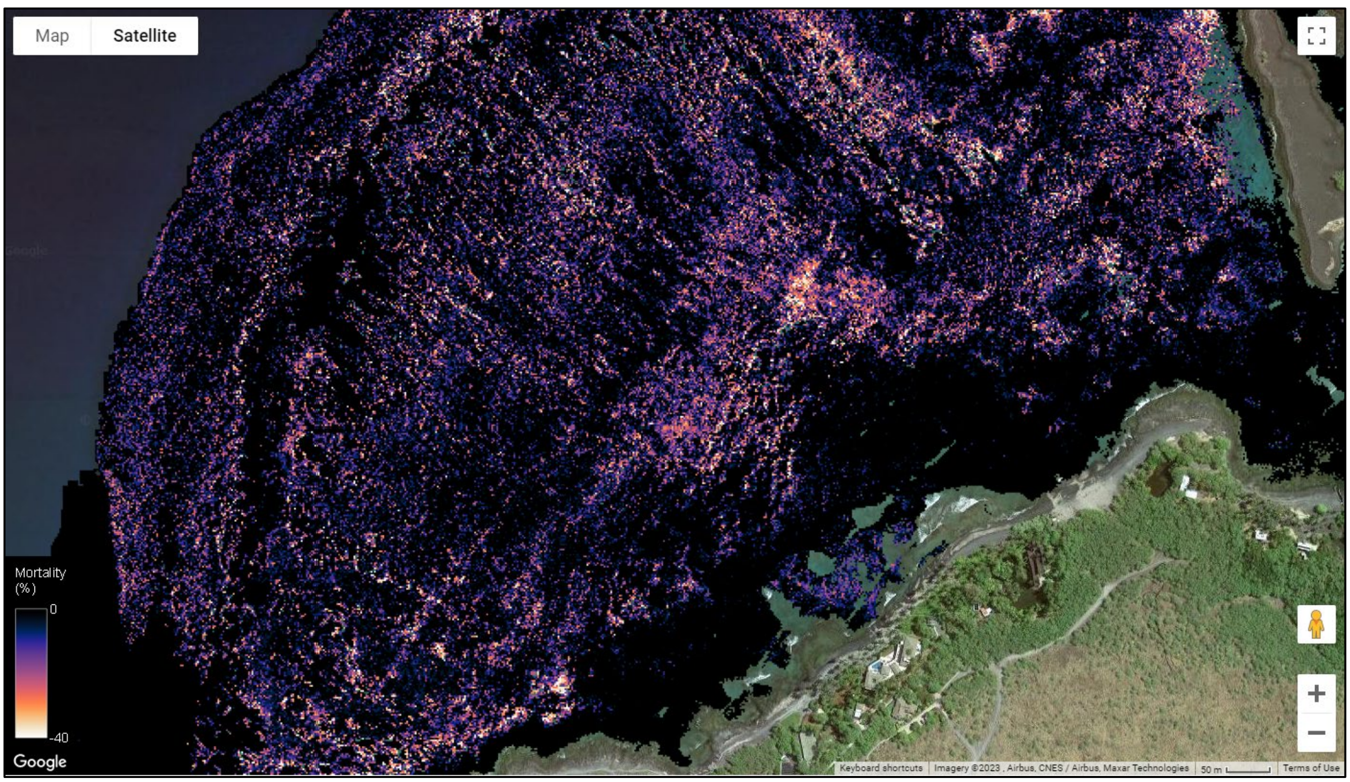
Event History

Climate Change

Climate change is a broad category that encompasses different types of events such as extreme heat, increased drought, and intense storms. Drought, Flood, Hurricane, and Windstorm event histories are discussed in their respective sections. Historical extreme heat is discussed here.

In 2019, an intense marine heatwave impacted areas from Alaska to Caliornia and Hawaiʻi. Across the State of Hawaiʻi, 273 daily high air temperature records were tied or broken (Harlow 2020). The increased ocean tempertures caused coral bleaching and loss. Figure 4.2-12 shows the percentage of coral mortality in the Kiholo Bay area of Hawaiʻi Island from the 2019 marine heatwave.

Figure 4.2-12. Coral Loss From the 2019 Marine Heatwave



Source: (Hawaiʻi Coral 2023)

Sea Level Rise

Sea level has been rising in the State of Hawaiʻi for the past century or more (refer to Table 4.2-2, Figure 4.2-6, and Figure 4.2-11). Rates of rise vary among the islands due to differing rates of subsidence based on distance from the actively-growing Island of Hawaiʻi. Other observations related to climate change and sea level rise in the State of Hawaiʻi include 70 percent of the beaches in the State of Hawaiʻi are undergoing chronic erosion (landward retreat), and over 13 miles of beach have been completely lost to erosion over the past century fronting seawalls and other shoreline structures. This dominant trend of beach erosion appears to be driven in part by local sea level rise (Anderson, et al. 2018, Romine, et al. 2013). Additional factors in addition to sea level rise contribute to coastal erosion and may be discussed in more detail pending further studies and development of erosion data. Shoreline retreat, wetland migration, and cliff collapse due to erosion are occurring on many of the coastlines in the State of Hawaiʻi. Groundwater tables in the state's low-lying coastal plains will rise with sea level rise and increasingly contribute to chronic coastal flooding and flooding (i.e., reduced drainage) with heavy rainfall events (Habel, et al. 2017). In addition, rising sea level will reduce the effectiveness and cause flooding through the state's coastal storm water drainage infrastructure.

Probability of Future Hazard Events

Overall Probability

The State of Hawaiʻi is currently experiencing the impacts of climate change. Surface temperatures are rising, rainfall and stream flow have decreased, rain intensity is increasing, sea level and sea surface temperatures have increased, and the ocean is acidifying. It is anticipated that these trends will continue or accelerate, causing further increases in temperature, extreme variation in precipitation (resulting in droughts or flooding), potential changes in storm systems (possibly more frequent or increased magnitude), and continued rise in sea levels, impacting the state's water resources and forests, coastal communities, and marine ecology (Fletcher 2010).

As global temperatures continue to increase, sea level will rise at increasing rates. The rate of future carbon dioxide emissions and future climate change determines how much the sea level will rise. The speed at which it rises depends mostly on the rate of glacier and ice sheet melting (Lindsey 2022, Sweet, et al. 2022). Sea level is projected to rise 3.2 feet the latter half of the century and impacts are assessed further in the Vulnerability Assessment below (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017). In summary, consequences of sea level rise for the State of Hawaiʻi are severe compared to many other coastal states, as the majority of the population, public infrastructure, and economic sectors exist on low-lying coastal plains which are highly susceptible to coastal hazards (Courtney, et al. 2020)

Research using numerical climate models point to increasing frequency and severity of extreme El Niño and La Niña events (Cai, et al. 2014). The impacts of El Niño may exacerbate the consequences of sea level rise. El Niño events in the tropical Pacific Ocean can cause sea levels to rise 6 to 12 inches above mean conditions in some areas are typically characterized by higher waves in winter (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017). Tropical cyclone activity is also increased around Hawaiʻi in El Niño years (NOAA n.d.).

Climate Change Impacts

Extreme heat events are expected to increase statewide. The increase in temperatures will be amplified in low-lying urban areas with a diminished tree canopy. This may include the built-up areas of the City and County of Honolulu, Kahului in Maui County, Līhuʻe in Kauaʻi County, and Kona and Hilo in Hawaiʻi County. Average temperatures are increasing by 0.3°F every decade, at four times the rate of 50 years ago.

Hawaiʻi has lost 1.5 million acres of native forests statewide. Forests are natural water and climate regulators. Climate change and forest contribute to a drier and hotter environment throughout the state. Wildfires amplified by climate change are anticipated to degrade air quality and increase landslides. Increases in sea surface temperatures will cause increasingly irregular patterns of drought, heavy rainstorms, and instense hurricanes. Warmer ocean water will continue to degrade and destroy coral reefs which will leave coastal areas unprotected from coastal flooding hazards (State of Hawaiʻi Climate Change Portal 2023).

Sea level rise is driven by climate change. As the planet warms, land ice melts and flows into the ocean. The volume of the ocean is expanding as the water temperature increases (Lindsey 2022, Sweet, et al. 2022). The "intermediate" scenario for Hawaiʻi is estimated at 3.9 feet of sea level rise by 2100. Models indicate that Hawaiʻi will experience sea level rise that is 16 to 20 percent higher than the global average (DLNR OCCL 2022).

4.2.2 VULNERABILITY ASSESSMENT

A statewide sea level rise exposure analysis was conducted for two flood scenarios, chronic coastal flooding (SLR-XA-3.2) and event-based coastal flooding with 3.2 feet of sea level rise (1%CFZ-3.2). The SLR-XA-3.2 data was generated for the Hawaiʻi Climate Mitigation and Adaptation Commission. Overall, vulnerability to SLR-XA-3.2 is the potential permanent loss of land and buildings and displacement of population located in the SLR-XA-3.2 hazard area due to chronic flooding. Land that is flooded in the 1%CFZ-3.2 is not considered "lost" because it is assumed the flooding is temporary and the floodwaters would recede. However, buildings and natural resources on that land may be damaged or destroyed as a result of the event. Therefore, vulnerability to the 1%CFZ-3.2 is the potential damage to assets as a result of the event-based coastal flooding exacerbated by sea level rise.

Sea Level Rise Hazard Area Definitions

SLR-XA-3.2 – To assess chronic coastal flood with mid- to late century sea level rise, the Sea Level Rise Exposure Area with 3.2 feet of sea level rise was used. The hazard area is called SLR-XA-3.2.

1%CFZ-3.2 – To assess the 1% annual chance coastal flood in mid- to late century, the 1% annual chance coastal flood with 3.2 feet of sea level rise was used. The hazard area is called 1%CFZ-3.2.

Assessment of State Vulnerability and Potential Losses

This section discusses statewide vulnerability of exposed state assets (state buildings and roads), community lifelines, and critical facilities to climate change and sea level rise hazards.

State Assets

Across the state, there are 54 state buildings that may be compromised or lost due to sea level rise (SLR-XA-3.2). Almost all of these buildings are located in the City and County of Honolulu (51 of the 55 buildings with a replacement cost value of nearly $57 million). Only replacement cost value was available for state buildings and reported as the total economic loss. However, a more accurate reflection of loss to the SLR-XA-3.2 hazard would be the combined value of the land and structure.

Table 4.2-3 summarizes the state buildings located in the SLR-XA-3.2 by county. The Department of Education has the greatest number of buildings (37) in the SLR-XA-3.2 hazard area as seen in Table 4.2-4. The loss of these structures may result in the interruption and/or relocation of state services if they remain in their present locations.

Table 4.2-3. Estimated State Building Loss from Sea Level Rise (SLR-XA-3.2) by County

County	Total Number of State Buildings	Total Value	Number of State Buildings in SLR-XA-3.2	Percent (%) of Total Buildings	Total Value of State Buildings in SLR-XA-3.2	Percent (%) of Total Value
County of Kaua'i	531	$990,850,824	1	0.2%	$248,896	0.03%
City and County of Honolulu	3,472	$17,393,945,915	51	1.5%	$56,886,036	0.3%
County of Maui	831	$3,097,491,689	2	0.2%	$370,372	0.01%
County of Hawai'i	1,261	$4,638,567,141	0	0.0%	$0	0.0%
Total	**6,095**	**$26,120,855,568**	**54**	**0.90%**	**$57,505,304**	**0.2%**

Source: State of Hawai'i Risk Management Office 2017; Hawai'i Climate Change Mitigation and Adaptation Commission 2017

Table 4.2-4. Estimated State Building Loss from Sea Level Rise (SLR-XA-3.2) by Agency

Agency	Total Number of State Buildings	Total Value	Number of State Buildings in SLR-XA-3.2	Percent (%) of Total Buildings	Total Value in SLR-XA-3.2	Percent (%) of Total Value
Dept. of Accounting & General Services	66	$953,963,738	0	0.0%	$0	0.0%
Dept. of Agriculture	70	$147,607,399	1	1.4%	$2,350,211	1.6%
Dept. of Attorney General	15	$108,425,480	0	0.0%	$0	0.0%
Dept. of Budget & Finance	16	$28,968,679	0	0.0%	$0	0.0%
Dept. of Business, Economic Development and Tourism	25	$645,480,379	1	4.0%	$2,300,000	0.4%
Dept. of Commerce & Consumer Affairs	2	$40,197,360	0	0.0%	$0	0.0%
Dept. of Defense	69	$267,352,836	0	0.0%	$0	0.0%
Dept. of Education	4,090	$10,598,205,739	37	0.9%	$16,732,208	0.2%
Dept. of Hawaiian Home Lands	12	$110,427,352	1	8.3%	$5,489,080	5.0%
Dept. of Health	44	$387,068,440	0	0.0%	$0	0.0%
Dept. of Human Resources Development	1	$5,973,872	0	0.0%	$0	0.0%
Dept. of Human Services	130	$480,212,294	2	1.5%	$3,234,562	0.7%
Dept. of Labor and Industrial Relations	22	$90,076,209	0	0.0%	$0	0.0%

Agency	Total Number of State Buildings	Total Value	Number of State Buildings in SLR-XA-3.2	Percent (%) of Total Buildings	Total Value in SLR-XA-3.2	Percent (%) of Total Value
Dept. of Land and Natural Resources	90	$101,441,821	8	8.9%	$1,232,468	1.2%
Dept. of Public Safety	154	$440,774,415	0	0.0%	$0	0.0%
Dept. of Taxation	1	$7,174,162	0	0.0%	$0	0.0%
Dept. of Transportation	68	$2,935,208,214	1	1.5%	$3,754,468	0.1%
Hawaiʻi State Ethics Commission	1	$984,533	0	0.0%	$0	0.0%
Hawaiʻi Health Systems Corporation	106	$1,230,852,871	0	0.0%	$0	0.0%
Hawaiʻi Housing Finance & Development Corporation	86	$360,851,671	0	0.0%	$0	0.0%
Hawaiʻi Public Housing Authority	273	$982,981,701	1	0.4%	$5,340,000	0.54%
Hawaiʻi State Legislature	2	$48,555,381	0	0.0%	$0	0.0%
Hawaiʻi State Public Library System	53	$525,584,082	0	0.0%	$0	0.0%
Judiciary	41	$534,877,354	0	0.0%	$0	0.0%
Legislative Reference Bureau	1	$2,996,162	0	0.0%	$0	0.0%
Office of Hawaiian Affairs	11	$54,125,645	1	9.1%	$248,896	0.5%
Office of the Auditor	2	$1,921,180	0	0.0%	$0	0.0%
Office of the Governor	1	$2,996,162	0	0.0%	$0	0.0%
Office of the Lieutenant Governor	2	$4,588,849	0	0.0%	$0	0.0%
Office of the Ombudsman	1	$1,818,060	0	0.0%	$0	0.0%
Research Corporation of the University of Hawaiʻi	3	$4,189,026	0	0.0%	$0	0.0%
University of Hawaiʻi	637	$5,014,974,503	1	0.2%	$16,823,413	0.3%
Total	**6,095**	**$26,120,855,568**	**54**	**0.9%**	**$57,505,304**	**0.2%**

Source: State of Hawaiʻi Risk Management Office 2017; Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017

Event-based coastal flooding from waves generated by infrequent but severe storms and other coastal hazards could occur at any time but will be exacerbated by sea level rise. There are 638 state buildings located in the 1%CFZ-3.2 area, of which the majority are in the City and County of Honolulu (458 buildings with a replacement cost value of $1.994 billion). Table 4.2-5 summarizes the state buildings located in the 1%CFZ-3.2 area by county. The Department of Education occupies the greatest number of buildings (392) that may be impacted as seen in Table 4.2-6.

Table 4.2-5. State Buildings Located in the 1%CFZ-3.2 by County

County	Total Number of State Buildings	Total Replacement Cost Value (RCV)	Number of State Buildings Exposed	Percent (%) of Total Buildings	Total RCV Exposed	Percent (%) of Total RCV
County of Kauaʻi	531	$990,850,824	112	21%	$205,951,080	21%
City and County of Honolulu	3,472	$17,393,945,915	458	13%	$1,994,518,893	11%
County of Maui	831	$3,097,491,689	50	6%	$176,627,159	6%
County of Hawaiʻi	1,261	$4,638,567,141	18	1%	$38,714,514	1%
Total	**6,095**	**$26,120,855,568**	**638**	**10%**	**$2,415,811,646**	**9%**

Source: State of Hawaiʻi Risk Management Office 2017; Tetra Tech Inc. and Sobis Inc. 2017

Table 4.2-6. State Buildings Located in the 1%CFZ-3.2 by Agency

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings Exposed	Percent (%) of Total Buildings	Total RCV Exposed	Percent (%) of Total Value
Dept. of Accounting & General Services	66	$953,963,738	10	15.15%	$167,495,223	17.56%
Dept. of Agriculture	70	$147,607,399	13	18.57%	$26,049,092	17.65%
Dept. of Attorney General	15	$108,425,480	4	26.67%	$31,157,323	28.74%
Dept. of Budget & Finance	16	$28,968,679	4	25.00%	$21,653,840	74.75%
Dept. of Business, Economic Development and Tourism	25	$645,480,379	4	16.00%	$15,921,383	2.47%
Dept. of Commerce & Consumer Affairs	2	$40,197,360	0	0.00%	$0	0.00%
Dept. of Defense	69	$267,352,836	9	13.04%	$29,801,107	11.15%
Dept. of Education	4,090	$10,598,205,739	392	9.58%	$891,873,401	8.42%
Dept. of Hawaiian Home Lands	12	$110,427,352	1	8.33%	$5,489,080	4.97%
Dept. of Health	44	$387,068,440	6	13.64%	$10,848,499	2.80%
Dept. of Human Resources Development	1	$5,973,872	0	0.00%	$0	0.00%
Dept. of Human Services	130	$480,212,294	30	23.08%	$179,075,774	37.29%
Dept. of Labor and Industrial Relations	22	$90,076,209	6	27.27%	$62,294,284	69.16%
Dept. of Land and Natural Resources	90	$101,441,821	32	35.56%	$16,570,694	16.34%
Dept. of Public Safety	154	$440,774,415	15	9.74%	$36,397,935	8.26%
Dept. of Taxation	1	$7,174,162	1	100.00%	$7,174,162	100.00%
Dept. of Transportation	68	$2,935,208,214	39	57.35%	$248,429,656	8.46%
Hawaiʻi State Ethics Commission	1	$984,533	0	0.00%	$0	0.00%
Hawaiʻi Health Systems Corporation	106	$1,230,852,871	1	0.94%	$936,734	0.08%
Hawaiʻi Housing Finance & Development Corporation	86	$360,851,671	5	5.81%	$118,247,972	32.77%
Hawaiʻi Public Housing Authority	273	$982,981,701	34	12.45%	$38,602,393	3.93%
Hawaiʻi State Legislature	2	$48,555,381	0	0.00%	$0	0.00%
Hawaiʻi State Public Library System	53	$525,584,082	11	20.75%	$25,026,076	4.76%
Judiciary	41	$534,877,354	5	12.20%	$74,290,061	13.89%
Legislative Reference Bureau	1	$2,996,162	0	0.00%	$0	0.00%
Office of Hawaiian Affairs	11	$54,125,645	6	54.55%	$43,013,415	79.47%
Office of the Auditor	2	$1,921,180	0	0.00%	$0	0.00%
Office of the Governor	1	$2,996,162	0	0.00%	$0	0.00%
Office of the Lieutenant Governor	2	$4,588,849	0	0.00%	$0	0.00%
Office of the Ombudsman	1	$1,818,060	0	0.00%	$0	0.00%
Research Corporation of the University of Hawaiʻi	3	$4,189,026	0	0.00%	$0	0.00%
University of Hawaiʻi	637	$5,014,974,503	19	2.98%	$446,172,321	8.90%
Total	**6,095**	**$26,120,855,568**	**647**	**10.62%**	**$2,496,520,425**	**9.56%**

Source: State of Hawaiʻi Risk Management Office 2017; Tetra Tech Inc. and Sobis Inc. 2017

Approximately 38.8 miles of state roads could be chronically flooded with 3.2 feet of sea level rise; with the majority of these roads located in the City and County of Honolulu (19.4 miles). The flooding may cause these roads to be impassible, which would jeopardize critical access to many communities and eventually lead to permanent road closures.

Statewide, there are more than 100 miles of state roads exposed to event-based coastal flooding in the 1%CFZ-3.2 hazard area. Many state roads serve as evacuation routes to higher ground. Not only will these roads be closed during coastal flood events and potentially isolate communities, the flood waters may accelerate the degradation of these roads leading to increased repair and replacement costs. The City and County of Honolulu has the greatest number of state (State Profile and Risk Assessment Supplement) road miles (50.9 miles) exposed to the 1%CFZ-3.2, followed by the Counties of Kauaʻi and Maui, respectively. More than 25% of the County of Kauai's state roads are located in the 1%CFZ-3.2 hazard area. Table 4.2-7 shows the length of state roads exposed to sea level rise by county. A complete list of state roads exposed is included in Appendix F (State Profile and Risk Assessment Supplement).

Table 4.2-7. State Roads Located in the Sea Level Rise Hazard Areas by County

County	Total Length (miles)	Miles of State Road in the SLR-XA-3.2	Percent (%) of Total Length	Miles of State Road in the 1%CFZ-3.2	Percent (%) of Total Length
County of Kauaʻi	103.7	7.4	7.1%	26.9	25.9%
City and County of Honolulu	374.9	19.4	5.2%	50.9	13.6%
County of Maui	245.9	11.8	4.8%	20.3	8.3%
County of Hawaiʻi	379.2	0.2	0.05%	2.8	0.7%
Total	**1,103.7**	**38.8**	**3.5%**	**100.9**	**9.1%**

Source: State of Hawaiʻi Department of Transportation 2022; Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017; Tetra Tech Inc. and Sobis Inc. 2017

Community Lifelines and Critical Facilities

Sea level rise may result in the permanent loss of community lifelines, including roads, airports, harbors, utility infrastructure, water/wastewater facilities and conveyance systems, and other public service facilities with cascading impacts statewide. There are 33 community lifelines located in the SLR-XA-3.2 hazard area (see Table 4.2-8). The County of Maui has the greatest number of community lifelines (14) exposed with the majority of the facilities being food, water, and shelter. Table 4.2-9 summarizes the number and percentage of exposed community lifelines. Food, water, and shelter have more than 4% of their facilities located in the SLR-XA-3.2 hazard area statewide. It is recognized that the replacement cost value listed in Table 4.2-9 does not depict an accurate loss estimate; however, this was the best available data for the 2023 SHMP Update. A more accurate reflection of loss to the SLR-XA-3.2 would be the combined value of the land and structure using tax-assessed data. In addition to land and structural loss, the loss of service by that community lifeline would further increase the total loss as a result of sea level rise.

Table 4.2-8. Community Lifelines and Critical Facilities Located in the SLR-XA-3.2, by County

County	Community Lifeline Categories								Additional Critical Facilities
	Communications	Energy	Food, Water, Shelter	Hazardous Material	Health & Medial	Safety & Security	Transportation	Total in the SLR-XA-3.2	
County of Kaua'i	0	0	2	0	0	4	0	6	0
City and County of Honolulu	1	1	6	0	2	3	0	13	
County of Maui	1	1	7	0	0	3	2	14	
County of Hawai'i	0	0	0	0	0	0	0	0	
Total	**2**	**2**	**15**	**0**	**2**	**10**	**2**	**33**	**0**

Source: Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020; Hawai'i Climate Change Mitigation and Adaptation Commission 2017

Table 4.2-9. Community Lifelines Located in the SLR-XA-3.2, by Category

Category	Total Number of Facilities	Total Value	Number of Facilities in SLR-XA-3.2	Percent (%) of Total Facilities	Value in the SLR-XA-3.2	Percent (%) of Total Value
Communications	188	$776,797,683	2	1.1%	$12,149,409	1.6%
Energy	89	$3,093,949,530	2	2.3%	$74,710,900	2.4%
Food, Water, Shelter	345	$11,847,189,588	15	4.4%	$546,303,600	4.6%
Hazardous Material	12	$436,474,800	0	0.0%	$0	0.0%
Health and Medical	193	$4,606,713,364	2	1.0%	$11,018,840	0.2%
Safety and Security	486	$38,164,188,232	10	2.1%	$4,218,454,122	11.1%
Transportation	56	$2,039,091,600	2	3.6%	$72,588,000	3.6%
Total	**1,369**	**$60,964,404,797**	**33**	**14.3%**	**$4,935,224,870**	**8.1%**

Source: Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020; Hawai'i Climate Change Mitigation and Adaptation Commission 2017

summarizes the total number of community lifelines and additional critical facilities located in the 1%CFZ-3.2 area by county. The City and County of Honolulu has the greatest number of critical facilities (119) within the hazard area with the majority of the facilities being food, water, and shelter.

Table 4.2-11 summarizes the number and percentage of exposed community lifelines and additional critical facilities. The transportation lifeline has 28.6% of its facilities within the hazard area.

Table 4.2-10. Community Lifelines and Critical Facilities Located in the 1%CFZ-3.2, by County

County	Community Lifelines								Additional Critical Facilities
	Communications	Energy	Food, Water, Shelter	Hazardous Materials	Health and Medical	Safety and Security	Transportation	Total in the 1%CFZ-3.2	
County of Kauaʻi	2	3	13	0	1	11	2	32	4
City and County of Honolulu	26	19	40	0	5	24	1	115	4
County of Maui	3	0	19	0	4	9	8	43	0
County of Hawaiʻi	2	2	17	1	0	1	5	28	2
Total	**33**	**24**	**89**	**1**	**10**	**45**	**16**	**218**	**10**

Source: *Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020; Tetra Tech Inc. and Sobis Inc. 2017*

Table 4.2-11. Community Lifelines and Critical Facilities Located in the 1%CFZ-3.2, by Category

Category	Total Number of Facilities	Total Replacement Cost Value	Number of Facilities in 1%CFZ-3.2	Percent of Total Facilities	Value in the 1%CFZ-3.2	Percent of Total Value
Communications	188	$776,797,683	33	17.6%	$100,222,641	12.9%
Energy	89	$3,093,949,530	24	27.0%	$823,383,230	26.6%
Food, Water, Shelter	345	$11,847,189,588	89	25.8%	$3,004,912,440	25.4%
Hazardous Material	12	$436,474,800	1	8.3%	$36,294,000	8.3%
Health and Medical	193	$4,606,713,364	10	5.2%	$112,519,594	2.4%
Safety and Security	486	$38,164,188,232	45	9.3%	$3,690,769,905	9.7%
Transportation	56	$2,039,091,600	16	28.6%	$581,650,800	28.5%
Additional Critical Facilities	106	$447,698,794	10	9.4%	$38,486,080	8.6%
Total	**1,369**	**$60,964,404,797**	**218**	**15.9%**	**$8,349,752,609**	**13.7%**

Source: *Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020; Tetra Tech Inc. and Sobis Inc. 2017*

Community lifelines located on the coast are exposed to the sea level rise hazard. The primary transportation arteries for the entry of people and goods to the state are the Daniel K. Inouye International Airport and Honolulu Harbor. The International Airport serves more than 21 million passengers and receives more than 382,000 tons of cargo annually (Daniel K. Inouye International Airport 2022). More than 10 million tons of commodities and more than 275,000 cruise ship passenger sailing pass through Honolulu Harbor each year (Department of Business, Economic Development & Tourism 2021).

In addition, each island has critical points of entry for people and goods which are considered vulnerable to sea level rise if located along the coast. Interruption of interisland and transoceanic shipping and travel would impact residents, visitors and all forms of economic activity (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017).

Assessment of Local Vulnerability and Potential Losses

This section provides a summary of vulnerability and potential losses to socially vulnerable and total populations, general building stock, environmental resources, and cultural assets. Similar to the analysis for state assets, a spatial exposure analysis was conducted. As noted above, vulnerability to SLR-3.2 is the potential permanent loss of assets and displacement of population located in the SLR-XA-3.2 hazard area. Vulnerability to the 1%CFZ-3.2 is the potential damage to assets as a result of event-based coastal flooding exacerbated by sea level rise.

The local HMPs were reviewed to integrate risk assessment results into the 2023 SHMP Update; a summary of information available is below.

- **County of Kauaʻi** – The County of Kauaʻi HMP provides an overview of how climate change will impact other hazards outlined in the County Risk Assessment, as well as an overview of sea level rise impacts to the county. To determine risk presented by sea level rise, Kauaʻi County utilized data from the Hawai'i Interagency Climate Adaptation Committee's Sea Level Rise Vulnerability and Adaptation Report to determine a Chronic Sea Level Rise Exposure Area (the area predicted to be inundated under ongoing normal conditions in the future) and Event-Based Sea Level Rise Inundation Area (the area that would be inundated under a 3.2-foot chronic sea-level-rise scenario if a 1 percent annual chance coastal flood event occurs). These analyses found that 17,221 Kaua'i residents and 8,448 buildings would be exposed in the Event-Based sea level rise area and 2,960 residents and 1,255 building would be exposed in the Chronic Exposure area. The County identified 229 critical facilities that would be impacted by both Chronic and Event-Based sea level rise. (County of Kauaʻi 2020).
- **City and County of Honolulu** – The City and County of Honolulu included climate change as a standalone risk in the HMP. The City and County included an explanation of how El Niño/La Niña would impact climate change within the region; anticipated future impacts from climate change; historical and projected sea level rise impacts; projected changes to tropical cyclone impacts; costs associated with sea level rise; and mitigation strategies to decrease climate risk to critical assets. The City and County explored two 500-year flood analyses for the end of century: one study with 2 feet of sea level rise and one study with no sea level rise. These analyses found that 2 feet of sea level rise exposed an additional 1,750 properties to a 500-year flood event by end-of-century, with a total of $1.228 billion assets exposed (City and County of Honolulu 2020).
- **County of Maui** – The County of Maui did not include climate change as a stand-alone hazard; however, climate change impacts are discussed throughout the plan
- **County of Hawaiʻi** – The County of Hawaiʻi HMP characterized both current and projected risks to the County due to climate change, as well as providing an overview of how climate change will impact the other hazards outlined in the County Risk Assessment. Projected changes include mean sea level rise of 1 to 3 feet by 2100; the potential submersion of low-lying coastal areas such as Hilo; a rise in sea surface temperatures by 2.3 ºF to 4.9 ºF by 2100; and an increasingly wet climate through 2100. To determine risk presented by sea level rise, Hawai'i County utilized data from the Hawaiʻi Interagency Climate Adaptation Committee's Sea Level Rise Vulnerability and Adaptation Report to determine a Chronic Sea Level Rise Exposure Area (the area predicted

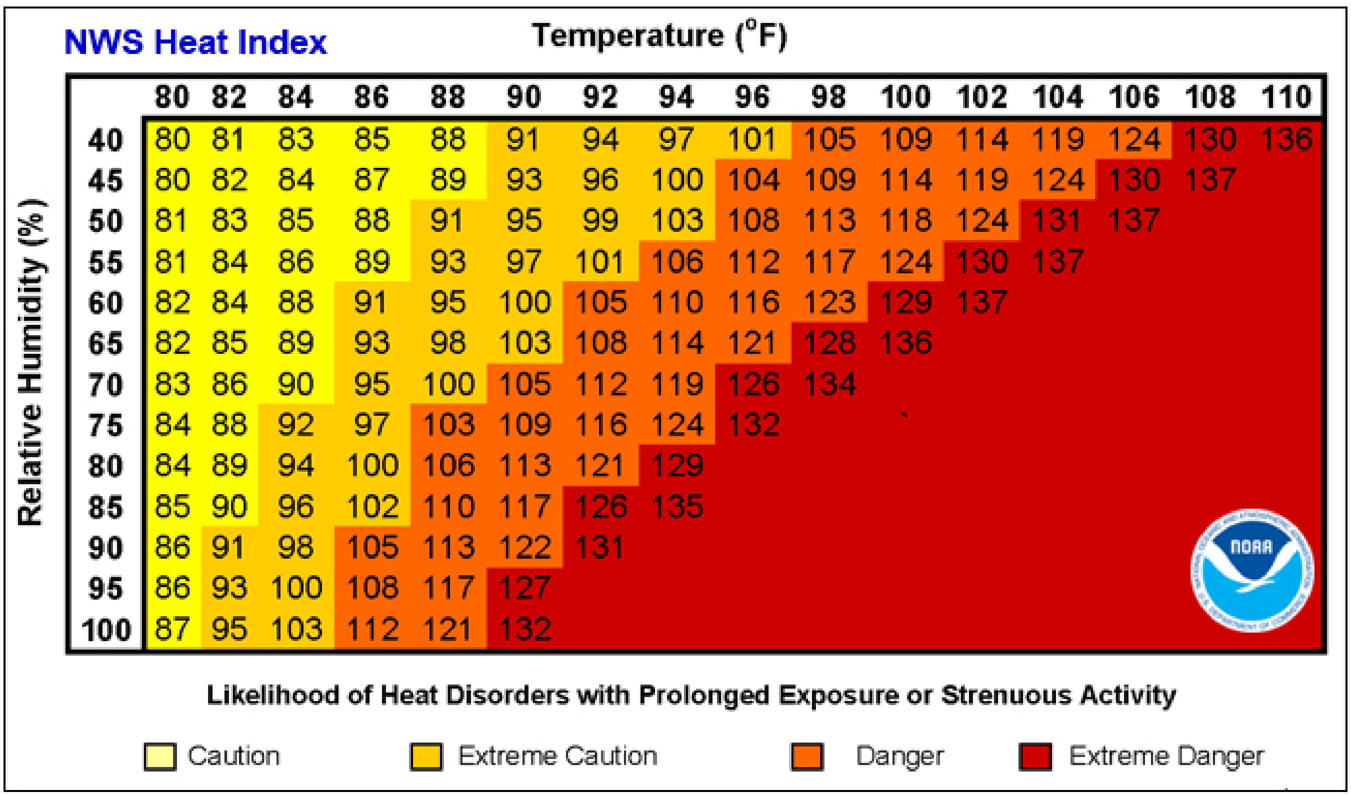
to be inundated under ongoing normal conditions in the future) and Event-Based Sea Level Rise Inundation Area (the area that would be inundated under a 3.2-foot chronic sea-level-rise scenario if a 1 percent annual chance coastal flood event occurs). The County identified 80 critical facilities that would be impacted by both Chronic and Event-Based sea level rise (County of Hawaiʻi 2020).

Socially Vulnerable and Total Populations

Climate Change

As the climate changes in the State of Hawaiʻi, residents will face increasing natural hazard threats. With increased temperatures, vulnerable populations could face increased exposure to extreme heat and its associated illnesses such as heatstroke and cardiovascular and kidney disease (Figure 4.2-13). The State of Hawaiʻi may also see an increase in levels of vector-borne diseases, water-borne diseases such as cholera, fish poisoning, heat-related illnesses, mental health problems, respiratory diseases and other non-communicable diseases, and injury and death from tropical storms and cyclones. Inundation and flooding has led to contamination of surface water and groundwater. Polluted runoff associated with excessive stormwater can contain sewage from overflowing manholes or chemicals from commercial and industrial facilities and has already caused the closure of the beaches around the State of Hawaiʻi annually (University of Hawaiʻi at Mānoa Sea Grant College Program 2014).

Figure 4.2-13. National Weather Service Heat Index Chart



NWS Heat Index

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution | Extreme Caution | Danger | Extreme Danger

Source: (National Weather Service n.d.)

Additionally, climate change can threaten food and water security, infrastructure, and public health and safety, all of which is expected to increase human migration from low- to high-elevation islands and continental sites.

This will make it increasingly difficult for residents to sustain the unique customs, beliefs, and languages of the state. Climate change impacts such as reduced streamflow, saltwater intrusion, and long periods of drought threaten the cultivation of taro and other traditional crops. Low-income families that practice subsistence farming would be especially vulnerable to food insecurity. The entire population of Hawaiʻi is vulnerable to climate change impacts due to the state's exposure, isolation, small size, and concentration of infrastructure and economy along the coasts. Hazard events amplified by climate change are expected to become more frequent so recovery from these events will be increasingly difficult for vulnerable populations (U.S. Global Change Research Program 2018).

Sea Level Rise

People living and working in the SLR-XA-3.2 hazard area may be displaced as homes and businesses become flooded and permanently lost. The loss of structures in this area may result in nearly 20,000 displaced residents, both homeowners and renters, in need of new homes statewide (Table 4.2-12). The greatest number of people that may be displaced by mid- to late century are located in the City and County of Honolulu (13,300 people). The people displaced would include a range of incomes and living situations.

Table 4.2-12. Estimated Population Displaced by Sea Level Rise (SLR-XA-3.2), by County

County	Total Population	Displaced Population	Percent of Total Population	Total Population in SLR-XA-3.2	Population Exposed as Percent of Total	Socially Vulnerable Population in SLR-XA-3.2	Socially Vulnerable Population Exposed as Percent of Total
County of Kauaʻi	71,949	0	0.00%	1007	1.4%	12	0.2%
City and County of Honolulu	979,682	13,300	1.4%	26681	2.7%	6469	0.7%
County of Maui	167,093	2,160	1.3%	2930	1.8%	484	0.3%
County of Hawaiʻi	201,350	1,000	0.5%	308	0.2%	48	0.02%
Total	**1,420,074**	**19,830**	**1.4%**	**30927**	**2.2%**	**7,127**	**0.5%**

Source: U.S. Census Bureau 2020; Centers for Disease Control and Prevention 2018; Hawaiʻi Climate Mitigation and Adaptation Commission 2017

The cost of interventions to protect properties from coastal flooding and erosion risk may financially stress lower- or middle-income residents. Relocating may be difficult because of the expenses and the availability of accessible housing or the time needed to make housing accessible (U.S. Environmental Protection Agency 2021).

The population over the age of 65 is more vulnerable and, physically, may have more difficulty evacuating during severe coastal flooding events. They may require extra time or outside assistance during evacuations and are more likely to seek or need medical attention, which may not be available due to isolation during a flood event (U.S. Environmental Protection Agency 2021).

Over 138,000 total residents and nearly 24,000 high vulnerability residents are vulnerable to temporary flooding from the 1%CFZ-3.2 if a severe coastal flood event impacts the entire state (Table 4.2-13). This represents the added risk of event-based coastal flooding from severe waves resulting from hurricanes and tropical cyclones that poses a potential for loss of human life and property and for severe and long-term economic disruption.

Table 4.2-13. 2020 U.S. Census Population Located in the 1%CFZ-3.2, by County

County	Population				
	Total Population	Population in 1%CFZ-3.2	Population Exposed as Percent (%) of Total	Socially Vulnerable Population Located in 1%CFZ-3.2	Socially Vulnerable Population Exposed as Percent (%) of Total
County of Kaua'i	71,949	4813.9	6.7%	559	0.8%
City and County of Honolulu	979,682	125,472	12.8%	21,533	2.2%
County of Maui	167,093	5,538	3.3%	1,038	0.6%
County of Hawai'i	201,350	2,624	1.3%	701	0.3%
Total	**1,420,074.00**	**138,448.20**	**9.7%**	**23,830**	**1.7%**

Source: *U.S. Census Bureau 2020; Centers for Disease Control and Prevention 2018; Tetra Tech Inc. and Sobis Inc. 2017*

Land Use Districts

Table 4.2-14 shows the number of square miles and percent of total acres in each state land use district statewide; refer to Appendix F for results by county. Statewide, Nearly 35 square miles of land are exposed to 3.2 feet of sea level rise. Conservation District lands, which contain valuable environmental resources, have the most area exposure, statewide; however, the exposure accounts for less than 1% of the total Conservation District land in the state. Additional discussion of exposure and vulnerability of environmental resource areas can be found in the Environmental Resources section below.

Table 4.2-14. State Land Use Districts within the Sea Level Rise Hazard Areas

Land Use District	Total (square miles)	Square miles in SLR-XA-3.2	Percent (%) of Total Area	Square miles in 1%CFZ-3.2	Percent (%) of Total Area
Agricultural	2,973.6	9.0	0.3%	35.8	1.0%
Conservation	3,202.9	13.7	0.4%	30.1	0.9%
Rural	16.3	0.6	3.7%	2.2	13.5%
Urban	319.1	11.7	3.7%	41.5	13.0%
Total	**6,511.95**	**34.9**	**0.5%**	**109.6**	**1.7%**

Source: *State Land Use Commission, Hawaii Statewide GIS Program 2021; Honolulu County GIS 2022; Hawai'i Climate Mitigation and Adaptation Commission 2017; Tetra Tech Inc. and Sobis Inc. 2017*

Urban District lands have the second highest area exposed, accounting for 3.7% of total Urban District land in the state. This is significant as development in these areas would need to be adapted in place to chronic flood conditions or moved elsewhere, which may result in encroachment or conversion of agricultural or Conservation District lands.

The 1%CFZ will expand with sea level rise meaning that more land area will be exposed to damaging wave impacts from a 1% Annual Chance Flood event. This is of particular concern for Urban Districts, which have the greatest share of developed land. With 3.2 feet of sea level rise, 13% of the state's Urban Districts are projected to be exposed to wave heights of more than 3 feet from a 1% Annual Chance Storm. This does not include exposure to wave heights of between 1.5 feet and 3 feet, which can also include significant structural damage.

General Building Stock

To further assess what is at risk, each county's general building stock's exposure was examined. Table 4.2-15 summarizes buildings that may be permanently lost due to 3.2 feet of projected sea level rise. These vulnerable structures include residential structures, hotels, and businesses. Due to the high concentration of development along the coast, the City and County of Honolulu has the greatest potential economic loss of the counties.

Table 4.2-15. Estimated Potential Structure and Property Value (Structure and Land) Loss from Sea Level Rise (SLR-XA-3.2)

County	Number of Structures	Estimated Structure and Land Value Loss
County of Kaua'i	940	$2,600,000,000
City and County of Honolulu	3,800	$12,900,000,000
County of Maui	1,553	$3,490,000,000
County of Hawai'i	130	$430,000,000
Total	**6,423**	**$19,420,000,000**

Source: Hawai'i Climate Mitigation and Adaptation Commission 2017

To more fully understand the potential economic loss to 3.2 feet of sea level rise, both the value of the land and structure must be considered. According to the 2017 *Hawai'i Sea Level Rise Vulnerability and Adaptation Report*, the value of projected flooded structures, combined with the land value projected to be flooded, amounts to over $19 billion across the state. The economic loss due to chronic flooding of roads, utilities, and other public infrastructure was not analyzed but will likely amount to a far greater loss. Utilities, such as water, wastewater, and electrical systems, often run parallel underneath roadways, making lost road mileage a good indication of extent of lost utilities. This chronically flooded infrastructure would have significant impacts on local communities as well as reverberating effects around each island through loss of commerce, loss of access to emergency services, and increased traffic on other roads and highways. Repair and relocation of vulnerable roadways are already costly efforts for the state and counties, which will only worsen as the sea level rises. Harbors and airports, often located in low-lying coastal areas in the state, face chronic flooding. For this reason, the economic loss due to flooded critical infrastructure is expected to be an order of magnitude greater than the potential economic loss from land and structures. Refer to the 2017 *Hawai'i Sea Level Rise Vulnerability and Adaptation Report* for more detailed discussion on vulnerable areas by island.

Damages to buildings as a result of a 1% annual chance coastal flood event may also displace people from their homes, threaten life safety, and impact a community's economy and tax base. Table 4.2-16 lists the estimated cost to repair or replace flooded structures and their contents in the 1%CFZ-3.2. Statewide, this would be more than $125 billion, of which 94% would occur in the City and County of Honolulu. This figure does not include the cost of damage to roads or utilities, which would be considerable. Areas with the highest potential economic loss resulting from a flood event are low-lying urban areas.

Table 4.2-16. Estimated General Building Stock Loss (Structure and Contents) to the 1%CFZ-3.2

County	Number of Structures Impacted	Potential Damages
County of Kauaʻi	5,360	$5,700,000,000
City and County of Honolulu	17,700	$120,000,000,000
County of Maui	2,830	$7,880,000
County of Hawaiʻi	470	$110,000,000
Total	**26,360**	**$125,817,880,000**

Source: Tetra Tech Inc. and Sobis Inc. 2017

Environmental Resources

The observed and projected influences of climate change on global and local ecosystems are diverse and often detrimental. Some of the changes likely to impact the state's ecosystems include accelerated sea level rise, ocean and atmospheric warming, increased flooding, ocean acidification, changing distributions of terrestrial and marine biota, and changing intensity and frequency of storms, among others (U.S. Global Change Research Program 2018).

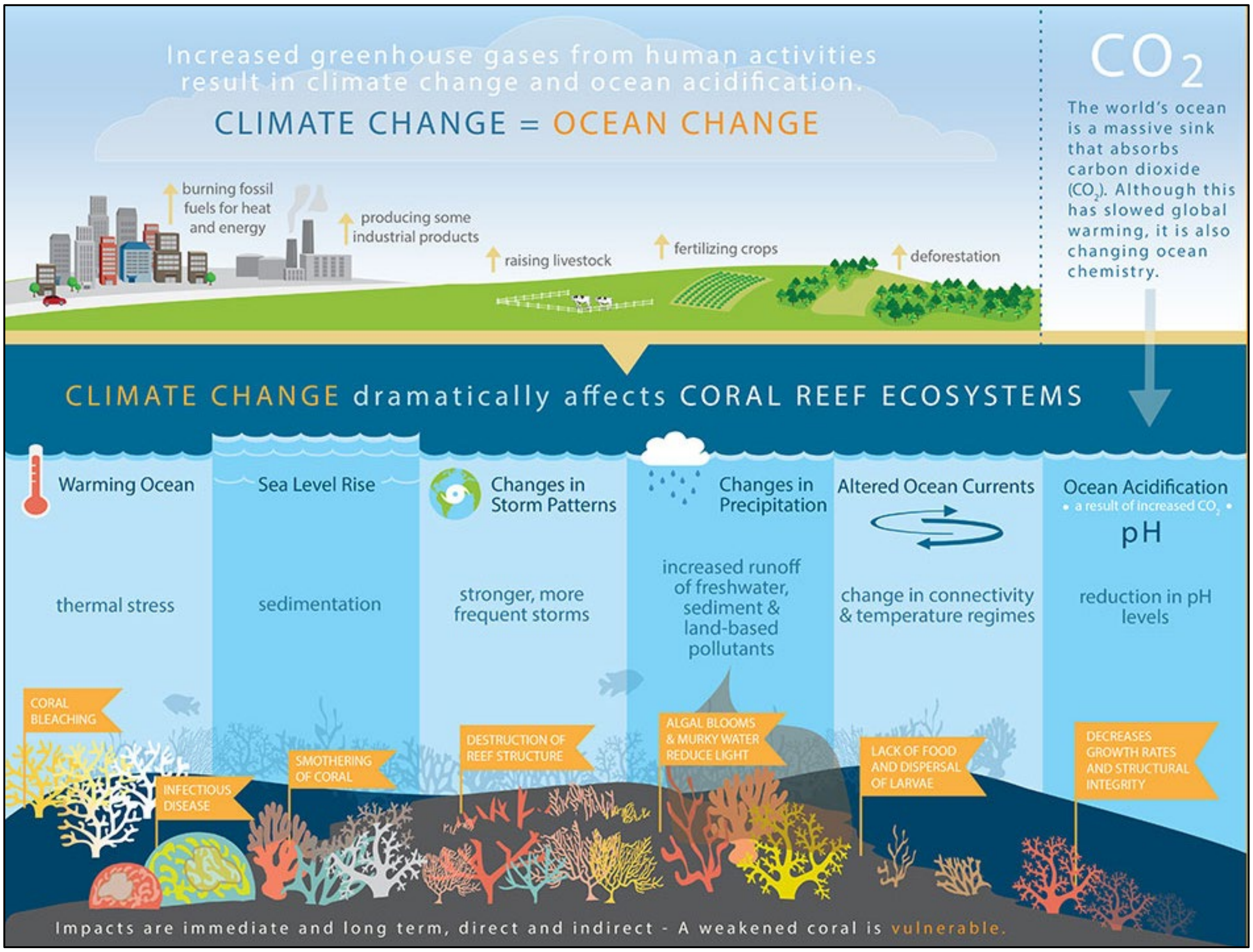
Climate Change

Hawaiian ecosystems will be challenged by increasing frequency and severity of climate-related disturbances (for example, storms, flooding, drought, wildfire, invasive species, and ocean acidification) and continued pressure from anthropogenic influences, such as change in land use, pollution, fragmentation of natural systems, and overexploitation of resources. Evidence of many of these climate-related impacts has already been observed in the State of Hawaiʻi (University of Hawaiʻi at Mānoa Sea Grant College Program 2014). The following provides details on how the ecosystems in the State of Hawaiʻi may be impacted by climate change.

- **Open Ocean**—The physical, chemical, and biological characteristics of the ocean are shifting around the State of Hawaiʻi under the influence of climate change. The ocean is getting warmer and more acidic, which has the potential to drive changes in circulation and biologic activity. This could disrupt the timing of feeding and spawning of marine species and reduce primary productivity and fish catches around the Hawaiian Islands. Acidification of the oceans threatens calcifying plankton, corals, and other species. Ocean warming could also lead to a more favorable environment for pathogens and invasive species, threatening native and endemic species of the State of HawaiʻI (Gove, et al. 2022).
- **Coral Reefs and Nearshore Habitats**—Coral reefs and other nearshore habitats face degradation from climate change and local anthropogenic influences (Figure 4.2-14), including sedimentation, direct physical impacts, overfishing, nutrient loading from runoff, trash and microplastics, and erosion. Warmer oceans are leading to increased coral bleaching and disease outbreaks in coral reefs (U.S. Environmental Protection Agency 2022). Research has shown that under a worst-case scenario half of the coral reef ecosystems worldwide will permanently face unsuitable conditions by 2025. These conditions will likely lead to corals dying off, and other marine life will struggle to survive due to disruptions in the food chain (University of Hawaiʻi News 2022). Hawaiian reefs experienced statewide bleaching events in 2014, 2015, and 2019 (National Oceanic and Atmospheric Administration 2022). Ocean acidification can cause a variety of responses in marine organisms, including inhibited development of calcium carbonate shells or skeletons in corals, shellfish, and plankton and

impaired physiological functions of some reef fish. Changing precipitation patterns over the Hawaiian Islands influence the stormwater runoff that enters coastal waters. Ocean acidification will reduce coral growth and health. Warming and acidification, combined with existing stresses, will strongly affect coral reef fish communities (University of Hawaiʻi at Mānoa Sea Grant College Program 2014).

Figure 4.2-14. Climate Change Threats to Coral Reefs



Source: (National Oceanic and Atmospheric Administration 2021)

- **Coasts and the Built Environment**—The coastline of the State of Hawaiʻi is composed of a diverse mixture of environments, including sandy carbonate beaches, dunes, steep bluffs, lava and limestone benches, marshes, and fishponds, many of which are eroding due to natural and anthropogenic causes (University of Hawaiʻi at Mānoa Sea Grant College Program 2014).
- **Terrestrial Ecosystems**—A changing climate can alter the habitats and conditions of endemic Hawaiian species, such as the Hawaiian honeycreeper and the Haleakalā silversword (Figure 4.2-15). Warmer temperatures could lead to a shift in the habitat ranges of native plants like the Haleakalā silversword, which is only found at high elevations on Mount Haleakalā and has experienced a decline in population over the last 20 years that is connected to temperature increase. Endemic bird species, such as the Hawaiian honeycreeper,

could decline in population due to the warming of high-elevation forests where risk of avian disease transmission was previously low. Ranges for pests, diseases, and invasive species may expand as a result of warming temperatures. The higher elevations in the State of Hawaiʻi are bearing the brunt of impacts and lower elevations are seeing new habitats emerge that previously did not exist in the archipelago (University of Hawaiʻi at Mānoa Sea Grant College Program 2014).

- **Freshwater Resources**—Climate change can lead to a decrease in annual precipitation, streamflow, and groundwater levels and increase the number of and duration of droughts. All of these factors can impact the water table of the State of Hawaiʻi. Groundwater provides a majority of drinking water in the State of Hawaiʻi and reduced total rainfall would reduce the amount of water recharging the aquifers and the amount of water available. If drought events continue to increase, dry areas could see more fire and problems with stressed water supplies (University of Hawaiʻi at Mānoa Sea Grant College Program 2014).

Figure 4.2-15. Hawaiian Honeycreeper (ʻIʻiwi) and Haleakalā Silversword

Sources: (American Bird Conservancy n.d.) (Pennisi 2019)

Sea Level Rise

The loss of natural and cultural resources statewide resulting from sea level rise is difficult to quantify in dollar amounts; however, their loss would deeply impact the state. Sea level rise would take its toll on the state's world-famous beaches, including such iconic stretches of beaches such as Oahu's North Shore "Seven Mile Miracle," the beaches of Kauai's North Shore, and West Maui beaches (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017).

Over the past century, 70 percent of the beaches in the State of Hawaiʻi are undergoing chronic erosion (landward retreat) and over 13 miles of beach have been completely lost to erosion over the past century fronting seawalls and other shoreline structures. This trend of beach erosion appears to be driven in part by local sea level rise (Anderson, et al. 2018). Shoreline retreat, wetland migration and cliff collapse due to erosion are occurring now on many of the State of Hawaii's coastlines. Coastal erosion rates range from 0.5 to 1 foot per year. Nearly one-quarter of the Hawaiian Island's beaches have been significantly degraded over the past 50 years (Surfrider Foundation 2021).

Sea level rise and coastal inundation will affect coral reefs and nearshore habitats of the State of Hawaiʻi and may result in a shift or loss of ecosystems. Beach and wetland systems may not be able to adapt to rising sea levels and could be lost if not allowed to migrate landward. The loss of wetlands could reduce the coast's ability to buffer impacts from storms and flooding (University of Hawaiʻi at Mānoa Sea Grant College Program 2014).

Additionally, sea level rise has the potential to impact facilities that could release wastewater or hazardous materials and waste to nearshore waters and coastal habitats. Septic tanks, cesspools, and other on-site sewage disposal systems (OSDS) as well as other hazard materials/waste storage and disposal sites are located along the coast. The OSDS exposed to chronic flooding in the SLR-XA with 3.2 feet of sea level rise area would not only result in failure of systems to operate properly but would also degrade nearshore water quality. In the County of Hawaiʻi, OSDS are located along many urban and rural shoreline areas. Releases from these OSDS may change disease risk for coral reefs and negatively impacting nearby coral resources, such as those off the coast of Puakō (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017).

Environmental resources, including critical habitat (or habitats that are known to be essential for an endangered or threatened species), wetlands, parks and reserves, and reefs located in the assessed hazard areas are summarized in Table 4.2-17. Wetlands and coral reefs provide protection from rising sea levels and damaging wave action (Owen 2021).

Table 4.2-17. Environmental Resources Located in the Sea Level Rise Hazard Areas

Environmental Asset	Total Square Miles of Asset	SLR-XA-3.2 Area	Percent (%) of Total Asset Area	1%CFZ-3.2 Area	Percent (%) of Total Asset Area
Critical Habitat [a]	951	2	0.18%	2	0.25%
Wetlands	3,637	22	0.61%	1,075	30%
Parks and Reserves	2,778	7	0.26%	21	1%
Reefs [b]	55	1	2.01%	49	90%
Total [c]	**7,420**	**32**	**0.43%**	**1,148**	**15.47%**

Source: Hawaiʻi Climate Mitigation and Adaptation Commission 2017; (U.S. Fish and Wildlife Service 2022); (U.S. Fish and Wildlife Service 2022); (Office of Planning and Sustainable Development 2022); (Department of Lands and Natural Resources 2022); Tetra Tech Inc. and Sobis Inc. 2017

Notes:

a. Critical habitat area mileage includes the combined area of coverage of individual critical habitat areas.

b. Results only show reefs within the range of the hazard area extent as delineated by the source data.

c. Total square miles may be over-reported as some environmental asset areas may overlap.

Cultural Assets

Many Native Hawaiian cultural resources would be impacted by sea level rise as well due to the number of cultural sites located within the SLR-XA-3.2. Cultural practices, including fishing, gathering, and other cultural practices that require shoreline access would be impacted (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017). Iwi kūpuna (ancestral remains) were often buried in dunes and beaches, now threatened by erosion and sea level rise. Table 4.2-18 summarizes the Hawaiian Home Lands by county and Table 4.2-19 summarizes cultural resources by square miles statewide that are vulnerable to sea level rise and exacerbated impacts from coastal event-based flood events due to sea level rise.

Table 4.2-18. Hawaiian Home Lands Vulnerable to Sea Level Rise

County	Area (in square miles)				
	Total Square Miles	SLR-XA-3.2 Hazard Area	Hazard Area as Percent (%) of Total Area	1%CFZ-3.2 Hazard Area	Hazard Area as Percent (%) of Total Area
County of Kaua'i	32.1	0.2	0.5%	0.7	2.2%
City and County of Honolulu	10.6	0.1	0.8%	0.3	2.4%
County of Maui	102.6	0.8	0.8%	1.9	1.9%
County of Hawai'i	191.5	0.1	0.1%	1.1	0.6%
Total	**336.8**	**1.2**	**0.4%**	**4.0**	**1.2%**

Source: *Hawaii State Department of Hawaiian Homelands 2021; Hawai'i Climate Mitigation and Adaptation Commission 2017; Tetra Tech Inc. and Sobis Inc. 2017*

Table 4.2-19. Cultural Resources Vulnerable to Sea Level Rise, Statewide

Cultural Resource Site Type	Area (in square miles)				
	Total Square Miles	SLR-XA-3.2 Hazard Area	Hazard Area as Percent (%) of Total Area	1%CFZ-3.2 Hazard Area	Hazard Area as Percent (%) of Total Area
Archaeology	90.9	3.7	4.1%	12.3	13.6%
Burial Sensitivity Area	2.1	0.4	20.6%	0.8	36.8%
Historic Building	2.7	0.1	4.2%	0.4	16.0%
Historic District	849.4	9.7	1.1%	141.1	16.6%
Historic Object	9.6	0.0	0.0%	0.0	0.0%
Historic Structure	20.7	0.2	0.9%	0.8	3.6%
Total	**975.4**	**14.1**	**1.5%**	**155.4**	**15.9%**

Source: *Department of Land and Natural Resources, Hawai'i State Historic Preservation Division 2022; Hawai'i Climate Mitigation and Adaptation Commission 2017; Tetra Tech Inc. and Sobis Inc. 2017*

Future Changes That May Impact State Vulnerability

Understanding future changes that impact vulnerability in the state can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The State of Hawai'i considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate

Climate Change

Climate change is a factor of change that is already influencing vulnerability to many of the other hazards of concern. Impacts of climate change on both the probability of future events and their resulting impacts are discussed in the hazard profile and vulnerability assessment sections of each hazard of concern in the 2023 SHMP Update. The extent to which climate change will be a factor of change in vulnerability for the state is only beginning to be understood through efforts like the *Hawai'i Sea Level Rise Vulnerability and Adaptation Report*. Two major factors will influence climate change impacts including whether or not global, human-caused greenhouse gas emissions will be reduced enough to avoid catastrophic impacts to the climate system and the extent to which feedback loops that are already occurring and little understood will exacerbate conditions.

Sea Level Rise

Sea level rise areas were overlaid on areas that may experience significant changes in development or redevelopment in future years (see Table 4.2-20; refer to Section 3 for more information on projected development areas). The results of this assessment indicate that only small portions of these areas are likely to be lost to chronic flooding from 3.2 feet of sea level rise; however, substantial portions of these areas are located in areas that will be exposed to wave action during a 1% Annual Chance Flood event with 3.2 feet of sea level rise. In the City and County of Honolulu, 18.6% of the Hawaiʻi Community Development Authority (HCDA) District Area and 6.5% of the Enterprise Zones would be exposed to these damaging waves. In the County of Kauaʻi, 9.9% of the Enterprise Zone's total area is exposed. As development is considered in these areas, care should be taken to avoid further developing land that will be lost to sea level rise, to integrate appropriate flood mitigation into development in areas that are within the 1% annual chance flood event with 3.2 feet of sea level rise, and to allow enough room for the migration of coastal resources inland as the shoreline moves landward.

Table 4.2-20. HCDA Community Development Districts, Enterprise Zones, and Maui Development Projects Within Sea Level Rise Hazard Areas

County	Area (in square miles)								
	HCDA Community Development Districts (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area	Maui Development Projects (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area	Enterprise Zones (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area
SLR-XA-3.2 Hazard Area									
County of Kauaʻi	-	-	-	-	-	-	251.0	6.4	2.5%
City and County of Honolulu	7.4	0.4	5.0%	-	-	-	297.3	5.5	2.1%
County of Maui	-	-	-	27.6	0.1	0.2%	1059.8	8.2	0.8%
County of Hawaiʻi	-	-	-	-	-	-	1274.9	3.3	0.3%
							2883.0	**23.3**	
1%CFZ-3.2 Hazard Area									
County of Kauaʻi	-	-	-	-	-	-	251.0	25.0	9.9%
City and County of Honolulu	7.4	1.4	18.6%	-	-	-	297.3	19.4	6.5%
County of Maui	-	-	-	27.6	0.1	0.3%	1059.8	15.6	1.5%
County of Hawaiʻi	-	-	-	-	-	-	1274.9	13.5	1.1%
Total	**7.4**	**1.4**	**18.6%**	**27.6**	**0.1**	**0.3%**	**2883.0**	**73.5**	**2.6%**

Source: Maui County Planning Department 2016; Hawaiʻi Community Development Authority 2021; Community Economic Development Program, Department of Business, Economic Development & Tourism, County Planning Departments 2021; Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017; Tetra Tech Inc. and Sobis Inc. 2017; U.S. Census Bureau 2021

Section 4.3 Cyber Threat

Cyber Threat

As technology advances and takes a more prominent role in the public and private sectors, incidents that damage or destroy that technology become more of a threat. Cyber-attacks against infrastructure can cripple supply chains, transportation, energy production and distribution, and other technology-dependent sectors.

CHANGES SINCE 2018

+0

Declared Disasters

+5

Cyber Threat Events

COUNTIES MOST VULNERABLE

Kauaʻi Honolulu Maui Hawaiʻi

SOCIALLY VULNERABLE POPULATION

22.3%

Of Total Population

316,257

Persons

CLIMATE PROJECTIONS

Climate change impacts are not known to have a direct effect on cybersecurity

Climate activists and deniers may carry out hacks to make a statement, prove a point, or benefit financially from instability

HAZARD RANKING

Low Medium High

COMMUNITY LIFELINES

1,369

Total

Cyber threat impacts on these physical state assets are unknown at this time.

Environmental Resources

State Buildings

Hawaiian Home Lands

Cultural Resources

Miles of State Road

CONTENTS

TABLES

FIGURES

[1] *Section Cover Photo: Stock photo*

SECTION 4. RISK ASSESSMENT

4.3 CYBER THREAT

2023 SHMP Update Changes

- The cyber threat hazard profile is new to the 2023 plan update.
- Cyber threat incidents that occurred in the State of Hawaiʻi from January 1, 2018, through December 31, 2022, were researched for this 2023 SHMP Update.

4.3.1 HAZARD PROFILE

Hazard Description

A cyber-attack is an attempt to compromise system security by gaining unauthorized access to system services, resources, or information. These attacks can be carried out by individuals, organizations, or government entities by damaging or disrupting a computer or computer network or by stealing data from a computer or computer network for malicious use. Individuals or groups may use system hacking to promote their social or political ideology. Malicious software, known as ransomware, may be used to restrict access to a system or data until money is paid. Cyber-attacks can impact and/or target organizations or individuals. Tactics used in cyber-attacks are always changing and becoming more sophisticated (Hawaiʻi Office of Homeland Security 2022).

A cyber incident is an event occurring on or conducted through a computer network that actually or imminently jeopardizes the confidentiality, integrity, or availability of computers, information or communication systems or networks, physical or virtual infrastructure controlled by computers or information systems, or information resident thereon (The White House 2016). Such incidents (differentiated from cyber-attacks by their targeting of organizations such as critical infrastructure or governmental entities rather than individuals) can lead to numerous impacts:

- Loss or theft of computer resources
- Inappropriate access to and disclosure of personal and secure information
- Disruption of services
- Damage to networks
- High cost of remediation
- Disruption of essential operations supporting critical infrastructure
- Disruption of resources needed for emergency management

As the use of digital information expands, the state will become more vulnerable to the potential technological hazard of cyber damage. Cyber threats to critical infrastructure can be posed by anyone with the capability, technology, opportunity, and intent to do harm. Potential threats can be foreign or domestic, internal or external, state-sponsored, group-sponsored or a single rogue individual.

Location

Many systems rely on computers for day-to-day operations, including traffic signals, power plants, HVAC systems, and all the systems the State of Hawaiʻi depends on to operate the government. Therefore, cyber threats can occur anywhere in the state.

Previous Occurrences and Losses

Disaster and Emergency Declarations

No FEMA, USDA, or State of Hawaiʻi disaster declarations or proclamations related to cyber threats have been issued relevant to Hawaiʻi, any of its counties, or nationally. However, critical infrastructure entities, government agencies and others report persistent attempts at cyber incidents on an ongoing basis.

Event History

The State of Hawaiʻi, Office of Homeland Security, began receiving information regarding state-based impacts from cyber incidents in 2021. As not all cyber incidents have mandated reporting requirements, this timing and the reporting received should not be taken as anything more than a snapshot of potential cyber incident activity. Additionally, impacts reported include those resulting from broader-based incidents that impacted entities across the globe. Finally, the timing of such incidents is fluid as threat actors may infiltrate impacted systems long before the entity becomes aware and, indeed, may remain within affected systems even after the entity believes they have remediated the incident. Incidents tabled below are indicative of type, but not of numbers of reports or impacted entities. Table 4.3-1 summarizes significant incidents in the state since 2018.

Table 4.3-1. Cyber Incidents from 2018 to 2022

Date of Incident	Event Type	Counties Affected	Impacts
2021	Vulnerability Exploitation	Honolulu	IT disruption, resource diversion (to mediation), reputational
2021	Ransomware	Honolulu	IT disruption, resource diversion (to mediation), reputational
2022	Vulnerability Exploitation	Maui	IT disruption, resource diversion (to mediation), reputational
2022	Targeted Phishing	Honolulu	None reported
2022	Denial of Service	Honolulu	Outward-facing website availability.

Source: Hawaiʻi Office of Homeland Security

Probability of Future Hazard Events

Overall Probability

There are over 2,200 cyber-attacks every day in the United States, which breaks down to nearly 1 cyber-attack every 39 seconds (Security Magazine 2023). Globally, 65 percent of board members felt that their organization was at risk of a cyber-attack (CPO Magazine 2022). A new organization is hit by ransomware every 14 seconds (Cloudwards 2022). There has been an 87 percent increase in malware infections over the last 10 years (Vuleta

2022). Aside from what has become mantra for cybersecurity practitioners (it's not a matter of if, but when), the probability of cyber incidents is only truly discernable at this point in time at the entity level, such as a singular business or organization. While it is the ambition of the state to have that depth of understanding with regards to its ciritcal infrastructure sectors and functions, it does not have that presently.

Climate Change Impacts

Climate change impacts are not known to have a direct effect on cybersecurity. However, climate change may impact the frequency or severity of cyber-attacks as valuable resources become scarcer. The increased use of computing resources due to a surge in remote work and supercomputing also contributes to climate change. People who no longer trust financial institutions due to prominent hacks and leaks are shopping and trading online or putting their money in cryptocurrencies. (Brode 2022).

An indirect impact of climate change on cyber threats could be politically based. Eco-terrorist hackers might target companies or agencies with whose policies or practices they do not agree.

Climate change impacts are not projected to change the location, intensity, frequency, or duration of cyber threats.

Extent

Cyber threats can vary in their severity based on the systems affected by an attack, the warning time, and the ability to preempt an attack (Cybersecurity & Infrastructure Security Agency n.d.). In 2016, the White House released a schema describing the extent of cybersecurity threats. The schema defines six levels of cyber incidents (Level 0–Level 5) as shown in Figure 4.3-1. Each level describes the incident's potential to affect public health or safety, national security, economic security, foreign relations, civil liberties, or public confidence. An incident that ranks at a Level 3 or above is considered “significant” (The White House 2016).

Costs associated with cyber attacks have varied widely across industries and year over year. Healthcare data breach costs increased from an average of $7.13 million in 2020 to $9.23 million in 2021, a 29.5 percent increase. Costs in the energy sector decreased from $6.39 million in 2020 to $4.65 million in 2021. Costs surged in the public sector, which saw a 78.7 percent increase in cost, from $1.08 million to $1.93 million (IBM Security 2021).

The severity and timing of cyber threats are impossible to predict. There may be no warning. Some cyber incidents take weeks, months or even years to be discovered and identified (FEMA 2021).

4.3.2 VULNERABILITY ASSESSMENT

Overall, it is difficult to quantify potential losses due to cyber threat incidents because of the many variables that must be considered, including but not limited to the target of the threat and the time it takes to secure or restore information systems. Potential impacts may be local, regional, or statewide, national, or international depending on the magnitude of the event and level of service disruptions. A qualitative assessment is discussed below.

Figure 4.3-1. Cybersecurity Threat Levels

	General Definition
Level 5 *Emergency* (Black)	*Poses an imminent* threat to the provision of wide-scale critical infrastructure services, national gov't stability, or to the lives of U.S. persons.
Level 4 *Severe* (Red)	*Likely to result in a significant* impact to public health or safety, national security, economic security, foreign relations, or civil liberties.
Level 3 *High* (Orange)	*Likely to result in a demonstrable* impact to public health or safety, national security, economic security, foreign relations, civil liberties, or public confidence.
Level 2 *Medium* (Yellow)	*May impact* public health or safety, national security, economic security, foreign relations, civil liberties, or public confidence.
Level 1 *Low* (Green)	*Unlikely to impact* public health or safety, national security, economic security, foreign relations, civil liberties, or public confidence.
Level 0 *Baseline* (White)	Unsubstantiated or inconsequential event.

Assessment of State Vulnerability and Potential Losses

This section discusses statewide vulnerability of exposed state assets (state buildings and roads) and critical facilities to cyber threats.

State Assets

All state-owned and leased facilities are vulnerable to cyber threats. While the physical structures of the buildings are typically not at risk, information systems and data storage within those buildings are vulnerable, as are the business and/or operation functions that they support. State computer networks may contain sensitive information and data, making them targets for cyber-attacks. Many assets are also essential to daily operations with computer networks to monitor and control functions throughout the state. A large-scale cyber incident could lead to significant economic losses to impacted state departments and agencies, businesses, and other dependent or interdependent industries.

Community Lifelines and Critical Facilities

All community lifelines and critical facilities across all critical infrastructure sectors are vulnerable to cyber threats. Interruption of services may impact facilities that need to be in operation in response to a cyber threat.

Assessment of Local Vulnerability and Potential Losses

This section provides a summary of vulnerability and potential losses to socially vulnerable and total populations, general building stock, and environmental resources and cultural assets. Each county's vulnerability and potential loss will vary greatly depending the target and the time it takes to secure or restore information systems. The local HMPs were reviewed, and their discussions of cyber threats are summarized below:

- Kauaʻi County—The 2021 County of Kauaʻi Multi-Hazard Mitigation and Resilience Plan does not discuss cyber threats in the risk assessment, but it includes one mitigation action to enhance cyber security measures across government agencies.
- City and County of Honolulu—The 2020 Multi-Hazard Pre-Disaster Mitigation Plan for the City and County of Honolulu does not address cyber threats.
- Maui County—The 2020 County of Maui Hazard Mitigation Plan Update does not address cyber threats.
- Hawaiʻi County—The 2020 County of Hawaiʻi Multi-Hazard Mitigation Plan provides a brief qualitative discussion of both cyber-attacks and cyberterrorism.

Socially Vulnerable and Total Populations

Because the majority of the population of the State of Hawai'i is considered to be exposed and vulnerable to cyber threats, the exposed population in socially vulnerable communities is equal to the statewide population. While socially vulnerable communities may not have access to devices that provide access to cyber threats (though unlikely given the ubiquitous nature of cellphones today), these communities likely rely heavily on agencies and programs that do, which could worsen the impacts of cyber events on these communities.

Cyber-attacks affect organizations and individuals alike. Exposure of personal information can result in individuals facing economic hardship from fraud, putting people at risk of poverty. For those already experiencing impoverishment, a cyber threat can compound the situation. Smaller businesses may face greater proportional impacts from cyber-attacks, as they have fewer resources to develop suitable cybersecurity protocolsto prevent cyber incidents and have fewer resources to recover from a loss of functionality. The vulnerable populations most susceptible to cyber threats are adults over 75 (Gaskell 2021).

General Building Stock

The general building stock is not at risk from cyber threats, but the information systems and data storage within those buildings are vulnerable, as are the business and/or operation functions that they support.

Environmental Resources

A cyber threat does not have direct impacts to environmental resources; however, secondary impacts to the environment can occur. If a water or wastewater treatment facility is targeted and operations are interrupted, outflows may result which could pollute land and water environments, or negatively impact the populations that rely on them.

Cultural Assets

Meticulous records and digital files can be swept away, impossible to recover or replace. Within the Comprehensive Cultural Property Risk Analysis Model (CPRAM), cyber-attacks have been identified as a root cause of a dissociation risk to collections, specifically the loss of database collection information.

Future Changes that May Impact State Vulnerability

Understanding future changes that impact vulnerability in the state can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The State of Hawaiʻi considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development or business growth
- Projected changes in population
- Other identified conditions as relevant and appropriate

An estimated 2,883 square miles of buildable land is available for development statewide. Because the entire state is vulnerable to cyber threats, any type of development of any of this land will be susceptible to damage and impacts from this hazard. Likewise, any growth of businesses, particularly those providing critical functions, like data centers or data service providers, expands the environment of potential cyber-attack targets.

Section 4.4 Drought

Drought

Droughts are characterized by periods of abnormally dry weather that diminish natural stream flows and soil moisture. They can come as a result of a lack of rainfall and are exacerbated by human activity that uses more water than an environment can support. Droughts impact local ecosystems and put stress on communities and economic activities.

CHANGES SINCE 2018

+13

Declared Disasters

+3

Multi-year Events

COUNTIES MOST VULNERABLE

Kauaʻi Honolulu Maui Hawaiʻi

SOCIALLY VULNERABLE POPULATION

22.3% Of Total Population

316,257 Persons

HAZARD RANKING

Low Medium High

COMMUNITY LIFELINES

Food, Water, Shelter

Greatest

CLIMATE PROJECTIONS

Climate change will increase the frequency of meteorological and agricultural droughts

An increase in wildfire events will destroy native plants and support the spread of fire-adapted invasive species

Increased temperatures, nutrient and sediment loads, and decreased dilution of pollutants threaten the availability of fresh water

Drought may directly or indirectly impact these physical state assets.

- Environmental Resources
- State Buildings
- Hawaiian Home Lands
- Cultural Resources
- Miles of State Road

CONTENTS

TABLES

FIGURES

[1] *Section Cover Photo: Drought conditions on leeward Hawaiʻi Island. Photo courtesy of DLNR*

SECTION 4. RISK ASSESSMENT

4.4 DROUGHT

2023 SHMP Update Changes

- Drought events that occurred in the State of Hawaiʻi from January 1, 2018, through December 31, 2022, were researched for this 2023 SHMP update.
- New and updated figures from federal and state agencies are incorporated.
- This section now includes a discussion of how drought impacts socially vulnerable populations and community lifelines.

4.4.1 HAZARD PROFILE

Hazard Description

A drought is a period of abnormally dry weather. Drought diminishes natural stream flow and depletes soil moisture, which can cause social, cultural, environmental, and economic impacts. In general, the term "drought" should be reserved for periods of moisture deficiency that are relatively extensive in both space and time. While some droughts may seem like extreme and rare events, drought is a normal and recurring part of the climate in Hawaiʻi.

Drought Types Defined

Meteorological Drought — When dry weather patterns dominate an area

Hydrological Drought — When low water supply becomes evident in the water system

Agricultural Drought — When crops become affected by drought

Socioeconomical Drought — When the supply and demand of various commodities is affected by drought

Ecological Drought – When natural ecosystems are affected by drought

(National Integrated Drought Information System n.d.)

Lack of rainfall is not the only factor contributing to the impacts of drought. Both natural events and human activities, such as expanding populations, irrigation, and environmental needs, put pressure on water supplies. Lack of rainfall combined with the demands society place on water systems and supplies contribute to drought impacts.

Average Rainfall

The climate, and consequently the amount of rainfall, of the Hawaiian Islands is directly influenced by the northeasterly trade winds. Leeward locations (south and west shores) are much drier and sunnier than windward locations (north and east shores), as depicted in Figure 4.4-1. Within leeward and windward locations, rainfall varies considerably according to elevation. Studies have shown fewer days with northeast trade winds than 40 years ago (Garza, et al. 2012). Fewer days of northeast trade winds leads to more muggy weather and volcanic haze and results in longer-term effects for the state.

Figure 4.4-1. Drought Conditions on Leeward Hawaiʻi Island

Source: DLNR

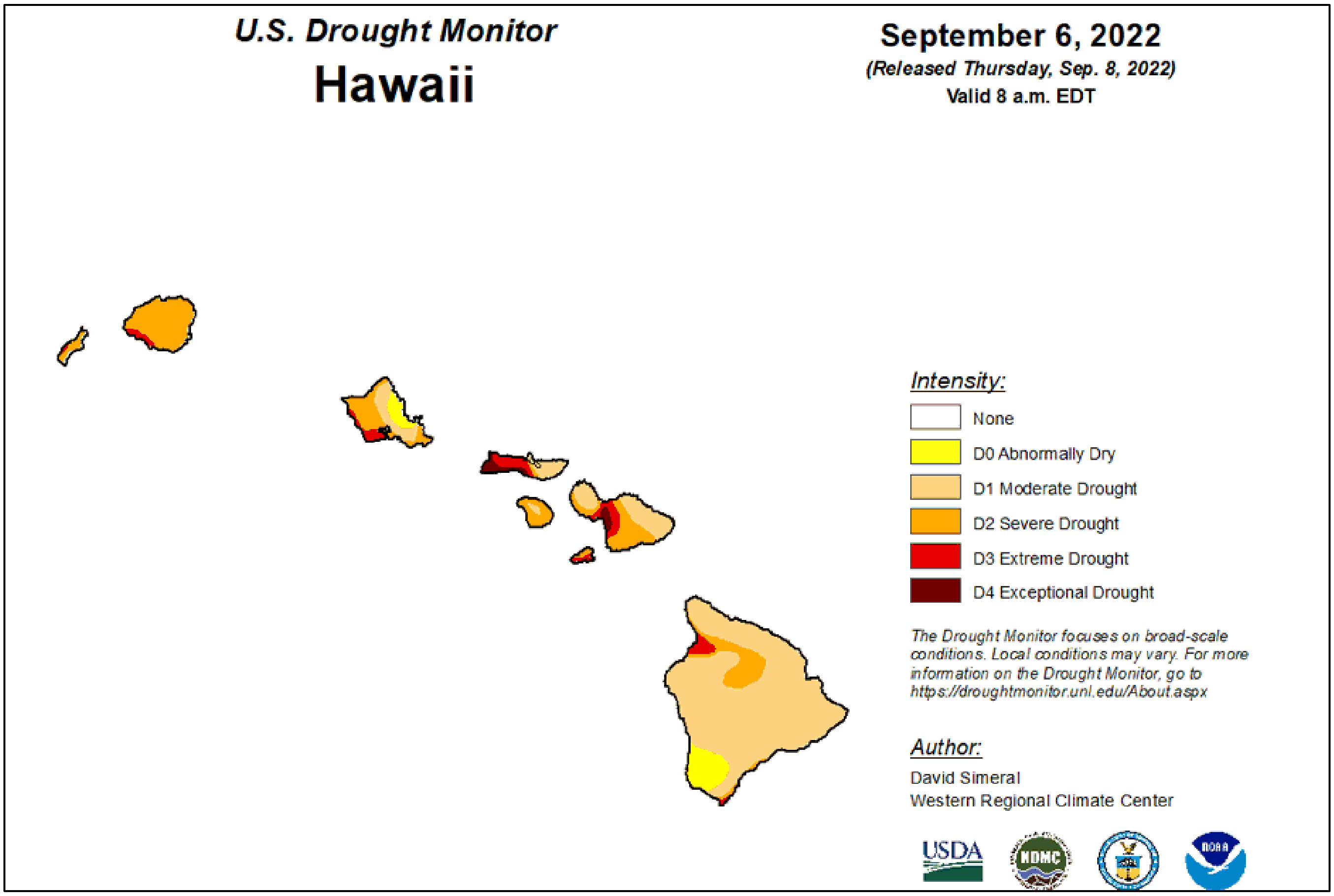
The trade winds are responsible for much of the rainfall, especially in windward areas. As their occurrences decrease, so will the total rainfall, leading to more drought conditions. Over the last 100 years, the State of Hawaiʻi has experienced longer, more severe, and more frequent droughts (Frazier, et al. 2022). Nearly the entire state experienced some degree of drought in 2022 (Figure 4.4-2).

Figure 4.4-3 shows a map of the main Hawaiian Islands indicating the average annual precipitation for the 30-year period between 1982 and 2011 (Giambelluca, et al. 2013).

Location

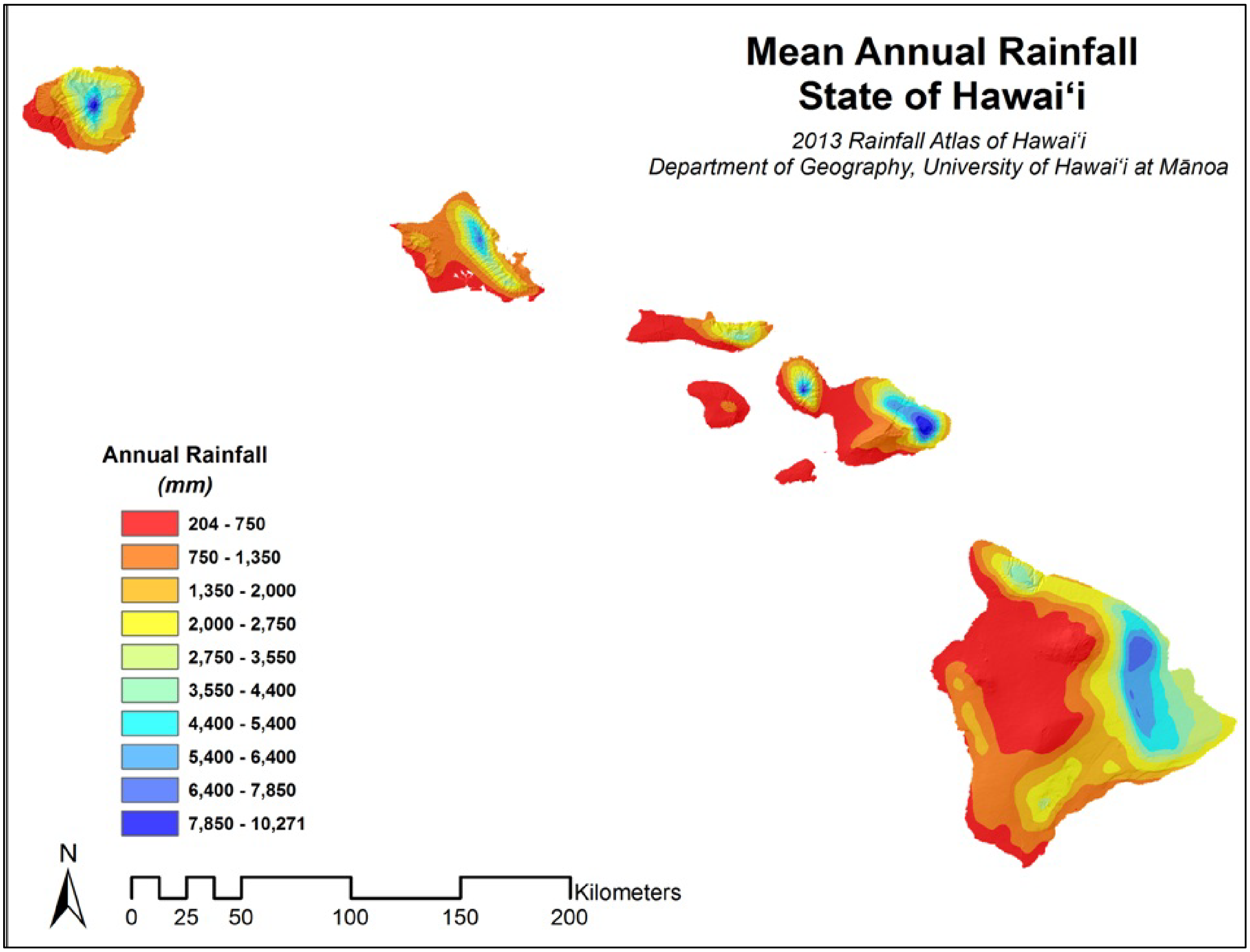
All areas of the state are susceptible to drought, although the extent and severity of the drought will depend on the variance of rainfall throughout the state based on location. The identification of areas that are vulnerable to drought impacts is difficult due to the differences in microclimate and impact sectors. Figure 4.4-4 and Figure 4.4-5 show general risks to the water supply and agriculture and commerce sectors, respectively. For water supply, the 30,000-60,000 residents who rely primarily on rainwater catchment are at the highest risk (shown in red in Figure 4.4-4) to drought because they could run out of water from a week or two of reduced rainfall (Frazier, et al. 2022).

Figure 4.4-2. Drought in the State of Hawaiʻi, 2022



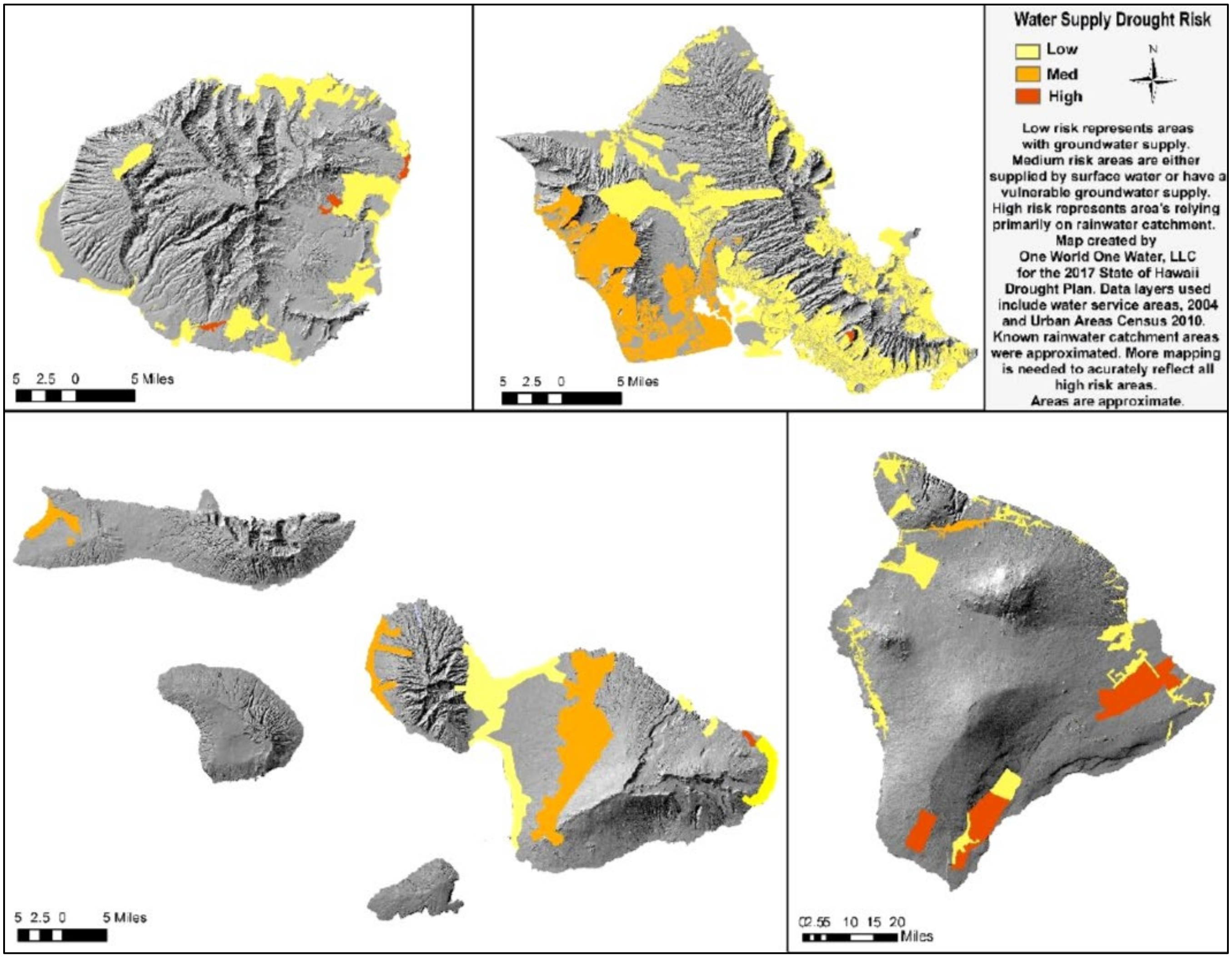
Source: (U.S. Drought Monitor 2022)

Figure 4.4-3. Mean Annual Precipitation Rainfall for the Main Hawaiian Islands



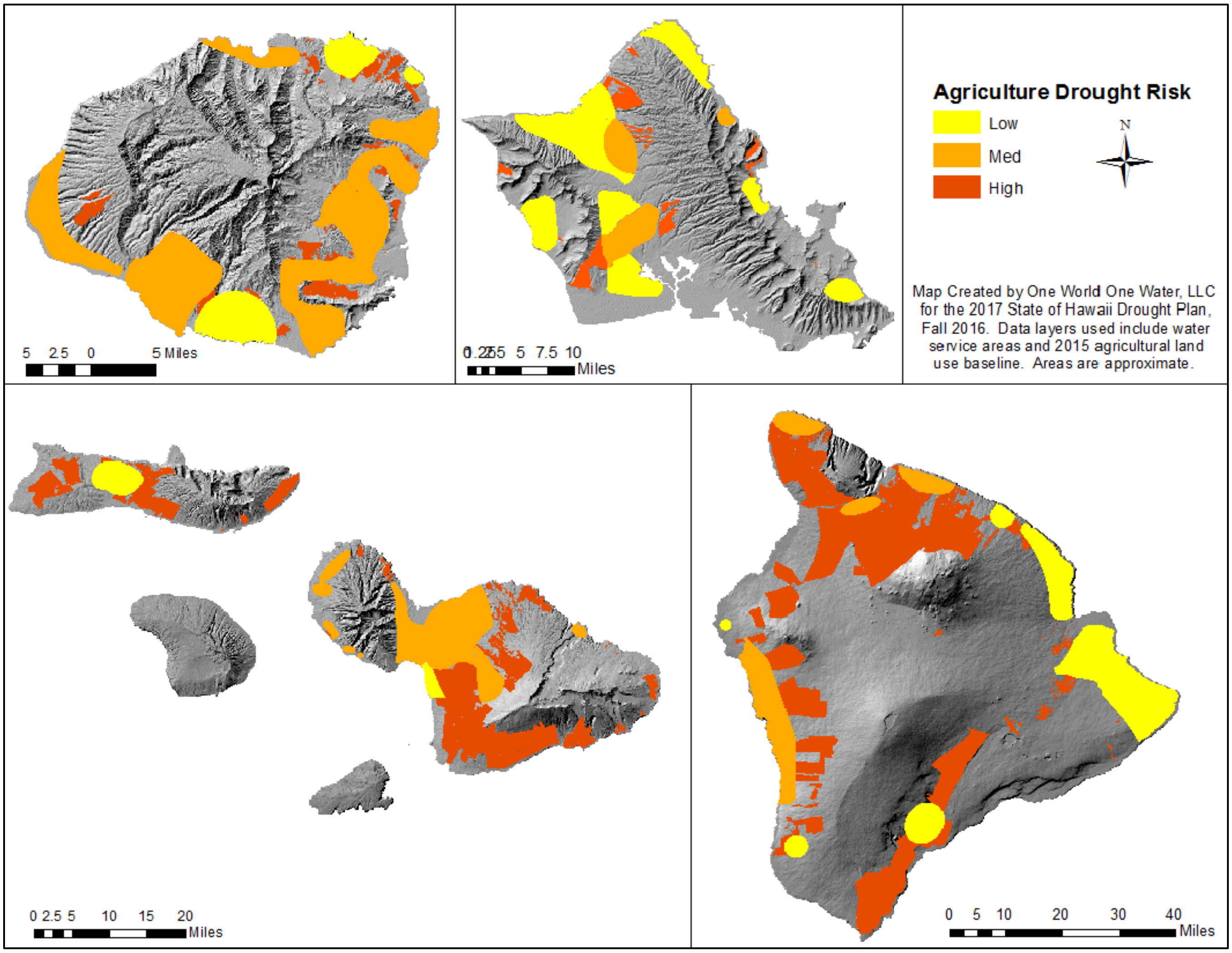
Source: *(Giambelluca, et al. 2013)*

Figure 4.4-4. Water Supply Drought Risk in the State of Hawaiʻi



Source: (DLNR Commission on Water Resource Management 2017)

Figure 4.4-5. Agricultural Drought Risk in the State of Hawaiʻi



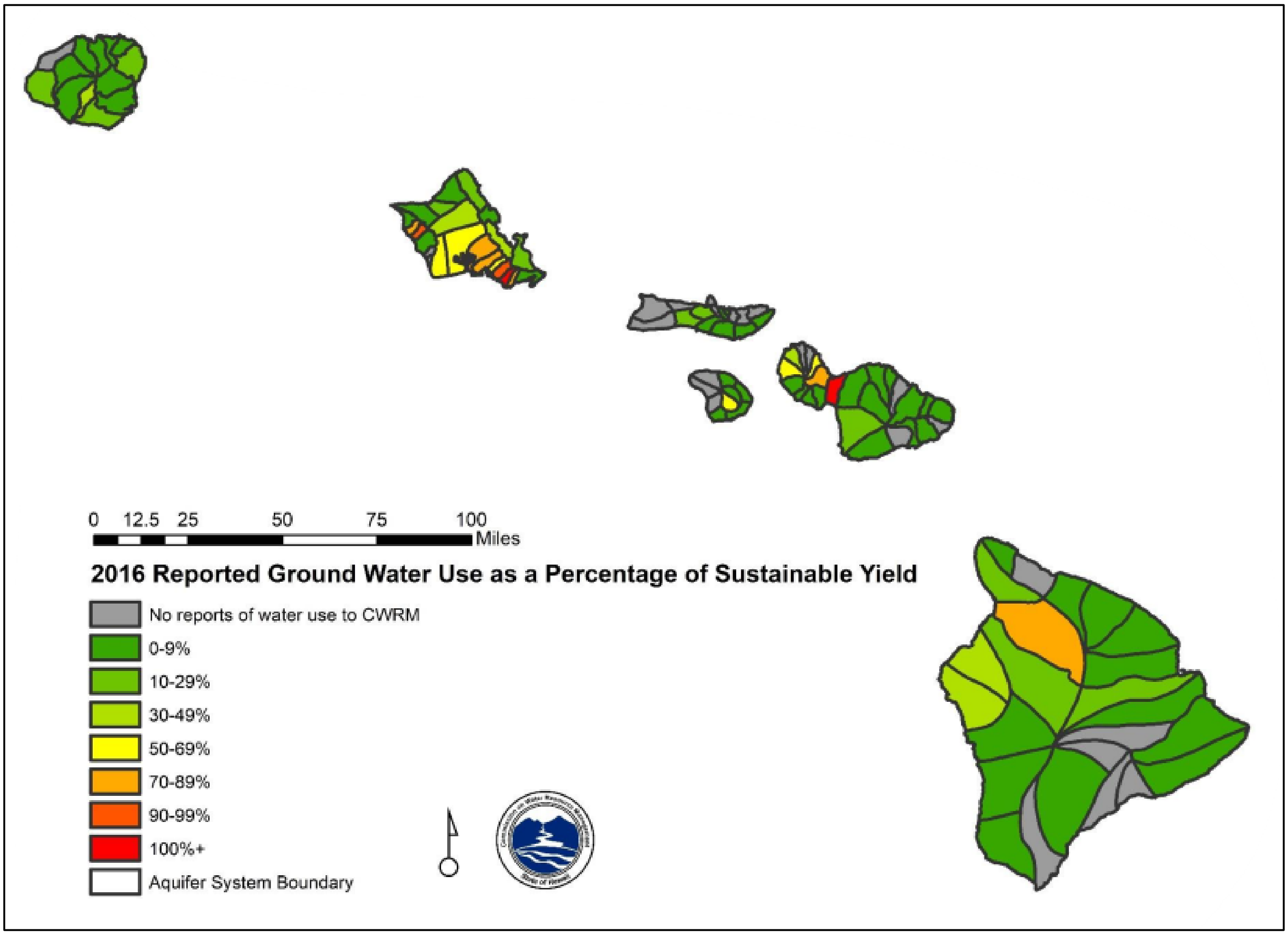
Source: (DLNR Commission on Water Resource Management 2017)

The DLNR Commission on Water Resource Management compiles reports that show groundwater use as a percentage of sustainable yield (Figure 4.4-6). Sustainable yield refers to the rate that groundwater can be pumped without endangering the quality or quantity of the water. Groundwater recharge in areas of the state experiencing drought conditions may not be able to sustain the amount or quality of water pumped for consumer use.

El Niño and La Niña

During El Niño, summers can have above-average rainfall that extends the growing season and increases fuel loads, especially in drier areas where plant growth is limited by lack of rainfall. Extended drought through the winter months then causes vegetation to dry out, which can significantly increase wildfire risk, especially for windward parts of the state that are usually wet year-round. A recent study by researchers in the University of Hawaiʻi at Mānoa concluded that at least two types of El Niño impact the state. Drought in Hawaiʻi is associated with the Eastern Pacific El Niño event (Lu, et al. 2020).

Figure 4.4-6. 2016 Reported Ground Water Use as a Percentage of Sustainable Yield



Source: (DLNR Commission on Water Resource Managment 2019)

La Niña is the opposite end of the oscillation. During these events, most of the tropical Pacific Ocean is cooler than average, and surface winds are stronger than normal. Rainfall decreases over the cooler central Pacific Ocean, including the State of Hawaiʻi. While La Niña is historically associated with wetter than normal rainfall in Hawaiʻi, drought conditions are still possible during these events. Areas with the lowest risk to drought are water supply areas that have adequate groundwater sources. Only a severe extended period of drought would affect these sources. Water supply sources will only become more vulnerable with climate change. For further information, refer to the Hawaiʻi Drought Plan 2017 Update. The Impacts on Climate Change subsection below details how climate change will impact drought throughout the State of Hawaiʻi.

For the environment, public health, and safety sector in the state, refer to the Communities at Risk from Wildfires figure (Figure 4.15-2) found in Section 4.15 (Wildfire). This figure is beneficial for understanding areas at risk from environmental hazards of drought. During periods of drought, vegetation dries out and has an increased susceptibility to wildfire.

Figure 4.4-5 identifies agricultural areas that are more vulnerable to drought conditions. If the water source for a region is groundwater, it has a lower risk during periods of drought as it can likely still withdraw groundwater to irrigate crops. Areas that rely on surface water have a medium drought risk as they typically have some ability to store water but sources can run out in an extended drought period. Unirrigated areas, mostly pastures, are at highest risk because they rely directly on rainfall for productivity. Drought risk may change in the future due to changes in land use, water access, and climate change.

Extent

The severity of a drought depends on the degree of moisture deficiency, the duration, and the size and location of the affected area. The longer the duration of the drought and the larger the area impacted, the more severe the potential impacts. Droughts are not usually associated with direct impacts on people or property, but they can have significant impacts on agriculture, which can impact people indirectly. When measuring the severity of droughts, analysts typically look at economic impacts on an area.

The National Drought Mitigation Center developed the Drought Impact Reporter in response to the need for a national drought impact database for the United States. The Drought Impact Reporter maps the effects of drought, based on reports from media, observers, and other sources. Impacts are an observable loss or change at a specific place and time due to drought. The Drought Impact Reporter is not a comprehensive set of data but is useful in tracking drought, if submissions are adequate, to aid in better understanding and response to drought impacts. The main emphasis is for drought planning. Drought impacts in the Drought Impact Reporter are likely under reported since submissions are made on a purely voluntary basis or picked up from media reports.

The Drought Impact Reporter contains information on 39 drought impacts from droughts that affected Hawaiʻi between January 1, 2018, and December 31, 2022. All of these impacts are from media reports. Most of the impacts (21) were classified as “agriculture.” Other impacts include “relief, response & restrictions” (20), “water supply & quality” (19), “plants & wildlife” (18), “fire” (6), “society & public health” (5), “business & industry” (3), and “tourism & recreation” (1) (National Drought Mitigation Center 2022).

Between January 1, 2018, and December 27, 2022, the County of Maui had 66 drought-related impacts; the County of Hawaiʻi had 25 drought-related impacts; the City and County of Honolulu had 19 drought-related impacts; and the County of Kauaʻi had 1 drought-related impact.

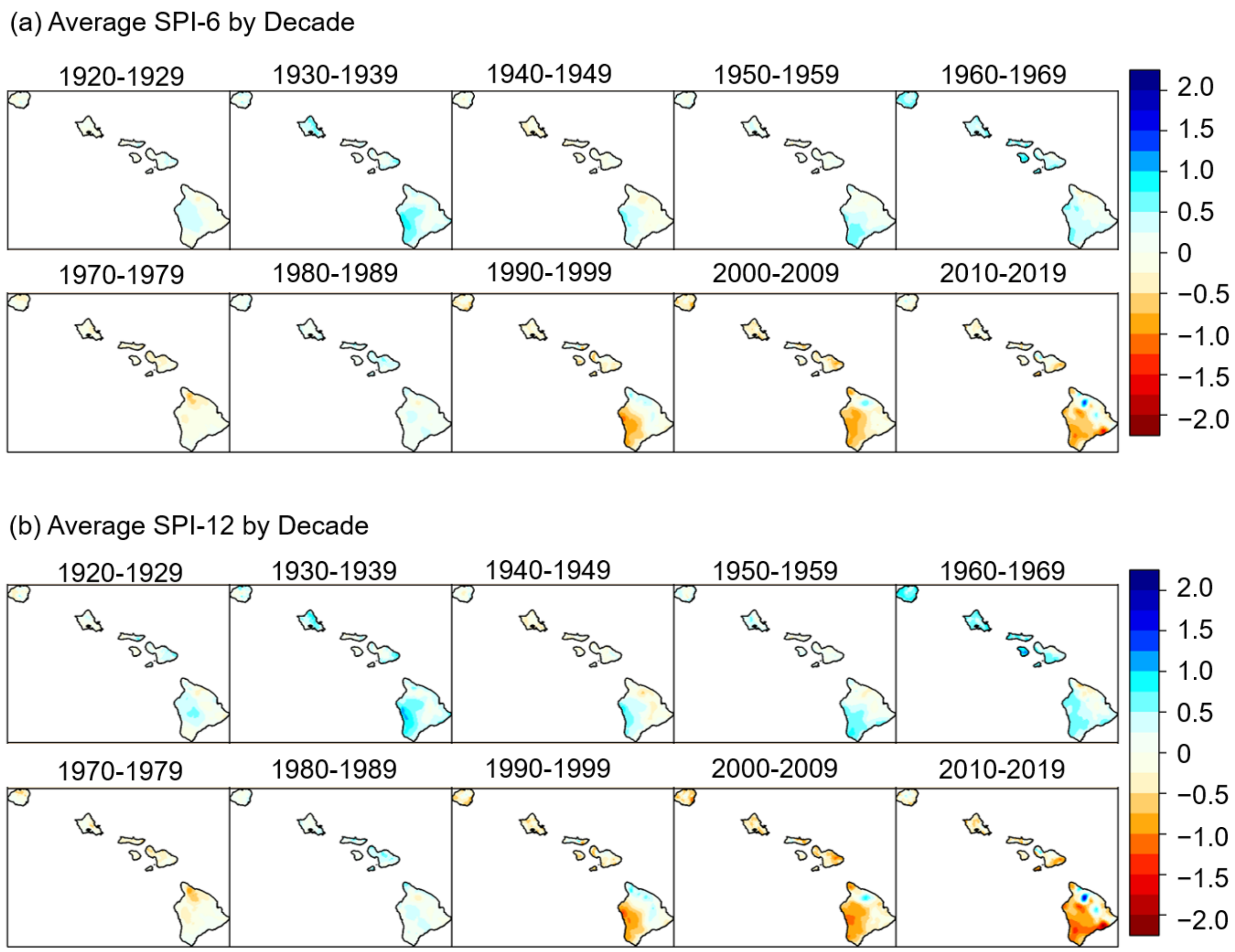
Drought Monitoring and Forecasting

There are two popular drought indices used in Hawaiʻi to monitor and forecast droughts: the Standardized Precipitation Index and the Percent of Normal Rainfall Index. A third index, the Keetch-Byram Drought Index, is used by the National Weather Service to track wildland fire fuel conditions and to assess the potential for wildland fire in the State of Hawaiʻi.

Standardized Precipitation Index

The Standardized Precipitation Index (SPI) has been embraced by agencies such as the National Drought Mitigation Center (NDMC) and the Western Regional Climatic Center (WRCC) and was adapted for use in Hawaiʻi by the National Weather Service Honolulu Forecast Office (National Weather Service n.d.). The SPI considers only precipitation, which makes the index ideal for use in Hawaiʻi, where there is a relatively dense network of rain gauges. The SPI is computed for time scales ranging from 1 to 48 months. Because the SPI values are normalized, the wide range of rainfall conditions across the State of Hawaiʻi can be assessed on an equal basis. Furthermore, SPI values can be generated for multiple time scales (see Figure 4.4-7). This feature is extremely useful for monitoring purposes because the effects of droughts occur over wide ranges of time scales. Finally, since the SPI uses standard statistical principles, it can also be used to monitor other data such as stream flow, reservoir levels, and ground water levels. Table 4.4-1 displays the different SPI categories and their associated values.

Figure 4.4-7. Average 6-month (a) and 12-month (b) SPI by decade (1920–2019) for the State of Hawaiʻi



Source: (Frazier, et al. 2022)

Table 4.4-1. SPI Categories

Value	Category
Greater than or equal to 2.00	Extremely Wet
1.50 to 1.99	Severely Wet
1.00 to 1.49	Moderately Wet
0.99 to -0.99	Near Normal
-1.00 to -1.49	Moderate Drought
-1.50 to -2.00	Severe Drought
Less than or equal to -2.00	Extreme Drought

Percent of Normal Rainfall Index

The Percent of Normal Rainfall Index (PNRI) is based on the percentage of current rainfall value compared against the long-term mean. The PNRI is one of the simplest methods of comparing current precipitation amounts to recorded historical averages. The index is calculated by dividing the actual precipitation amount by a 30-year (typically) precipitation mean. Time scales are generally stated in months or a year. The PNRI is effective for comparing a single region or season in easily understood terms.

One of the disadvantages of using the PNRI is that the mean precipitation is often not the same as the median precipitation. The reason for this is that precipitation on monthly or seasonal scales does not have a normal distribution while the PNRI implies a normal distribution where the mean and median are considered being the same. Another disadvantage of the PNRI is that due to the variety in the precipitation records over time and location, there is no way to determine the frequency of the departures from normal or compare different locations inhibiting attempts to mitigate drought based on the departures from normal and form a plan of response.

Keetch-Byram Drought Index

The Keetch-Byram Drought Index (KBDI) is calculated using weather station latitude, mean annual precipitation, maximum dry bulb temperature, previous 24-hour rainfall. The KBDI is used by the National Weather Service and foresters to assess fuel conditions and potential for wildfire. The KBDI describes soil moisture deficit with values ranging from 0 to 800. A value of 800 indicates extreme drought, and a value of 0 reflects saturated soil. KBDI at the Honolulu International Airport fluctuates through the year, while values in excess of 600 represent the highest 34% of values from 1975-2010. A KBDI of greater than 600 is typically encountered by late July and normally persists through late October. The National Weather Service (NWS) issues Red Flag Warnings when all three of the following conditions are met for two hours or more during any part of a day at the Honolulu International Airport (National Weather Service 2022):

- KBDI ≥ 600
- Minimum Relative Humidity ≤ 45 % (2 hours or more)
- Wind ≥ 20 mph (≥ 17 knots) (2 hours or more)

Warning Time

Droughts are climatic patterns that occur over long periods of time. Only generalized warning can take place due to the numerous variables that scientists have not pieced together well enough to make accurate and precise predictions. Though only generalized warnings can take place, the U.S. Drought Monitor provides current and recent history of areas and populations affected by drought (U.S. Drought Monitor 2022).

El Niño events are strongly correlated with drought in the State of Hawaiʻi. There is an approximately 70% chance of a drier than normal winter season following the onset of an El Niño event. This can give a lead time of up to 12 months or so for managers and decision makers to prepare for a potential drought. The intensity and duration of drought cannot be predicted, but an El Niño occurrence is one of the only indicators managers have to forecast drought in Hawaiʻi. It is very difficult to predict an El Niño or La Niña event, but scientists monitor various ocean and atmospheric elements associated with these events and utilize complex computer models to make El Niño/La Niña forecasts. The National Oceanic and Atmospheric Administration (NOAA) Climate Prediction Center produces a monthly El Niño/Southern Oscillation (ENSO) Diagnostic Discussion, which provides analysis of current oceanic and atmospheric conditions as well as projection summaries of ENSO prediction models. A La Niña event can also affect rainfall and is historically related to wetter than normal conditions; however, this association is not as consistent as El Niño is to drought.

Drought is a very slow-developing hazard, and depending on the impact sector, it may take anywhere from months to years for the impacts and effects of drought to be felt. Scientists at this time do not know how to predict drought more than one month in advance for most locations. Predicting drought depends on the ability to forecast precipitation and temperature. Anomalies of precipitation and temperature may last from several months to several decades. How long they last depend on interactions between the atmosphere and the oceans, soil moisture and land surface processes, topography, internal dynamics, and the accumulated influence of weather systems on the global scale (Zhou, et al. 2019).

Previous Occurrences and Losses

During the planning for this update, many sources were researched that provided drought information regarding previous occurrences throughout the State of Hawaiʻi. The 2018 Plan discussed drought events that occurred in the state through 2017. For this 2023 SHMP Update, drought events were summarized between January 1, 2018 and December 31, 2022.

Disaster and Emergency Declarations

The following disaster declarations or emergency proclamations related to drought have been issued for Hawaiʻi:

- Federal disaster (DR) or emergency (EM) declarations, 1955–2022: no drought events
- Hawaiʻi state emergency proclamations, 2018–2022: 8 events, classified as drought
- USDA agricultural disaster declarations, 2012–2022: 34 events, classified as drought

Table 4.4-2 and Table 4.4-3 provide the United States Department of Agriculture (USDA) Secretarial disaster declarations in all Hawaiian counties from January 1, 2018, through December 31, 2022. Maui County received the most USDA declarations during this timeframe.

Table 4.4-2. Drought-Related USDA Declarations, 2018 to 2022

Year	Approval Date	Designation Number	Description of Disaster	Counties Affected
2019	July 9, 2019	S4492	Drought	Hawaiʻi
2019	July 3, 2019	S4495	Drought	Maui
2019	March 19, 2019	S4490	Drought	Kauaʻi
2020	November 18, 2020	S4870	Drought	Kauaʻi
2020	November 6, 2020	S4863	Drought	Honolulu
2020	March 11, 2020	S4649	Drought	Maui, Hawaiʻi
2021	November 19, 2021	S5107	Drought	Kauaʻi
2021	September 10, 2021	S5073	Drought	Honolulu
2021	June 25, 2021	S4991	Drought	Hawaiʻi
2021	March 5, 2021	S4918	Drought	Maui
2022	August 15, 2022	S5253	Drought	Kauaʻi
2022	April 8, 2022	S5148	Drought	Maui, Hawaiʻi
2022	March 15, 2022	S5185	Drought	Maui, Honolulu

Source: (USDA 2022)

Table 4.4-3. Summary of USDA Secretarial Disasters in Hawaiʻi by County, 2018 to 2022

County	2018	2019	2020	2021	2022	5-Year Total
Kauaʻi	0	1	1	1	1	4
Honolulu	0	0	1	1	1	3
Maui	0	1	1	1	2	5
Hawaiʻi	0	1	1	1	1	4

Source: (USDA 2022)

Insured Crop Losses

According to the USDA Risk Management Agency (RMA), insured crop losses through the State of Hawaiʻi as a result of drought conditions for the five-year period of 2018 to 2022 totaled $780,330. In Table 4.4-4, the USDA RMA insured crop losses through the State of Hawaiʻi as a result of drought conditions are shown by year, from 2018 to 2022. It shows the highest year of crop losses as 2022 in this five-year period, followed by 2021. This data only applies to insured crops.

Table 4.4-4. Total Insured Crop Insurance Paid by Year, 2018 to 2022

Year	Crop Insurance Paid
2018	$0
2019	$0
2020	$0
2021	$344,991
2022	$435,339
Total:	**$780,330**

Source: (USDA Risk Management Agency 2022)

Event History

Table 4.4-5 provides a summary of drought events that have impacted the State of Hawaiʻi between 2018 and 2022. Drought events that occurred prior to 2018 can be found in Appendix E (Hazard Profile Supplement).

Table 4.4-5. Drought Events in Hawaiʻi, 2018 to 2022

Date(s) of Event	Event Type	Counties Affected	Description
January 1 to February 22, 2018	Drought	All	All portions of the state experienced consecutive weeks of abnormally dry to severe drought conditions, particularly Hawaiʻi County.
May 31 to October 11, 2018	Drought	All	All portions of the state experienced consecutive weeks of abnormally dry to severe drought conditions, particularly Hawaiʻi and Maui Counties.
December 6, 2018 to December 22, 2022	Drought	All	All portions of the state experience consecutive weeks of abnormally dry to exceptional drought conditions. During the time span, Maui experience 33 weeks of exceptional drought. A significant lack of rainfall across Maui County resulted in lack of groundwater recharge and surface flow; increase wildfire activity; grasslands dried and were unable to meet the needs of cattle; and thousands of axis deer starved to death from lack of forage. Dry conditions in Honolulu County, coupled with the shutdown of three wells due to Navy fuel tank leaks contaminating the water supply led to voluntary water restrictions. Below normal rainfall in Hawaiʻi County degraded pastures throughout the island; contributed to the 20,000-acre Leilani and 40,000 Mana Road Fires; and led to residents trucking water to fill catchment tanks. During the 2021-2022 wet season, portions of Kauaʻi, Maui, and Hawaiʻi Counties received 40 percent of average rainfall; portions of Oʻahu received 70 percent of average rainfall.

Source: (U.S. Drought Monitor 2022, National Drought Mitigation Center 2022, USDA 2022, Hawaiʻi Wildfire Management Organization 2022)

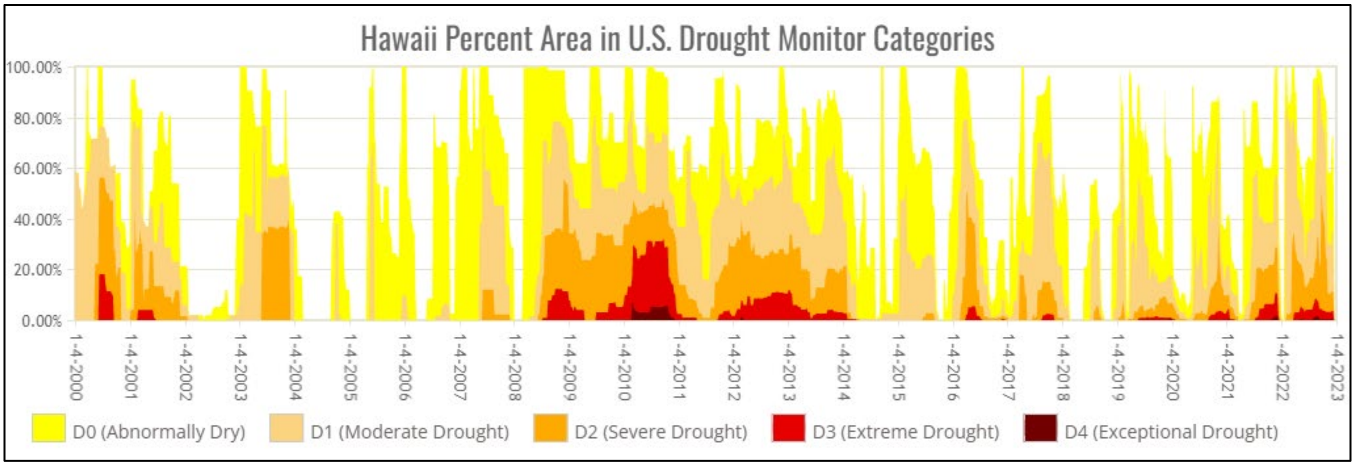
As shown in Table 4.4-2 and Figure 4.4-8, droughts have been and will continue to be a significant concern in the State of Hawaiʻi. Planning for and coping with recurring, if unpredictable, drought events is complicated by the inherent water resource limitations of the islands and the uneven range of drought-related concerns and relevant priorities across counties. The statewide variability in resources, vulnerability, and risk necessitates a sectoral approach to drought mitigation. Statewide, three sectors were identified as being vulnerable to drought as well as having the potential to be ameliorated through mitigation measures: public water supply; agriculture and commerce; and environment, public health, and safety.

PROBABILITY OF FUTURE HAZARD EVENTS

Overall Probability

During the entire time period for the 2023 SHMP Update, from January 1, 2018, to December 31, 2022, drought conditions existed somewhere in the State of Hawaiʻi. Based on the history of droughts in the state, the State of Hawaiʻi can expect drought conditions on an ongoing basis.

Figure 4.4-8 Percent of Hawaiʻi State Affected by Each USDM Rating, 2000–2022



Source: (U.S. Drought Monitor 2022)

Climate Change Impacts

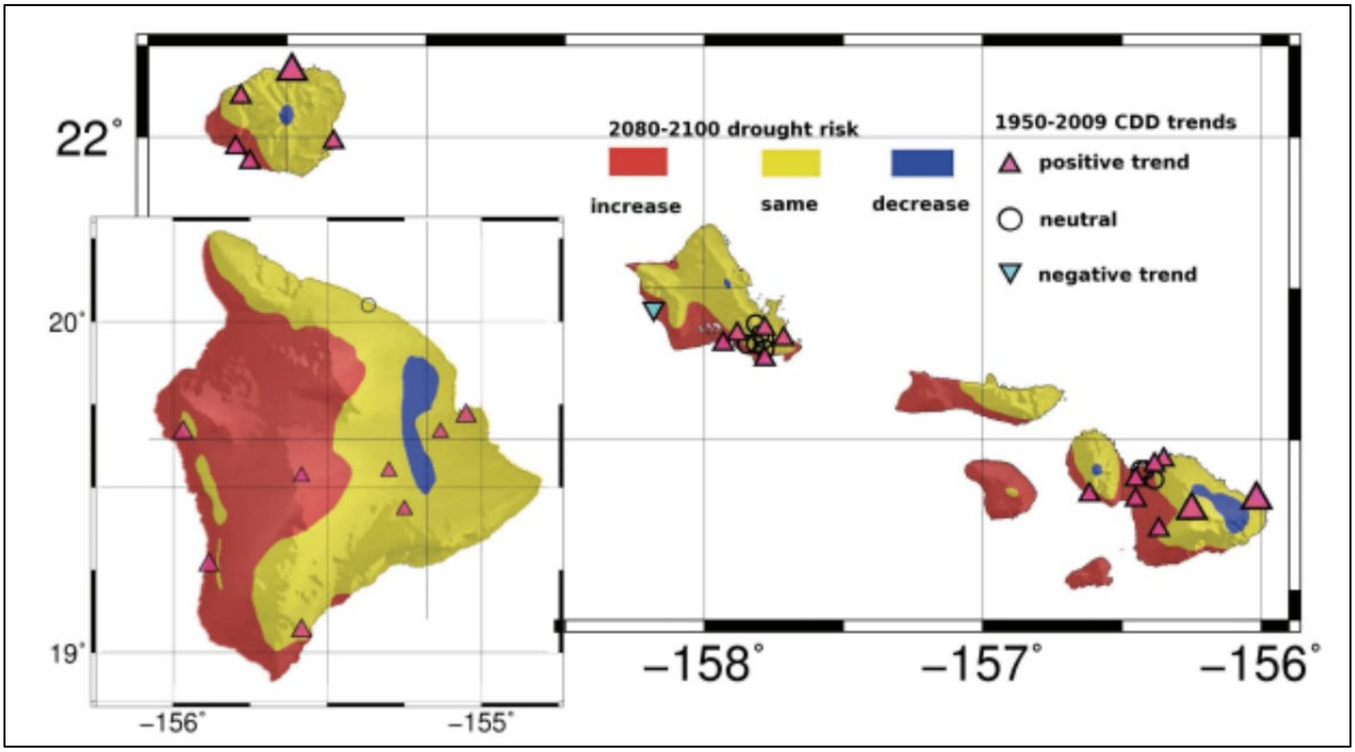
The effects of climate change on the drought hazard in the State of Hawaiʻi are described in detail in *Hawaiʻi Drought Plan 2017 Update* (DLNR Commission on Water Resource Management 2017). Climate change threatens the quality and quantity of fresh water available. Increasing temperatures, increased nutrient and sediment loads, and decreased dilution of pollutants during periods of drought threaten the availability of fresh water.

Over the past 100 years, the average annual rainfall has decreased, receiving almost one foot less rainfall today than a century ago. When trends are analyzed seasonally and spatially, much larger dry season declines are found, particularly on the leeward side of islands. Streamflow and base flow have also declined during this period of time, with impacts to groundwater storage, which supplies 99% of the state's domestic water use. In addition, the State of Hawaiʻi is at risk to sea level rise (see Section 4.2 – Climate Change and Sea Level Rise). Rising sea levels may contaminate fresh water with salt water (Frazier, et al. 2022).

Drought can also increase the likelihood of wildfire. An increase in wildfire events will destroy native plants and support the spread of fire-adapted (and often fire-promoting) invasive species (Hawaiʻi Wildfire Management Organization 2022, Wessendorf 2022).

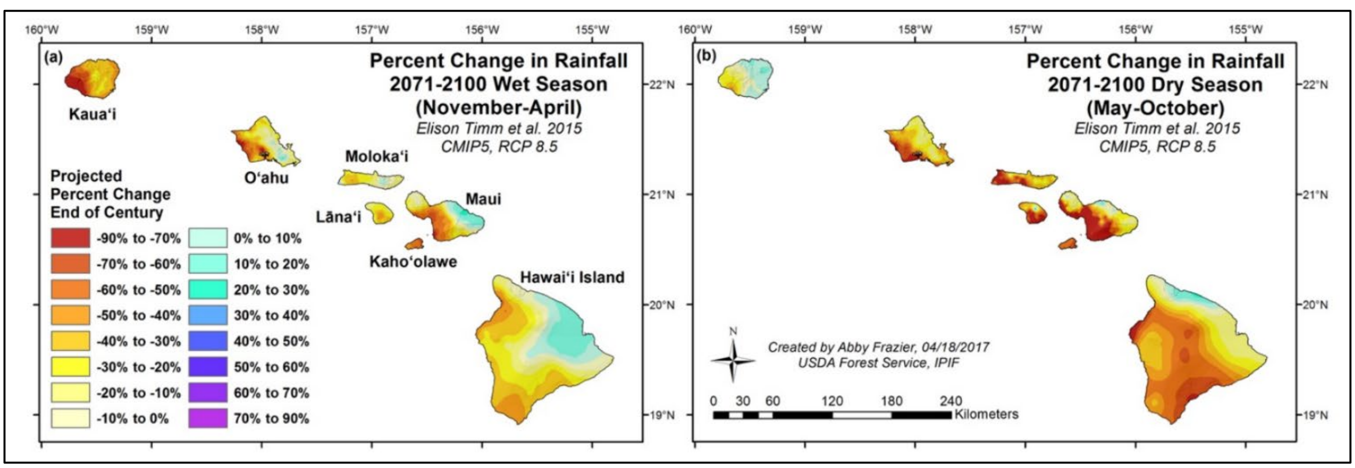
It is anticipated that climate change will increase the frequency of meteorological and agricultural droughts. This will increase the frequency of brief hydrological droughts, and the probability of a long hydrological drought. Figure 4.4-9 shows the potential for increased drought risk in the State of Hawaiʻi based on historical drought and future projections of climate change. Figure 4.4-10 shows precipitation projections for the 2071 to 2100 wet and dry seasons in Hawaiʻi based on statistical downscaling methods. There is inherent uncertainty in any global climate model that is downscaled to reflect the intricacies and microclimates of the Hawaiian Islands. These computer models continue to be refined, and research on future rainfall and water availability in Hawaiʻi is ongoing.

Figure 4.4-9. Future Projections of Drought Based on Historical Data and Future Climate Projections



Source: (DLNR Commission on Water Resource Management 2017)

Figure 4.4-10. Percent Change in Rainfall



Source: (DLNR Commission on Water Resource Management 2017)

4.4.2 VULNERABILITY ASSESSMENT

The Hawaiʻi Drought Plan 2017 Update lists the different impacts of drought in the state, including decimation of crops and livestock, the creating of dustbowls and erosion of landscapes, damage to terrestrial and aquatic wildlife habitats, enhanced wildfires, and economic damage. In addition to these impacts, the State of Hawaiʻi has other issues such as growing conflicts between agricultural uses of surface water and instream uses, surface and groundwater interrelationships, and the effects of growing water demands on traditional and cultural uses of water. Droughts have always been and will continue to be prevalent in the state. Droughts will continue to adversely affect the environment, economy, and the citizens of Hawaiʻi (DLNR Commission on Water Resource Management 2017).

Assessment of State Vulnerability and Potential Losses

This section discusses statewide vulnerability of exposed state assets (state-owned or state-leased buildings), state roads, and critical facilities and community lifelines to droughts.

State Assets

As reported in the *Hawaiʻi Water Plan*, the state owns both potable, non-potable, and irrigation water systems that may be impacted by drought (Department of Land and Natural Resources 2020). Impacts to water systems may include loss or severe reduction of water supply, loss of water pressure, or poor water quality. Drought does not directly affect buildings, so no state buildings are considered vulnerable to drought. However, there are secondary impacts that state buildings would be vulnerable to as a result of drought: wildfires and expansive soil effects on concrete and structure foundations.

Drought conditions may make structures more vulnerable to wildfires, which are more likely during a prolonged drought. Risk to life and property is greatest in areas where forested areas adjoin urbanized areas known as the wildland urban interface (WUI). Therefore, all state buildings and critical facilities (discussed below) in and adjacent to the WUI zone and located in high wildfire risk areas are considered vulnerable to wildfire. Section 4.15 describes the state's vulnerability to the wildfire hazard.

State buildings could be affected by the shrink-swell cycle that occurs as soils swell during wet periods and shrink during drought periods can cause damages to concrete components and structure foundations. Bridges and roads are especially vulnerable to damages as a result of the shrink-swell cycle. The Hawaiʻi Department of Transportation (HDOT) monitors this type of damage and is responsible for the repairs of those roads and bridges that are state-owned/maintained.

Community Lifelines and Critical Facilities

As stated previously, drought does not directly impact structures. However, water-dependent community lifelines and critical facilities may be impacted. Under extreme drought conditions, where local water supplies are depleted and water utilities are unable to supply adequate water pressure, fire stations and healthcare facilities could be impacted. Healthcare facilities, including hospitals, clinics, and nursing homes, rely on water for heating, cooling, and ventilation systems as well as for equipment sterilization, sanitation, water-based patient treatments, fire suppression, and hazmat decontamination.

Community lifeline and critical facility elements such as landscaping may not be maintained due to limited resources, but the risk to the facilities inventory will be largely aesthetic. For example, when water conservation measures are in place, landscaped areas will not be watered and may die. These aesthetic impacts are not considered significant.

Secondary impacts from drought include an increased risk of wildfires which could threaten community lifelines and critical facilities and the concrete components and structure foundations from the shrink-swell cycle of expansive soils, as discussed above. Tertiary impacts include sediment runoff during severe rainfall events in areas where the vegetation and ground cover have been burned by wildfire. Sediments can damage and kill Hawaii's fragile coral reef systems. Uninhibited runoff could reduce recharge of the underlying aquifers.

Assessment of Local Vulnerability and Potential Losses

Drought impacts cross jurisdictional boundaries and primarily impact the population's water supply and the agricultural/aquacultural industry. The state is vulnerable to drought, both statewide and county-specific, because it has limited groundwater resources and is isolated. Buildings are not anticipated to be directly affected by a drought, and all are expected to be operational during a drought event. As discussed above, droughts can create conditions conducive to wildfires, and therefore local populations and buildings in and adjacent to the wildfire hazard areas are considered vulnerable to wildfire.

The unique terrain and orography of the Hawaiian Islands produce extremely variable microclimates and drought may impact limited geographical areas or affect large portions of an island. Where some areas on an island may be experiencing drought, other areas may be free of drought conditions. Drought conditions and impacts in Hawaiʻi may vary greatly both temporally and spatially, and this is an important factor to consider when planning for drought mitigation and preparedness.

Drought events impact the economy, including loss of business function and damage and loss of inventory. Industries that rely on water for business may be impacted the hardest (e.g., agriculture/aquaculture). Even though a majority of businesses will still be operational, they may be impacted aesthetically. These aesthetic impacts are most significant to the recreation and tourism industry which is an important part of each county's economy.

Economic impacts may include:

- Losses from crop, livestock, timber, and aquaculture production and associated businesses
- Losses from tourism industry, recreation providers and associated businesses
- Losses related to the increased costs resulting from increased energy demand and from shortages caused by reduced hydroelectric generation capacity
- Revenue losses for federal, state, and local governments from a reduced tax base and for financial institutions from defaults and postponed payments
- Long-term loss of economic growth and development

The size of the agriculture industry varies from county to county. A prolonged drought event could have significant impacts to the state's economy, particularly in counties that have large amounts of agricultural lands. Additionally, damaged and dead crops are also vulnerable to wildfires which can spread easily during periods of drought. Additional information about the potential exposure areas to drought in each county are discussed further below.

Based on past information, during a long-term drought (several months to years) drought first affects unirrigated agriculture and pasture operations. As the drought continues, surface water-supplied water systems are impacted due to lowered stream flows, there is an increase in wildland fire occurrence, and residences that rely on rainwater catchment may need to purchase drinking water from water delivery companies (water haulers). If the drought continues, ground water supplies and drinking water utilities may be affected due to decreases in aquifer recharge, which is replenished by rainfall during normal conditions.

The local HMPs were reviewed to integrate risk assessment results into the 2023 SHMP Update; a summary of information available is below.

- County of Kauaʻi – The County of Kauaʻi HMP included Drought and Extreme Heat as one hazard. The County utilized the U.S. Drought Monitor to identify past drought events and the geographic areas most impacted by drought. The County also identified planning issues around drought, including a lack of drought-tolerant landscape designs; a failure to utilize groundwater recharge techniques; a lack of active water conservation; and a need for cooling centers(County of Kauaʻi 2020).
- City and County of Honolulu – The City and County of Honolulu studied the impact of drought on three different sectors: the water supply sector, the agricultural and commerce sector, and the environment, public health and safety sector. The City and County used the 2017 Hawaiʻi Drought Plan to identify risk to these sectors. There is little risk to the City and County's water supply; moderate risk to the agricultural enterprises in the central area of the island; and drought risk in the wildland urban interface near the Mililani/Waipio region (City and County of Honolulu 2020).
- County of Maui – The Maui County HMP includes a risk assessment of both drought and extreme heat. The county utilized rainfall records to identify areas prone to drought, finding that leeward-facing areas such as Maui's Upcountry are particularly vulnerable to drought. The County HMP included a discussion of how drought would impact Maui's socially vulnerable residents, identifying communities that would be especially at risk from drought impacts, including single-parent households, households including dependent individuals, low-income households, households living in properties built prior to 1950, and households with mobility and transportation constraints (County of Maui 2020).
- County of Hawaiʻi – The County of Hawaiʻi used the Standardized Precipitation Index (SPI) and the U.S. Drought Monitor to identify areas of drought risk within the county. The county also integrated Hawaiʻi's Drought Risk and Vulnerability Assessment and GIS Mapping Project into the risk assessment; the Assessment found areas of concern for drought in Hawaiʻi County are located on the western side of the island, coinciding with low rainfall zones (County of Hawaiʻi 2020).

Socially Vulnerable and Total Populations

Directly or indirectly, the entire population of the State of Hawaiʻi is vulnerable to drought events. Drought can affect people's health and safety as well as other impacts. Health problems related to low water flows, poor water quality, or dust could arise. Additional possible impacts include recreational risks; air quality reduction; diminished living conditions related to compromised, local hydroelectric power sources; compromised food and nutrition; and increased incidence of illness and disease. Vulnerable populations who rely on rainfall catchment for residential water supply may be especially impacted if they do not have the physical or financial ability to obtain imported water to refill dry catchment tanks. How and to what degree drought affects the state's population does vary.

Overall, there are primarily three drought impact sectors that are critical to the health and welfare of the state's population in terms of social, economic, and environmental aspects. These impacts include: the Water Supply Sector; the Agriculture and Commerce Sector; and the Environment, Public Health, and Safety Sector. These sectors are not mutually exclusive, and as such, impacts in one sector may result in secondary or cumulative impacts in other sectors. The following describes these sectors:

Water Supply Sector

The water supply sector includes public and private urban and rural drinking water systems, agriculture water systems, and rainwater catchment systems. Since the availability of freshwater is crucial to human survival in both direct and indirect ways, minimizing the impact of drought to the state's freshwater is a significant priority. In the State of Hawaiʻi, most public water systems (PWS) are supplied by groundwater sources, but there are seven surface water supplied systems and four rainfall catchment water systems that are considered PWS by the Department of Health (DLNR Commission on Water Resource Management 2017).

Agricultural and Commerce Sector

The Agriculture and Commerce Sector experiences severe negative drought impacts due to dependence upon both surface water and rainfall. Rainfall shortage-induced impacts are often exacerbated by the limits placed on ground water pumping during drought periods. A persistent shortage of rainfall and the resultant lack of soil moisture can result in reduced ground cover and lower agricultural yields. Reduced ground cover and pasture can result in the reduction of livestock herd sizes and is also associated with an increased rate of erosion. Drought impacts to the agriculture sector are highly dependent on whether or not the crops are irrigated since unirrigated pasture, orchards, or other fields are most vulnerable to droughts. Irrigated agricultural areas become more vulnerable when water supplies become more threatened. Commerce sectors such as tourism will also experience negative drought impacts since tourism directly depends on healthy, thriving Hawaiian ecosystems (DLNR Commission on Water Resource Management 2017).

Environment, Public Health, and Safety Sector

The Environment, Public Health, and Safety Sector mainly focuses on the increased incidence of wildfires due to drought conditions. Wildfires are described in Section 4.15 (Wildfire). However, there are environmental impacts of drought conditions that are also an important component of this sector. Stressed water supplies exacerbate already vulnerable island ecosystems and can result in impacts to wildlife habitats, water quality, land quality, and biodiversity and can contribute to erosion (DLNR Commission on Water Resource Management 2017).

General Building Stock and Economy

As stated previously, drought does not directly impact structures, including the general building stock. The general building stock, as defined for this plan, would continue to be functional during a drought. The only secondary impacts from drought would be an increased risk of wildfires which could threaten buildings located close to WUI areas, and to the concrete components and structure foundations from the shrink-swell cycle of expansive soils, as discussed previously.

Drought causes the most significant economic impacts on industries that use water or depend on water for their business, most notably in the State of Hawaiʻi, agriculture and aquaculture as well as landscaping businesses. In addition to losses in yields in crop and livestock production, drought is associated with increased insect infestations, plant diseases, and wind erosion. Drought can lead to other losses, including reduced income for farmers and reduced business for retailers and others who provide goods and services to farmers.

According to the 2021 USDA Agriculture Overview for the State of Hawaiʻi, statewide there are 1,100,000 acres in agricultural use (U.S. Department of Agriculture 2023). Each county varies in the acreage of agricultural land and the overlapping risk from drought. Table 4.4-6 shows the most recent compiled USDA Census of the State of Hawaiʻi and the total value of agricultural products sold totaled nearly $564 million that are exposed to drought conditions.

Table 4.4-6. State of Hawaiʻi Agriculture Market Value

Agricultural Products Sold	Market Value
Value of crops, including nursery and greenhouse	$417,069,000
Value of livestock, poultry, and their products	$146,733,000
Total value of agricultural products sold	**$563,803,000**

Source: (U.S. Department of Agriculture 2017)

During drought, ranchers lose pasture and forage resources. Ranchers may have to purchase expensive supplemental feed and reduce herd size. This can lead to large revenue losses with impacts to livelihoods and industry sustainability. After a severe multi-year drought, it may take a decade or more of normal rainfall conditions to financially recover to pre-drought ranching revenue levels (Frazier, et al. 2022).

Environmental Resources and Cultural Assets

Environmental losses from drought are associated with damage to plants, animals, wildlife habitat, and air and water quality; forest and range fires; degradation of landscape quality; loss of biodiversity; and soil erosion. Some of the effects are short-term and conditions quickly return to normal following the end of the drought. Other environmental effects linger for some time or may even become permanent.

Watersheds are critical to replenishing Hawaii's groundwater aquifers, which supply most of the state's drinking water. Healthy watersheds also reduce polluted runoff into our nearshore waters and support healthy stream ecosystems. Watersheds impacted by drought-induced ecosystem damage or wildfires result in decreased ground and surface water supplies and damage to nearshore waters and reef ecosystems.

Wildlife habitat, for example, may be degraded through the loss of wetlands, lakes, and vegetation. However, many species will eventually recover from this temporary condition. The degradation of landscape quality, including increased soil erosion, may lead to a more permanent loss of biological productivity. The impacts to vegetation and wildlife can include death from dehydration and the spread of invasive species or disease because of stressed conditions. Invasive species pose problems for the ecosystems in which they are introduced. Like many hazards that affect the State of Hawaii's environment, invasive species have both direct and indirect impacts.

One fairly recent but pervasive consequence of drought is the impact to the wild axis deer population in the County of Maui. Axis deer are considered an invasive species in Hawaiʻi, and one estimate places the population in Maui County at 60,000 animals (Maui Now 2022). During drought, the natural food and water sources of axis deer in forested and upland areas are severely reduced, which causes the animals to move into agricultural and urban areas. Seeking food and water, the deer decimate agricultural crops, residential vegetable gardens, and irrigation systems in areas where deer normally do not inhabit. Deer have also been involved in automobile collisions on highways and roads, causing a dangerous traffic hazard. Severe drought is also associated with game mammal die-offs on Molokaʻi and Lānaʻi Islands.

When groundwater is not replenished over a period of time, aquifer and well water levels diminish, making irrigation and drinking water difficult to obtain. In addition, contamination of surface water sources can occur during drought conditions. Surface water reservoirs (although there are few in Hawaiʻi) may experience increased pollutant levels and lower levels of oxygen, contributing to higher concentrations of illness-causing bacteria and protozoa as well as toxic blue-green algae blooms. Further, reduced aquifer recharge and depletion of aquifer storage may affect the discharge of groundwater to the coastal nearshore waters. This may negatively impact the groundwater dependent ecosystems, which rely on coastal discharge of groundwater to flourish.

Growing public awareness and concern for environmental quality has required that public officials focus greater attention and resources on these effects. Since the tourism industry accounts for a significant portion of the state's economy, adverse effects on the natural environment could have serious effects on this important sector (DLNR Commission on Water Resource Management 2017).

The primary impacts on cultural assets from drought would be an increased risk of wildfires which could threaten these assets, and to structure foundations from the shrink-swell cycle of expansive soils.

Droughts may impact Native Hawaiian traditional and customary practices, which rely on healthy terrestrial, marine, and groundwater dependent ecosystems. These practices may include the collection of plants, animals, and minerals and other practices. As discussed above, drought and its secondary impacts can damage watersheds and nearshore waters may impair, diminish, or impede the exercise of traditional and customary practices.

Future Changes that May Impact State Vulnerability

Understanding future changes that impact vulnerability in the state can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The state considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Availability and vulnerability of water supplies
- Other identified conditions as relevant and appropriate, including the impacts of climate change

As the resident and visitor populations in the State of Hawaiʻi continue to increase, the stresses on the state's water sources will increase as more resources will be needed for human use and consumption and these resources are further taxed by changing climate conditions. Drought conditions and development are interrelated – as water is drawn down from increased rates of use, drought can occur more readily than from lack of precipitation alone. In addition, newly developed land or expansion into upland forested areas may reduce groundwater recharge as more land in the state becomes impermeable.

Native Hawaiian cultural practices are closely tied to the natural environment. Together, drought, wildfire, and invasive species threaten many of Hawaii's iconic plants and animals. When coupled with land use change and the spread of diseases facilitated by warming temperatures, impacts to native species and their habitat may incur (McGinn 2022)

Drought Hazard Mitigation Success Story

Credit: Hawaiʻi Climate Data Portal

The 2018 SHMP included an action to enhance the Hawaiʻi State Rain Gauge Network. In late 2021, the project was funded by the National Science Foundation to deploy 84 new Mesonet meteorological stations across the State. These Mesonet stations collect and produce real time weather data. Measurements include rainfall, air temperature, relative humidity, wind speed and direction, air pressure, solar radiation, reflected solar radiation, incoming and outgoing longwave radiation, net radiation, soil heat conduction, soil temperature at three depths, and soil moisture at three depths.

In addition to increasing understanding of drought conditions across the state, data from the Hawaiʻi Mesonet increases the State's capacity to forecast the weather, issue flood and wildfire warnings, and provides resources for emergency management, water resource management, agriculture and ranching.

University of Hawaiʻi students help install, calibrate and maintain the weather data.

For more details on the Mesonet project, please see Hawaiʻi Mesonet – Hawaiʻi Climate Data Portal (hawaii.edu)

Section 4.5 Earthquake

Earthquake

Earthquakes can be caused by natural shifts in tectonic plates, movement of magma within volcanoes, and the flex and bend of earth's crust. Hawai'i experiences earthquakes regularly, although the majority of them are so small that they can only be detected by seismometers. Most of them occur on or near Hawai'i Island and are related to the island's active volcanoes. Impact statistics below are based on a 100-year statewide probabilistic earthquake.

CHANGES SINCE 2018

+1

Declared Disasters

+50

Events 4.0+ M

COUNTIES MOST VULNERABLE

SOCIALLY VULNERABLE POPULATION

1.66%

Of Total Population

23,547

Persons

HAZARD RANKING

COMMUNITY LIFELINES

1,369

Total

CLIMATE PROJECTIONS

Melting glaciers and the resulting weight shift may induce seismic activity

During times of drought, pumping groundwater from underground aquafers has been shown to impact patterns of stress loads on the Earth's crust

El Niño cycles in the Pacific trigger seismic responses as the pressure of water changes with sea level fluctuations

489

State Buildings

93

Miles of State Road

SQUARE MILES

3,211

Environmental Resources

14

Hawaiian Home Lands

71

Cultural Resources

CONTENTS

TABLES

FIGURES

[1] *Section Cover Photo: Road damage from the 2018 earthquakes in Leilani Estates, Hawaiʻi Island. Photo by Grace Simoneau/FEMA*

SECTION 4. RISK ASSESSMENT

4.5 EARTHQUAKE

2023 SHMP Update Changes

- Earthquake events that occurred in Hawaiʻi from January 1, 2018, through December 31, 2022, were researched for this 2023 SHMP Update.
- New and updated figures from federal and state agencies are incorporated.
- This section now includes a discussion of how earthquakes impact socially vulnerable populations and community lifelines.
- Six types of cultural resources (archaeology, burial sensitivity area, historic building, historic district, historic object, and historic structure) are added to the vulnerability assessment.

4.5.1 HAZARD PROFILE

Thousands of earthquakes occur every year in the State of Hawaiʻi. Earthquakes in Hawaiʻi are caused by eruptive processes within the active volcanoes or by deep structural adjustments due to the weight of the islands on Earth's underlying crust. Most of these earthquakes are closely related to volcanic processes and are so small they can only be detected by seismometers. Some are strong enough to be felt on one or more of the islands. Some earthquakes are strong enough to cause significant damage and impact residents across the state (U.S. Geological Survey Hawaiian Volcano Observatory n.d.). Additionally, local or distant earthquakes can lead to tsunamis in the State of Hawaiʻi. For details regarding the volcano hazard in Hawaiʻi, refer to Section 4.14. For details regarding the tsunami hazard in the State of Hawaiʻi, refer to Section 4.13.

Hazard Description

Hawaiian earthquakes fall into three main categories: volcanic, tectonic, and mantle:

- Volcanic – Magma movement within, and eruptions from, the presently active volcanoes in the state (Kīlauea, Mauna Loa, Hualālai, Haleakalā, and Kamaʻehuakanaloa) are usually accompanied by hundreds to thousands of small earthquakes that rarely cause significant damage. The small earthquakes are caused by the movement of magma and often occur in shallow swarms, especially after an eruption. These volcanic earthquakes are important for volcano monitoring (U.S. Geological Survey Hawaiian Volcano Observatory n.d.) (U.S. Geological Survey Hawaiian Volcano Observatory n.d.).
- Tectonic – These are earthquakes on major faults within and at the base of the volcanoes. The earthquakes are driven by deformation of the volcano, often by gravity, but also from inflation prior to eruption. While tectonic earthquakes are commonly associated with eruptions, they are not directly caused by the

eruptions, rather, they share a common cause, such as inflation. Tectonic earthquakes may occur at any time and can be damaging (Figure 4.5-1). The largest and most damaging tectonic earthquakes are those that occur right at the base of a volcano, where it sits on preexisting sea floor (U.S. Geological Survey Hawaiian Volcano Observatory n.d.).

- Mantle – This type of earthquake reflects the flexing/bending of the earth's crust and upper mantle, known as the lithosphere, due to the weight of the islands above. This is the most common source of damaging earthquakes north of the Island of Hawaiʻi. This type of earthquake generally occurs more than 12 miles below sea level (U.S. Geological Survey Hawaiian Volcano Observatory n.d.).

Figure 4.5-1. Road Damage from a Tectonic Earthquake in Hawaiʻi County, 2018

Source: Big Island Gazette

Location

The majority of earthquakes in the State of Hawaiʻi occur on and around the County of Hawaiʻi, especially in the southern districts of the island where Kīlauea, Mauna Loa, and Kamaʻehuakanaloa volcanoes are located. These three volcanoes are the most active in the state (U.S. Geological Survey Hawaiian Volcano Observatory n.d.). Most earthquakes are caused by ruptures along geological faults. The County of Hawaiʻi has 12 fault systems: Hilina fault system, Kaʻōiki-Honuʻapo fault system, Kaʻōiki seismic zone, Kahuku fault system, Kealakekua fault system, Kīlauea Volcano, Mauna Kea Volcano, Hualālai Volcano, Koaʻe fault system, Kohala Volcano, Kamaʻehuakanaloa, and Mauna Loa Volcano. Shaking from large-scale events could potentially be felt anywhere in the state, but are most likely to be felt close to the earthquake's epicenter. Where shaking can be felt is discussed in more detail in the Extent subsection below.

National Earthquake Hazard Reduction Program (NEHRP) Soil Classifications

Ground shaking is the primary cause of earthquake damage to buildings and infrastructure. Softer soils amplify ground shaking. One contributor to shaking amplification is the velocity at which the rock or soils transmits shear waves (S-waves). The NEHRP defined five soil types based on their shear-wave velocity (Vs.) that aid in identifying locations that will be significantly impacted by an earthquake. The NEHRP soil classification system ranges from A to E, as noted in Table 4.5-1, where A represents hard rock that reduces ground motions from an earthquake and E represents soft soils that amplify and magnify ground shaking and increase building damage and losses.

Table 4.5-1. NEHRP Soil Classifications

Soil Classification	Description
A	Hard Rock
B	Rock
C	Very dense soil and soft rock
D	Stiff soils
E	Soft soils

Source: (FEMA 2020)

The NEHRP soil classifications have only been determined and spatially-delineated for the Counties of Maui and Hawaiʻi (Table 4.5-2). Approximately 112 square miles (or 9.5%) of the County of Maui is underlain by NEHRP soil Classes D and E, mainly Class D; the County of Hawaiʻi has a similar size area underlain by Class D and E soils (130.1 square miles). Figure 4.5-2 and Figure 4.5-3 show the NEHRP soil classifications for these two counties.

Table 4.5-2. Area of NEHRP Class D and E Soils

County	Area (in square miles)		
	Total Area	Area of NEHRP Class D and E Soils	Area as % of Total Area
County of Kauaʻi	624.3	Unknown	Unknown
City and County of Honolulu	598.6	Unknown	Unknown
County of Maui	1,176.3	111.9	9.5%
County of Hawaiʻi	4,039.6	130.1	3.2%
Total	**6,438.8**	**242**	**3.8%**

Source: AECOM 2008; Tetra Tech 2015

Figure 4.5-2. NEHRP Soil Classification for the County of Maui

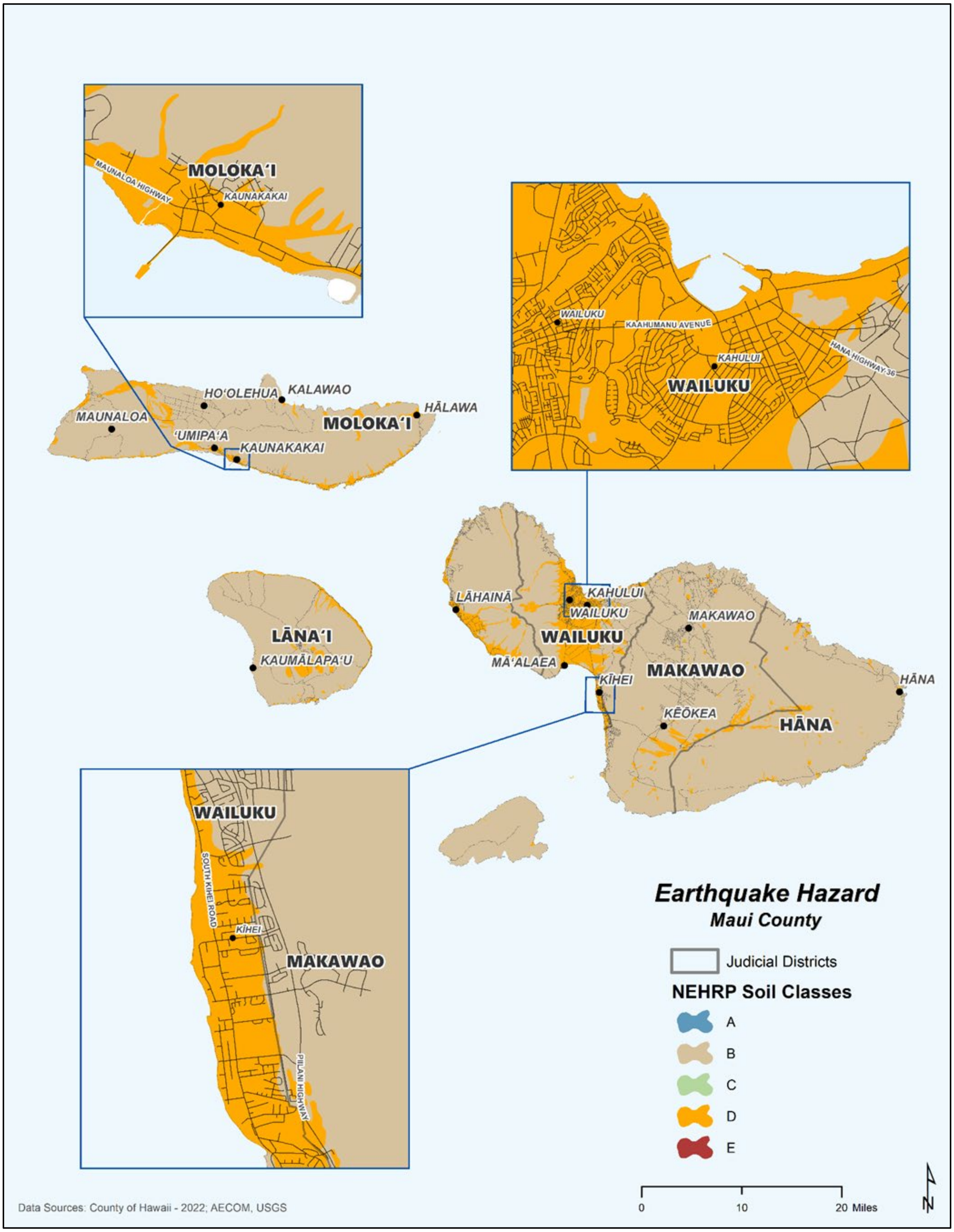
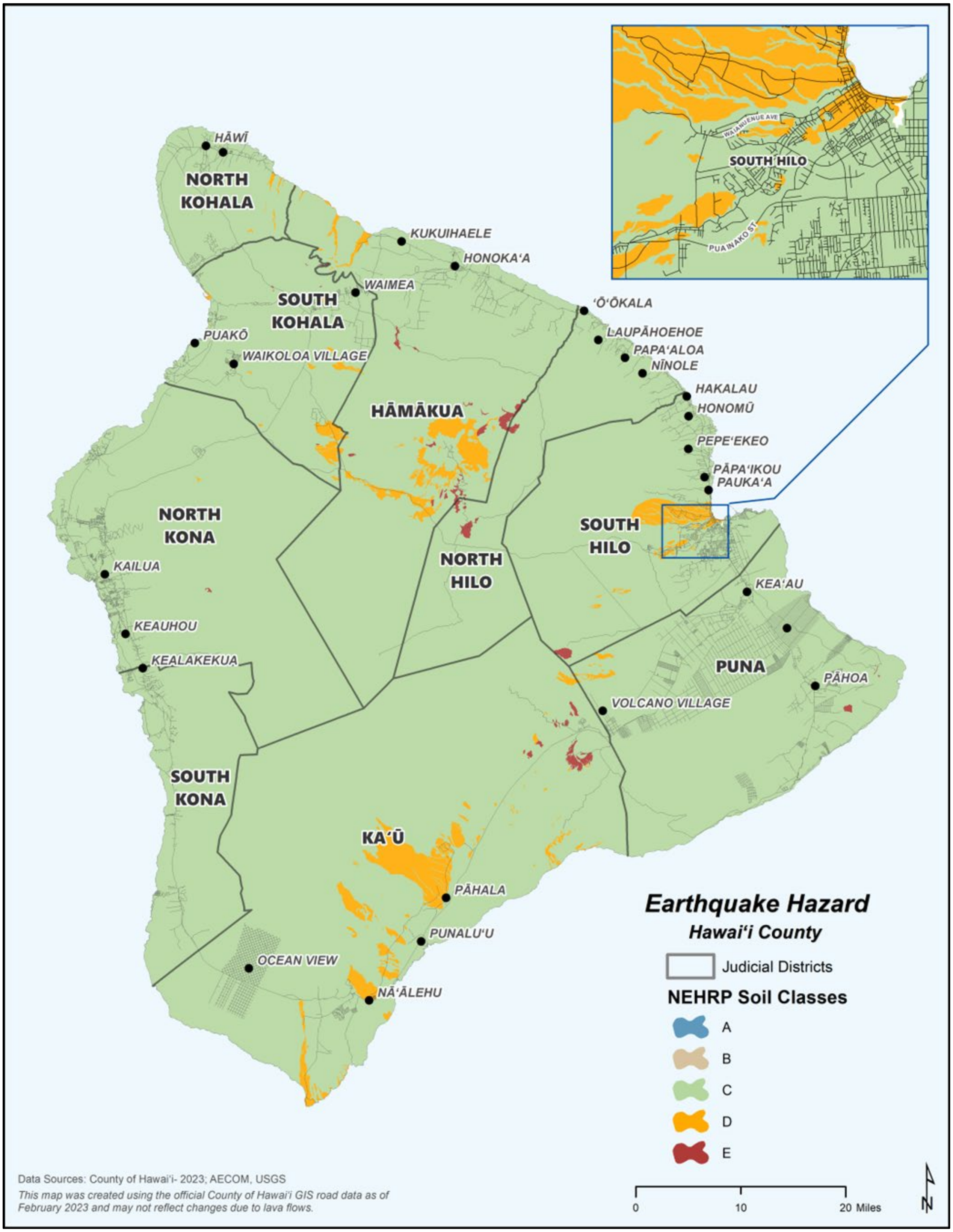


Figure 4.5-3. NEHRP Soil Classification for the County of Hawai'i



Liquefaction Susceptibility

Liquefaction can be defined as a process by which sediments below the water table temporarily lose strength and behave as a liquid, usually in areas of loosely packed soil. Roads might buckle, bridges and overpasses might crash down, low-rise buildings might sink, but high-rise buildings which are anchored in the underlying rock should be able to survive without collapsing (U.S. Geological Survey n.d.). Areas underlain by NEHRP Class D and E soils are more susceptible to liquefaction. Refer to the figures above for the location of these types of soils in the County of Maui and the County of Hawai'i.

In addition, NOAA Coastal Service Center sponsored a project in 2005 to identify areas with the potential for soil liquefaction in the Counties of Maui and Hawai'i. The results of the study showed small areas of high liquefaction susceptibility in Maui: the west Maui region (from Lahaina to Nāpili), the south Maui area (from Kīhei to Mākena), and the central Maui region (Kahului and Wailuku) (Wallace 2005)

EXTENT

The severity of an earthquake is classified by magnitude and intensity. Magnitude is a measure of the amount of energy released during an earthquake; each earthquake has a single magnitude. Intensity is a measure of the severity of ground shaking and so varies from place to place.

Ground Motion

One way to express an earthquake's severity is to compare its acceleration to the normal acceleration due to gravity. Peak ground acceleration (PGA) measures the rate of change in motion to the earth's surface and expresses it as a percent of the established rate of acceleration due to gravity (9.8 meters per second squared [m/sec^2]). PGA is expressed as a percent acceleration force of gravity (%g). For example, 100%g PGA in an earthquake (an extremely strong ground motion) means that objects accelerate sideways at the same rate as if they had been dropped from the ceiling. 10%g PGA means that the ground acceleration is 10 percent that of gravity.

Key Terms Simplified

- **PGA** — Peak ground acceleration is motion experienced by a person on the ground during an earthquake.
- **SA** — Spectral acceleration is motion experienced by a building during an earthquake (U.S. Geological Survey 2019).

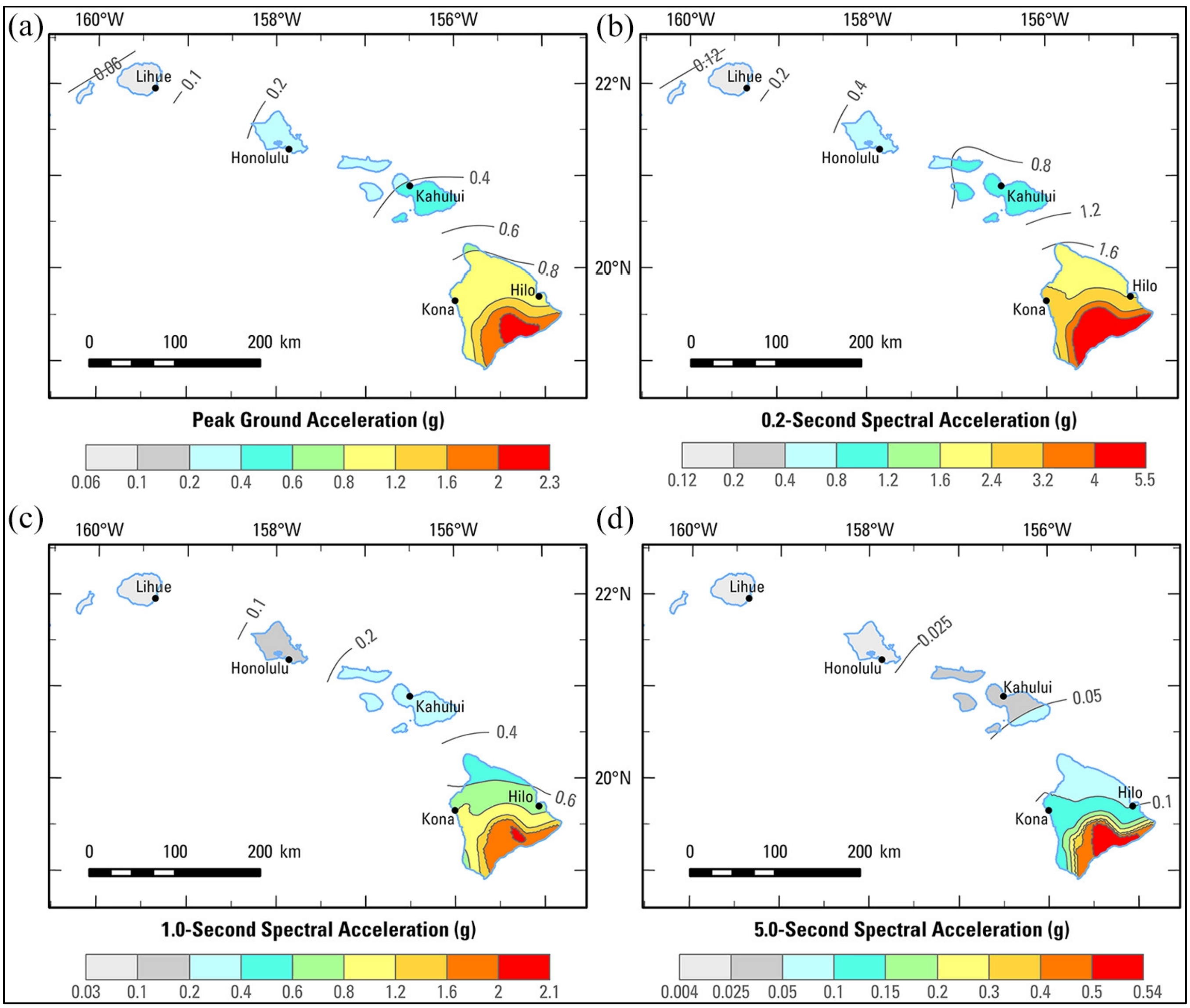
Damage levels experienced in an earthquake vary with the intensity of ground shaking and with the seismic capacity of structures. The following generalized observations provide qualitative statements about the likely extent of damages for earthquakes with various levels of ground shaking (PGA) at a given site:

- Ground motions of 1 to 2%g are widely felt by people; hanging plants and lamps swing strongly, but damage levels, if any, are usually very low.
- Ground motions below 10%g usually cause only slight damage, except in unusually vulnerable facilities.

- Ground motions of 20 to 50%g may cause significant damage in some modern buildings and very high levels of damage (including collapse) in poorly designed buildings.
- Ground motions greater than 50%g may cause higher levels of damage in many buildings, even those designed to resist seismic forces.

According to USGS Earthquake Hazards Program, PGA maps (also known as earthquake hazard maps) are used as planning tools when designing buildings, bridges, highways, and utilities so that they can withstand shaking associated with earthquake events. These maps are also used as planning tools for the development of building codes that establish construction requirements appropriate to preserve public safety. Figure 4.5-4 shows contours of PGA and 0.2, 1, and 5 SA with 2% chance of occurring over the next 50 years.

Figure 4.5-4. 2021 Seismic Hazard Map, PGA, 0.2, 1, and 5 SA with 2% Probability of Exceedance in 50 Years



Source: (Petersen, Shumway and Shiro 2021)

This map was created with data from the USGS to produce uniform probabilistic seismic hazard maps for the United States. The 2% of a 50-year PGA value means that over the next 50 years, there is a 2% probability of this level of ground shaking or higher. The 2% of a 50-year PGA represents a level of ground shaking close to but not the absolute worst-case scenario. The figures show the majority of the state has low levels of seismic hazard, with the Island of Hawaiʻi having intermediate to high levels of seismic hazard.

Magnitude

An earthquake's magnitude is a measure of the energy released at the source of the earthquake. Magnitude is commonly expressed by ratings on the moment magnitude scale (Mw), the most common scale used today (U.S. Geological Survey n.d.). This scale is based on the total moment release of the earthquake (the product of the distance a fault moved, the area of the fault surface, and the strength of the rock). The scale is as follows:

- Great—Mw > 8
- Major—Mw = 7.0 – 7.9
- Strong—Mw = 6.0 – 6.9
- Moderate—Mw = 5.0 – 5.9
- Light—Mw = 4.0 – 4.9
- Minor—Mw = 3.0 – 3.9
- Micro—Mw < 3.0

Intensity

The intensity of an earthquake is based on the observed effects of ground shaking on people, buildings, and natural features, and varies with location. The Modified Mercalli scale expresses intensity of an earthquake; the scale is a subjective measure that describes how strong a shock was felt at a particular location. The Modified Mercalli scale expresses the intensity of an earthquake's effects in a given locality in values ranging from I to XII. Table 4.5-3 summarizes earthquake intensity as expressed by the Modified Mercalli scale and lists damage potential and perceived shaking by PGA factors, compared to the Mercalli scale.

Table 4.5-3. Modified Mercalli Intensity and Peak Ground Acceleration Equivalents

Modified Mercalli Scale	Perceived Shaking	Potential Structure Damage		Estimated PGA (%g)
		Resistant Buildings	Vulnerable Buildings	
I	Not Felt	None	None	Less than 0.17%
II-III	Weak	None	None	0.17% – 1.4%
IV	Light	None	None	1.4% – 3.9%
V	Moderate	Very Light	Light	3.9% – 9.2%
VI	Strong	Light	Moderate	9.2% – 18%
VII	Very Strong	Moderate	Moderate/Heavy	18% – 34%
VIII	Severe	Moderate/Heavy	Heavy	34% – 65%
IX	Violent	Heavy	Very Heavy	65% – 124%
X – XII	Extreme	Very Heavy	Very Heavy	More than124%

Source: (U.S. Geological Survey n.d.)

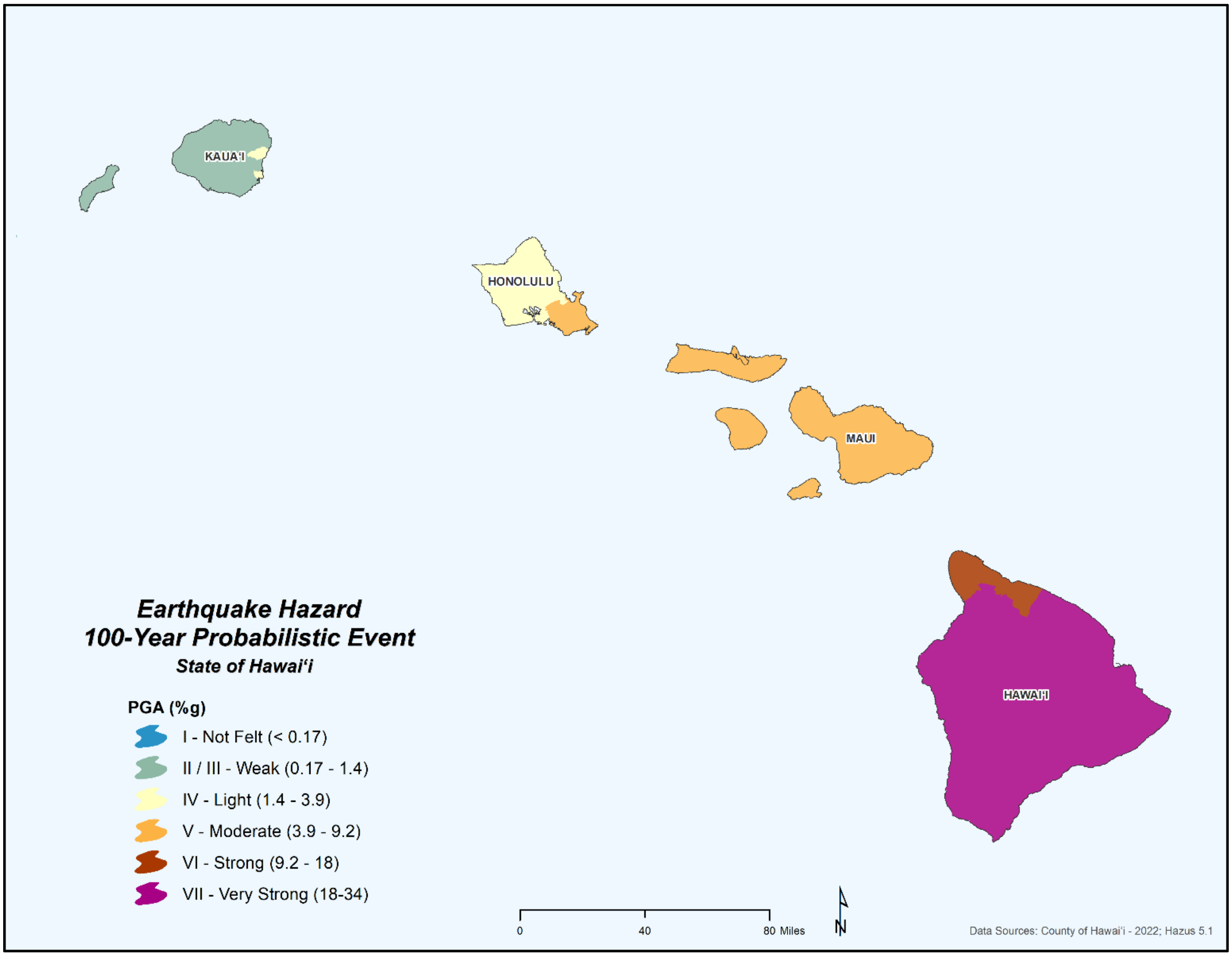
ShakeMap

The ShakeMap was developed by the USGS and facilitates communication of earthquake information beyond just the magnitude and location. A ShakeMap shows the extent and variation of ground shaking in a region immediately following significant earthquakes.

Three types of ShakeMaps are typically generated:

- Probabilistic — A probabilistic seismic hazard map shows the hazard from earthquakes that geologists and seismologists agree could occur. The maps are expressed in terms of probability of exceeding a certain ground motion, such as the 10 percent probability of exceedance in 50 years. This level of ground shaking has been used for designing buildings in high seismic areas.
- Figure 4.5-5 shows the estimated ground motion for the 100-year probabilistic seismic hazard in the State of Hawaiʻi generated by Hazus version 5.1.
- Scenario Maps — Earthquake scenario maps describe the expected ground motions and effects of hypothetical large earthquakes for a region. Maps of these scenarios can be used to support all phases of emergency management.
- Historic/Current Scenario Events — ShakeMaps are generated for historic earthquake events or earthquake events that have recently occurred. Recent events help emergency managers and the public understand where damages are likely and also provide insight to what types of damages would be likely if the event were to occur with today's level of development. Four historic scenarios were chosen for analysis in the 2023 SHMP Update (see Figure 4.5-6 through Figure 4.5-9):
    - Kalapana M7.2 earthquake on November 29, 1975 (Kalapana M7.7 ShakeMap data represents this event)
    - Kaʻū District M7.9 earthquake on April 3, 1868 (Kaʻū M8.0 ShakeMap data represents this event)
    - Lānaʻi M6.8* earthquake on February 20, 1871 (Lānaʻi M7.0 ShakeMap data represents this event)
    - Note: The M6.8 scenario was recommended by subject matter experts at the beginning of the planning process. New analysis by SOEST and USGS revised the Lānaʻi earthquake magnitude to 7.5. The revised scenario may be used in the analysis performed for future updates.
    - Northeast (NE) Maui M6.5 earthquake on January 23, 1938 (NE Maui 7.0 ShakeMap data represents this event)

Figure 4.5-5. PGA for the 100-Year Probabilistic Statewide Scenario



○

Figure 4.5-6. Kalapana M7.2 Earthquake Scenario

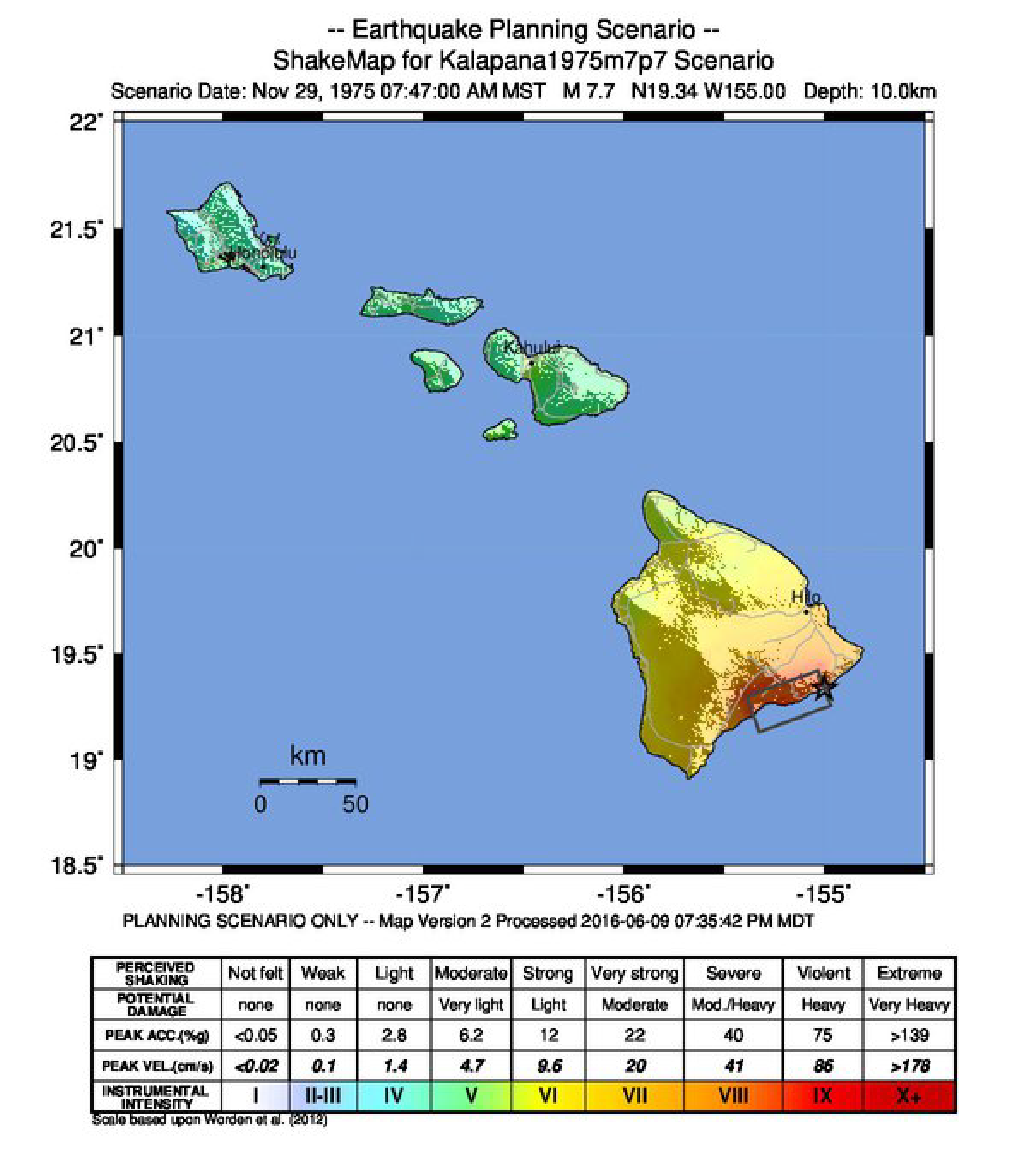


Figure 4.5-7. Kaʻū District M7.9 Earthquake Scenario

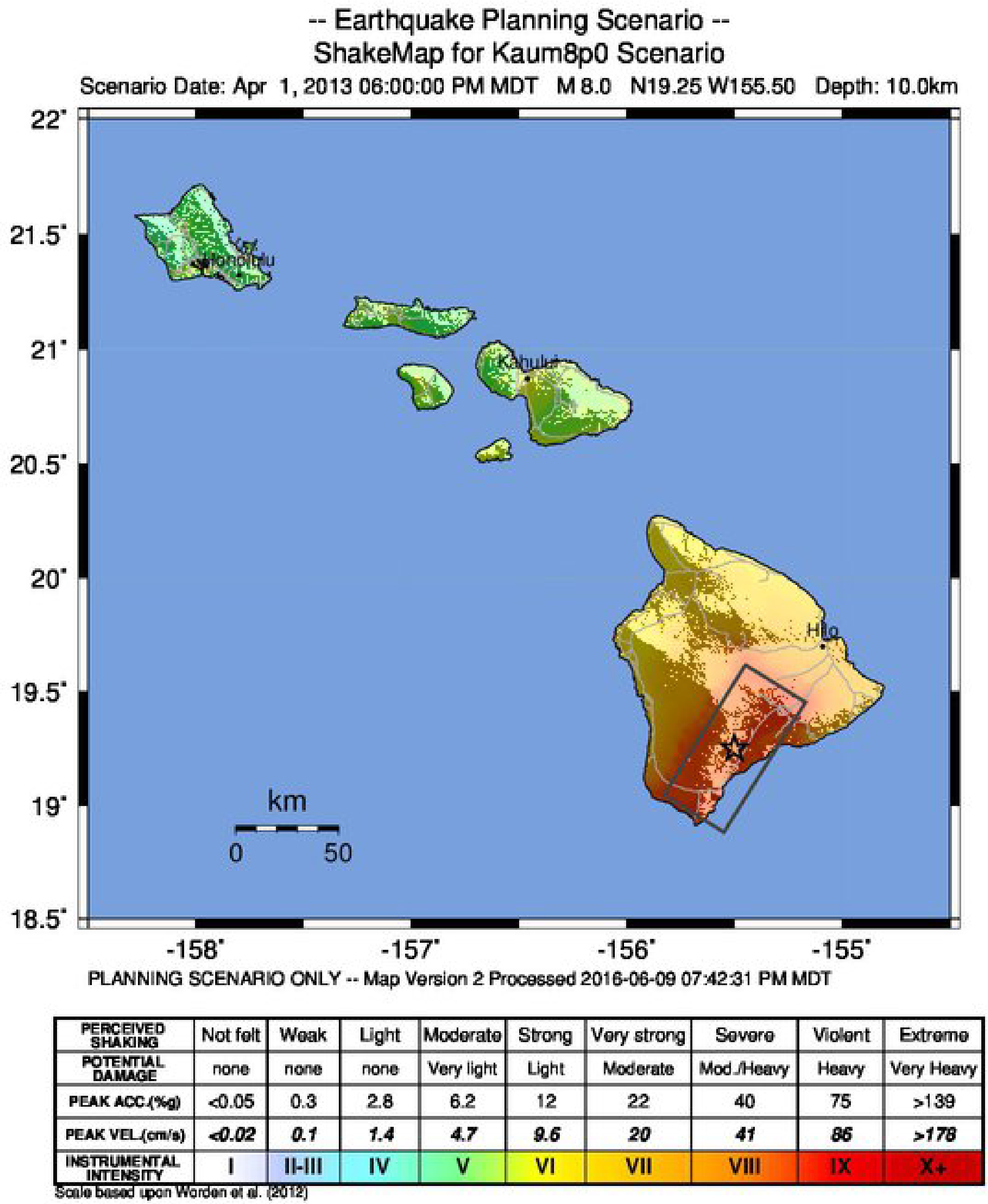
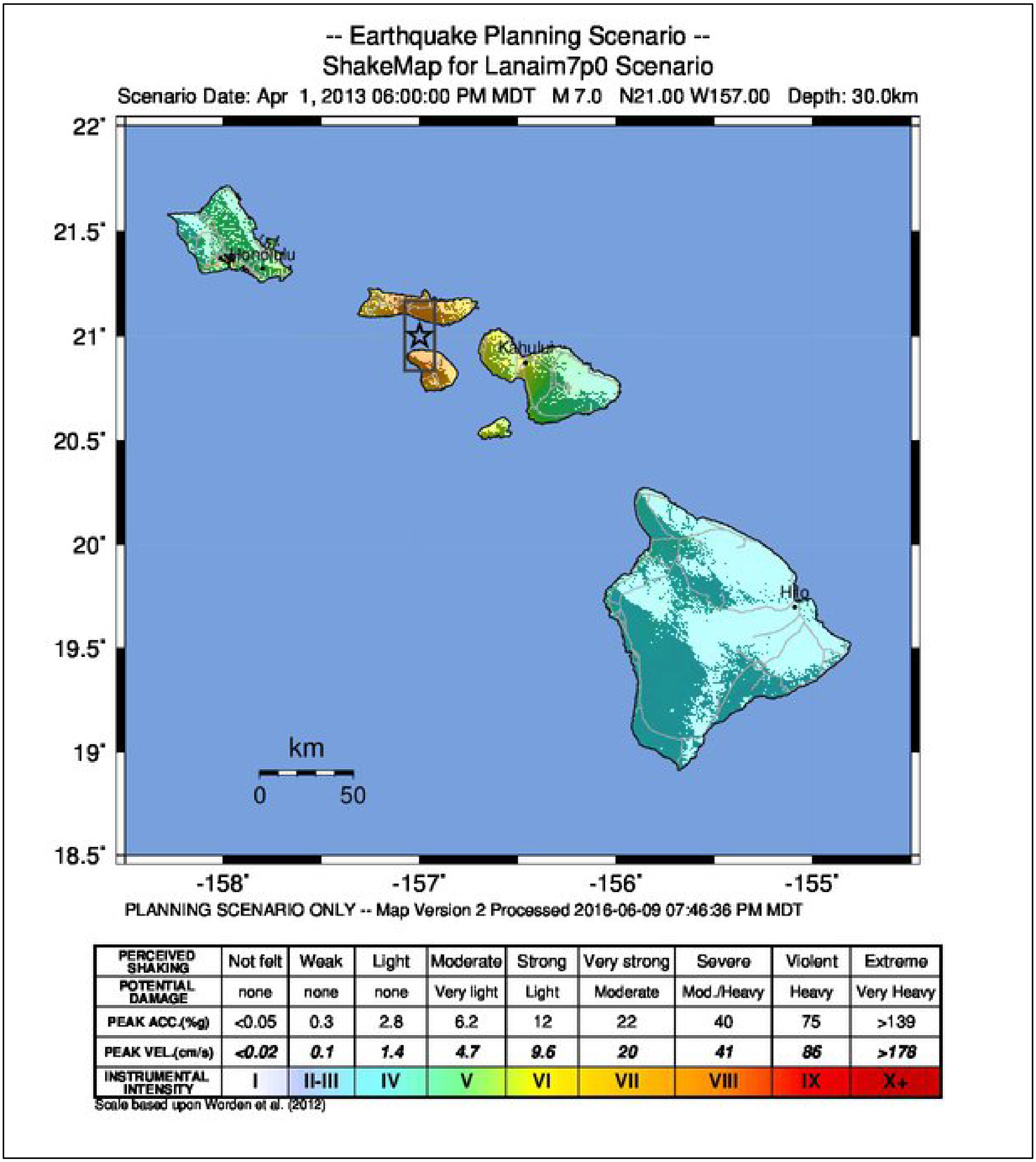
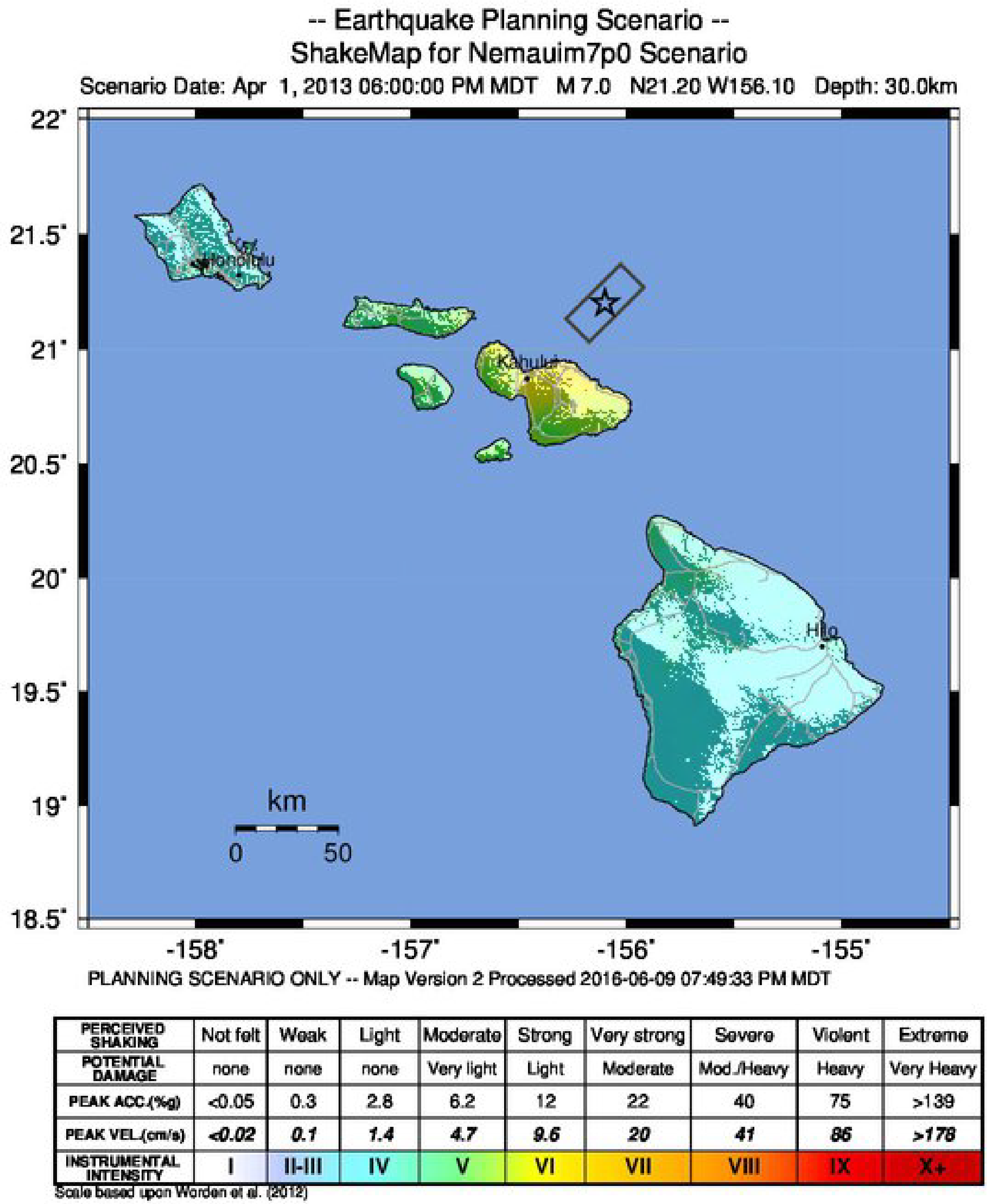


Figure 4.5-8. Lānaʻi M6.8 Earthquake Scenario*



Note: **The M6.8 scenario was recommended by subject matter experts at the beginning of the planning process. New analysis by SOEST and USGS revised the Lānaʻi earthquake magnitude to 7.5. The revised scenario may be used in the analysis for future updates.*

Figure 4.5-9. Northeast (NE) Maui M6.5 Earthquake Scenario



Warning Time

Under the Disaster Relief Act of 1974, the USGS has the federal responsibility to issue alerts for earthquakes, enhance public safety, and reduce losses through effective forecasts and warnings. The USGS currently issues rapid, automatic earthquake information via the internet, email messages, text messages, and social media (U.S. Geological Survey n.d.). Currently, there is no reliable way to predict the day or month that an earthquake will occur at any given location. The ShakeAlert® earthquake early warning system has been developed to monitor for significant earthquakes and issue alerts to warn that strong shaking is expected imminently. The ShakeAlert system is being developed to cover California, Oregon, and Washington. Depending on how far a person is from the earthquake, these potential warning systems could give from a few seconds to a minute's notice that major shaking is about to occur (U.S. Geological Survey 2022). The warning time is very short, but it could allow for someone to get under a desk, step away from a hazardous material they are working with, or shut down a computer system. Currently, no such earthquake early warning system has been developed for Hawaiʻi.

PREVIOUS OCCURRENCES AND LOSSES

During the planning process for this plan update, many sources were researched that provided earthquake information regarding previous occurrences and losses associated with earthquake events throughout the State of Hawaiʻi. The 2018 Plan discussed specific earthquake events that occurred in the State of Hawaiʻi through 2017. For this 2023 SHMP Update, earthquake events were summarized between January 1, 2018, and December 31, 2022. According to the USGS, over 18,000 earthquakes have been recorded in the state between 2018 and 2022. The magnitudes of these events range from 2.5 to 6.9 (U.S. Geological Survey 2022).

Table 4.5-4 includes details regarding earthquake events that occurred in the state between 2018 and 2022 that had a magnitude of 4 or higher. For events prior to 2018, please refer to Appendix E (Hazard Profile Supplement).

Table 4.5-4. Earthquake Events in Hawaiʻi with a Magnitude of 4.0 or Greater, 2018 to 2022

Date(s) of Event	Magnitude	Location (recorded epicenter)	Counties Affected	Description
May – August 2018	0.5 to 6.9	Kīlauea Volcanic Eruption and Earthquakes (DR-4366)	Hawaiʻi	Between May 1 and August 31, there were nearly 42,000 recorded earthquakes, ranging from magnitude 0.5 to magnitude 6.9; of these more than 50 earthquakes of magnitude >= 5 occurred at Kilauea. On May 1, the USGS HVO issued a report that a migration of seismicity and deformation downrift (east) of Puʻu ʻŌʻō indicated that a large area along the East Rift Zone was potentially at risk of new outbreak, possibly in the Lower Puna area. Between May 3 and September 4, Kīlauea erupted, with numerous earthquakes occurring each day. On May 11, FEMA issued a major disaster declaration for the State of Hawaiʻi due to the eruption of Kīlauea. The County of Hawaiʻi was included in this declaration. For details regarding this volcanic eruption, please refer to Section 4.14 (Volcanic Hazards).
February 7, 2019	4.6	86 km SW of Hawaiian Ocean View, Hawaiʻi	Hawaiʻi, Maui, Honolulu	The USGS reported that the earthquake could be felt on Hawaiʻi, Maui, and Oʻahu. The depth, location, and recorded seismic waves of the earthquake suggest a source due to bending of the oceanic plate from the weight of the Hawaiian island chain.

Date(s) of Event	Magnitude	Location (recorded epicenter)	Counties Affected	Description
March 13, 2019	5.5	13 km SSE of Volcano, Hawaiʻi	Hawaiʻi	USGS reported that over 260 people felt the earthquake. The location, depth, and waveforms recorded were consistent with slip along Kīlauea's south flank.
April 13, 2019	5.3	20 km E of Kalaoa, Hawaiʻi	Hawaiʻi, Maui, Honolulu	USGS reported that over 1,000 people felt the earthquake as far away as Oʻahu. Authorities responded to reports of rockfalls along Highways 19 and 11 on Hawaiʻi Island. Three aftershocks were recorded within an hour of the earthquake, including a magnitude 3.0 event. The location and depth of the event suggest it is likely related to flexure or settling of the crust beneath the weight of the island.
April 27, 2019	4.2	15 km SSE of Fern Forest, Hawaiʻi	Hawaiʻi	USGS reported that over 100 people felt the earthquake on Hawaiʻi Island. This earthquake was part of the continuing adjustments beneath the south flank of Kīlauea.
August 12, 2019	4.5	8 km ENE of Pāpaʻikou, Hawaiʻi	Hawaiʻi	USGS reported that the depth, location, and recorded seismic waves of the earthquake suggest a source due to bending of the oceanic plate from the weight of the Hawaiian island chain.
August 22, 2019	4.2	44 km SE of Nāʻālehu, Hawaiʻi	Hawaiʻi	USGS reported that approximately 30 people felt the earthquake off the coast of Kaʻū and that the earthquake was most likely due to bending of the Earth's crust under the weight of Hawaiʻi Island.
November 11, 2019	4.9	18 km SW of Laupāhoehoe, Hawaiʻi	Hawaiʻi, Maui, Honolulu	USGS reported that weak shaking was felt as far away as Oʻahu. Over 1,000 people felt the earthquake. Debris was reported on roadways in the Hāmākua district. The depth, location, and recorded seismic waves suggest a source due to bending of the oceanic plate from the weight of the volcanoes in the Hawaiian island chain.
February 3, 2020	4.2	12 km SSE of Volcano, Hawaiʻi	Hawaiʻi	USGS reported that more than 280 people felt the earthquake. It was likely an aftershock of the 2018 magnitude 6.9 earthquake as the volcano continues to settle.
July 2, 2020	4.6	15 km S of Fern Forest, Hawaiʻi	Hawaiʻi, Maui	USGS reported that nearly 1,200 people felt the earthquake as far away as Maui. It was likely an aftershock of the 2018 magnitude 6.9 earthquake as the volcano continues to settle.
July 3, 2020	4.3	13 km S of Fern Forest, Hawaiʻi	Hawaiʻi, Maui	USGS reported that more than 850 people as far away as Maui reported light shaking. It was likely an aftershock of the 2018 magnitude 6.9 earthquake as the volcano continues to settle.
July 27, 2020	4.7	19 km SE of Nāʻālehu, Hawaiʻi	Hawaiʻi, Maui	USGS reported that more than 600 people as far away as Maui reported light shaking. USGS reported that the depth, location, and recorded seismic waves of the earthquake suggest a source due to bending of the oceanic plate from the weight of the Hawaiian island chain.
August 1, 2020	4.2	8 km ENE of Pāhala, Hawaiʻi	Hawaiʻi	USGS reported that nearly 200 people felt the earthquake that appeared to be part of the seismic swarm under the Pāhala area, which had been going on for over a year.
December 4, 2020	4.1	22 km ENE of Hōnaunau-Nāpōʻopoʻo, Hawaiʻi	Hawaiʻi	USGS reported that more than 80 people felt the earthquake. The event followed an uptick in seismic activity observed at the summit of Kīlauea volcano.
December 12, 2020	4.4	20 km SSE of Waimea, Hawaiʻi	Hawaiʻi, Maui, Honolulu	USGS reported that nearly 700 people felt the earthquake as far away as Oʻahu. Deep earthquakes in this region are most likely caused by the structural adjustment of the Earth's crust due to the heavy load of Mauna Kea.
December 21, 2020	4.4	4 km S of Fern Forest, Hawaii	Hawaiʻi, Maui	USGS reported that more than 450 people felt the earthquake, which hit about an hour after Kīlauea volcano began to erupt.

Date(s) of Event	Magnitude	Location (recorded epicenter)	Counties Affected	Description
February 2, 2021	4.1	13 km SSE of Fern Forest, Hawaiʻi	Hawaiʻi	USGS reported that more than 350 people on the island of Hawaiʻi felt the earthquake.
March 11, 2021	4.2	17 km NNE of Pāhala, Hawaiʻi	Hawaiʻi, Maui	USGS reported that more than 300 people as far away as Maui felt the earthquake.
March 14, 2021	4.1	12 km SSE of Volcano, Hawaiʻi	Hawaiʻi, Maui	USGS reported that about 180 people as far away as Maui felt the earthquake. The location, depth, and waveforms recorded were consistent with slip along Kīlauea's south flank.
April 3, 2021	4.3	5 km NW of Pāhala, Hawaiʻi	Hawaiʻi, Maui	USGS reported that more than 150 people as far away as Maui felt the earthquake. This quake was part of a swarm of earthquakes reported beneath the northwest flank of Mauna Loa beginning on March 29.
May 23, 2021	4.2	15 km S of Volcano, Hawaiʻi	Hawaiʻi	USGS reported that about 230 people felt the earthquake on Hawaiʻi Island, which was the largest of several quakes that day.
June 2, 2021	4.0	42 km ESE of Nāʻālehu, Hawaiʻi	Hawaiʻi	USGS reported that fewer than 10 people on the island of Hawaiʻi felt the earthquake located about 26 miles offshore, under the Kamaʻehuakanaloa Seamount.
June 18, 2021	4.5	8 km ENE of Pāhala, Hawaiʻi	Hawaiʻi, Maui, Honolulu	USGS reported that nearly 500 people felt the earthquake as far away as Oʻahu. The earthquake was part of an ongoing seismic swarm under the Pāhala area, which started in August 2019.
July 5, 2021	5.2	12 km NNW of Kukuihaele, Hawaii	Hawaiʻi, Maui, Honolulu	USGS reported that more than 1,300 people felt the earthquake as far away as Oʻahu. The earthquake was related to stress from the weight of the island on the underlying ocean crust and mantle.
July 7, 2021	4.2	73 km WNW of Kalaoa, Hawaii	Hawaiʻi, Maui, Honolulu	USGS reported that about 100 people felt the earthquake as far away as Oʻahu. The earthquake was likely due to readjustment of the oceanic plate from the weight of the island chain and posed no significant hazard.
August 18, 2021	4.1	9 km E of Pāhala, Hawaiʻi	Hawaiʻi	USGS reported that more than 40 people on the Island of Hawaiʻi felt the earthquake and was believed to be part of an ongoing seismic swarm under the Pāhala area.
October 5, 2021	4.6	8 km ENE of Pāhala, Hawaiʻi	Hawaiʻi, Maui, Honolulu	USGS reported that more than 250 people felt the earthquake as far away as Oʻahu. The event appeared to be part of the swarm of deep Pāhala earthquakes that had been recorded in the region for months. There were several smaller earthquakes within minutes of the magnitude 4.6 quake.
October 10, 2021	6.2	7 km SSE of Nāʻālehu, Hawaiʻi	Hawaiʻi, Maui, Honolulu, Kauaʻi	USGS reported more than 3,400 people felt the earthquake across the entire state. Strong shaking was felt on the island of Hawaiʻi. The depth, location, and recorded seismic waves of the earthquake suggested a source due to bending of the oceanic plate from the weight of the Hawaiian island chain, a common source for earthquakes in this area.
October 10, 2021	4.3	22 km S of Nāʻālehu, Hawaiʻi	Hawaiʻi, Maui	USGS reported about 20 people felt the earthquake as far away as Maui.
December 24, 2021	4.9	42 km ESE of Nāʻālehu, Hawaiʻi	Hawaiʻi, Maui	USGS reported about 20 people felt the offshore earthquake as far away as Maui. The earthquake was preceded by over 50 small earthquakes on the south rift zone of Kamaʻehuakanaloa over the past two weeks. It is unknown whether it was caused by any volcanic or intrusive activity on Kamaʻehuakanaloa.
January 4, 2022	4.3	8 km E of Pāhala, Hawaiʻi	Hawaiʻi	USGS reported more than 160 people felt the earthquake.

Date(s) of Event	Magnitude	Location (recorded epicenter)	Counties Affected	Description
January 25, 2022	4.7	10 km NNE of Wailua, Hawaii	Maui, Honolulu, Hawaiʻi	USGS reported about 850 people felt the earthquake. The earthquake was located off the coast of Maui at a depth indicative of oceanic plate bending due to the weight of the islands.
January 31, 2022	4.0	8 km ENE of Pāhala, Hawaiʻi	Hawaiʻi	USGS reported more than 30 people felt the earthquake on Hawaiʻi island. It appeared to be part of the ongoing seismic swarm, which has been going on for over a year with more than 10,000 separate quakes.
March 20, 2022	4.5	21 km SSE of Waimea, Hawaiʻi	Hawaiʻi, Maui, Honolulu	USGS reported about 750 people felt the earthquake as far away as Oʻahu. Deep earthquakes in this area are most likely caused by structural adjustments of the Earth's crust due to the heavy load of Mauna Kea.
April 15, 2022	4.3	8 km ENE of Pāhala, Hawaiʻi	Hawaiʻi, Honolulu	USGS reported more than 100 people felt the earthquake on Hawaiʻi and Oʻahu. The earthquake appeared to be part of the ongoing seismic swarm under the Pāhala area.
April 15, 2022	4.6	9 km E of Pāhala, Hawaiʻi	Hawaiʻi, Maui, Honolulu	USGS reported more than 500 people felt the earthquake as far away as Oʻahu. The earthquake appeared to be part of the ongoing seismic swarm under the Pāhala area.
May 21, 2022	4.7	3 km NW of Hōlualoa, Hawaiʻi	Hawaiʻi, Maui, Honolulu	USGS reported more than 1,600 people felt the earthquake as far away as Oʻahu. The earthquake was primarily caused by a lateral slip along a sub-vertical fault.
May 29, 2022	4.0	70 km WSW of Kekaha, Hawaiʻi	Kauaʻi	No reports of shaking were reported as a result of this offshore earthquake.
July 27, 2022	4.3	9 km ENE of Pāhala, Hawaiʻi	Hawaiʻi	USGS reported about 200 people felt the earthquake.
July 27, 2022	4.6	43 km ESE of Nāʻālehu, Hawaiʻi	Hawaiʻi, Maui	USGS reported more than 30 people felt the offshore earthquake. This earthquake was part of the seismic swarm under the Pāhala area, which had been going on since 2019.
August 23, 2022	4.0	9 km E of Pāhala, Hawaiʻi	Hawaiʻi	USGS reported nearly 140 people felt the earthquake. This earthquake was part of the seismic swarm under the Pāhala area.
September 6, 2022	4.0	12 km ENE of Pāhala, Hawaiʻi	Hawaiʻi	USGS reported about 90 people felt the earthquake. This earthquake was part of the seismic swarm under the Pāhala area.
September 8, 2022	4.2	9 km ENE of Pāhala, Hawaiʻi	Hawaiʻi	USGS reported more than 80 people felt the earthquake. This earthquake was part of the seismic swarm under the Pāhala area.
September 27, 2022	4.5	9 km ENE of Pāhala, Hawaiʻi	Hawaiʻi, Maui, Honolulu	USGS reported more than 350 people felt the earthquake as far away as Oʻahu. This earthquake was part of the seismic swarm under the Pāhala area.
October 14, 2022	4.6	8 km S of Pāhala, Hawaiʻi	Hawaiʻi, Maui, Honolulu, Kauaʻi	USGS reported more than 1,000 people across the state felt the earthquakes which caused damage to structures and contents in the Pāhala area. Rocks fell onto Highway 11. USGS scientists said the tremors appear to be related to readjustments along the southeast flank of Mauna Loa, but it was difficult to tell if the earthquakes were magma driven.
October 14, 2022	5.0	7 km SSW of Pāhala, Hawaiʻi	Hawaiʻi, Maui, Honolulu, Kauaʻi	USGS reported more than 1,000 people across the state felt the earthquakes which caused damage to structures and contents in the Pāhala area. Rocks fell onto Highway 11. USGS scientists said the tremors appear to be related to readjustments along the southeast flank of Mauna Loa, but it was difficult to tell if the earthquakes were magma driven.

Date(s) of Event	Magnitude	Location (recorded epicenter)	Counties Affected	Description
October 14, 2022	4.0	9 km SSW of Pāhala, Hawaiʻi	Hawaiʻi, Maui, Honolulu, Kauaʻi	USGS reported more than 1,000 people across the state felt the earthquakes which caused damage to structures and contents in the Pāhala area. Rocks fell onto Highway 11. USGS scientists said the tremors appear to be related to readjustments along the southeast flank of Mauna Loa, but it was difficult to tell if the earthquakes were magma driven.
November 27, 2022	4.2	27 km E of Hōnaunau-Nāpōʻopoʻo, Hawaiʻi	Hawaiʻi, Maui	USGS reported about 50 people felt the earthquake on Hawaiʻi and Maui islands. Swarms of earthquakes continued sporadically when new fissures on Mauna Loa began to spill lava on the caldera floor. For details regarding this volcanic eruption, please refer to Section 4.14 (Volcanic Hazards).
November 29, 2022	4.0	9 km E of Pāhala, Hawaiʻi	Hawaiʻi	USGS reported about 80 people felt the earthquake. Scientists indicated that the earthquake was not related to the eruption of Mauna Loa but was part of the ongoing seismic swarm under the Pāhala area.

Source: FEMA 2022; USGS 2022
Note: With earthquake documentation for Hawaiʻi being so extensive, not all sources have been identified or researched. Additionally, loss and impact information for many events could vary depending on the source. Therefore, the table may not include all events that have occurred in the state (in that time period and magnitude level).

Disaster and Emergency Declarations

The following disaster declarations or emergency proclamations related to earthquake have been issued for Hawaiʻi:

- **Federal disaster (DR) or emergency (EM) declarations, 1955–2022**: 5 events, classified as earthquake, volcanic disruptions, or seismic waves
- **Hawaiʻi state emergency proclamations, 2018–2022**: No events, classified as earthquake
- **USDA agricultural disaster declarations, 2012–2022**: None

Table 4.5-5 lists the earthquake events that have affected the State of Hawaiʻi and were declared a FEMA disaster between 2018 and 2022. For details regarding all declared disasters to date, refer to Section 4.1 (Overview). Refer to Appendix D (Map Atlas), which illustrates the number of earthquake-related federally declared disasters by county since 1955.

Table 4.5-5. Earthquake-Related Federal Declarations (2018 to 2022)

Year	Event Type	Date Declared	Federal	Counties Affected
2018	Kīlauea Volcanic Eruption and Earthquakes	May 11, 2018	DR-4366	Hawaiʻi

Source: FEMA 2022

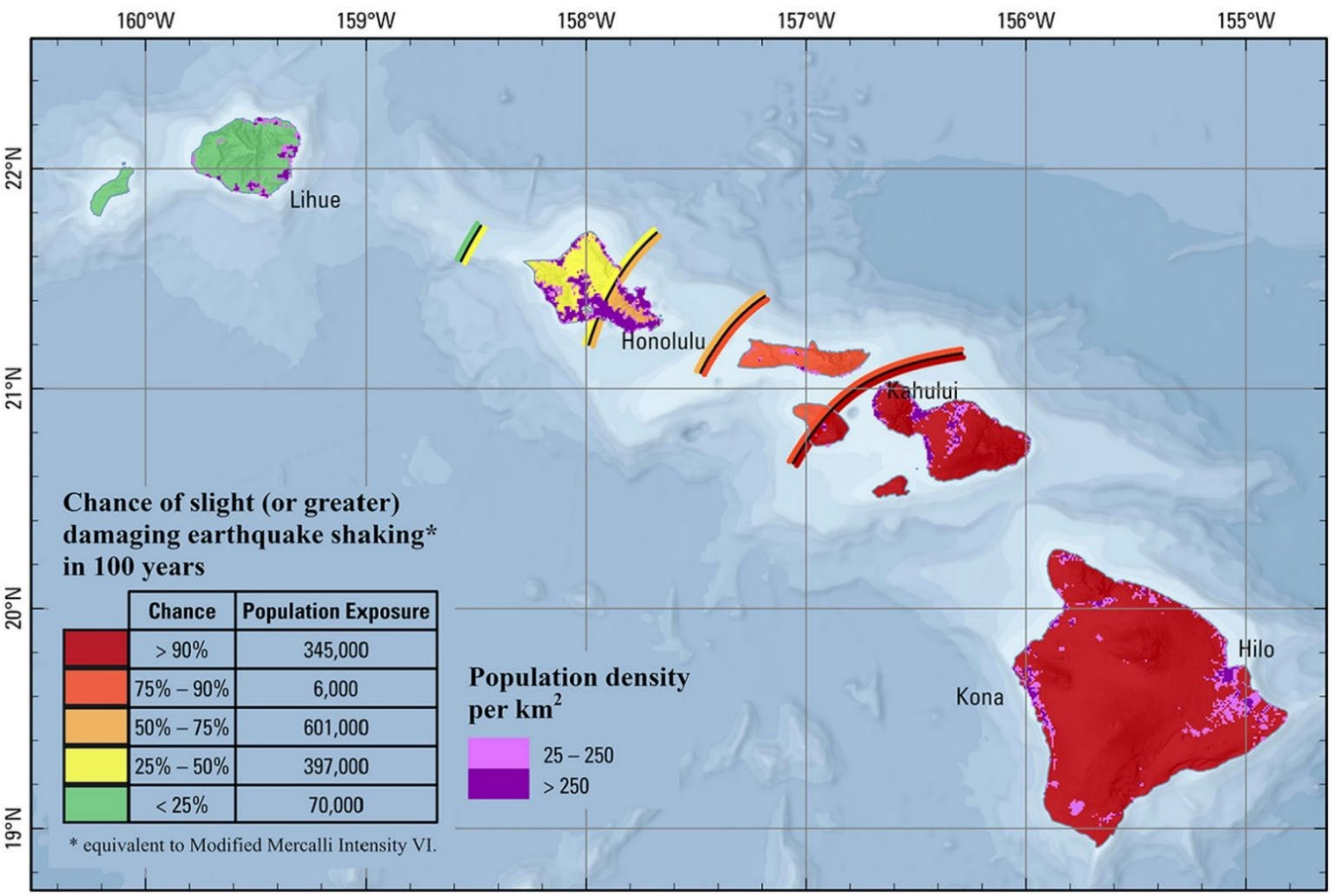
Probability of Future Hazard Events

Overall Probability

For the purpose of this 2023 SHMP Update, the probability of future occurrences is defined by the number of events over a specified period of time. Between 1950 and 2022, there have been 9,302 earthquakes, magnitude

3 (often felt but causes minor damage) and greater (refer to Table 4.5-3 for a description of magnitude and intensity), with epicenters in or near the State of Hawaiʻi. Based on this historic data, the state may experience an average of 129 earthquakes, magnitude 3 or greater, each year. As for earthquakes categorized as strong to severe, between 1950 and 2022, there have been 11 earthquakes, magnitude 6 and greater, with epicenters in or near the State of Hawaiʻi. Based on this historic data, the state has an estimated 15 percent annual chance of a strong or greater strength earthquake occurring. Figure 4.5-10 shows the probability of over 100 years of the state experiencing an earthquake with at least minor damage.

Figure 4.5-10. Chance of Minor or Greater Damaging Earthquake Shaking Within 100 Years



(Petersen, Shumway and Shiro 2021)

An updated ground shaking model published in 2021 indicates that there is a 90 percent chance that the 345,000 people on the islands of Hawaiʻi and Maui could experience damaging levels of shaking during the next 100 years. A lower but significant chance of damaging shaking is expected across Oʻahu; within the southeastern portion of the island near Honolulu there is a greater than 50 percent chance of damaging shaking occurring during this period.

Climate Change Impacts

The potential impacts of global climate change on earthquake probability are still being studied. Some scientists feel that melting glaciers could induce tectonic activity. As ice melts and water runs off, tremendous amounts of weight are shifted on the Earth's crust. As newly freed crust returns to its original, pre-glacier shape, it could cause seismic plates to slip and stimulate volcanic activity. Additionally, changes in the Earth's crust from periods of drought can be significant. Similarly, pumping of groundwater from underground aquafers for human use, which is exacerbated during times of drought, has been shown to impact patterns of stress loads by "unweighting" the Earth's crust (NASA 2019). A University College London study reported that El Niño cycles in the Pacific Ocean over the past 40 years have triggered a regular seismic response as the pressure of water changes with sea level fluctuations. The eastern Pacific experiences more earthquakes in the months after the cycle lowers sea levels in the area by a few centimeters, which flexes the plates beneath (Pearce 2012). These climate change impacts could affect the entire state.

Secondary impacts of earthquakes could be magnified by climate change. Earthquakes can cause large and sometimes disastrous landslides. Any steep slope is vulnerable to slope failure. Rising air temperatures can facilitate soil breakdown, allowing more water to penetrate soils and affect the rates of erosion, sediment control, and the likelihood of landslides. Climate change may also increase the probability of more frequent, intense rainstorms. This can result in greater erosion, higher sediment transport in rivers and streams, and a higher probability of landslides, primarily as a result of higher soil content (University of Washington 2014). Refer to Section 4.11 (Landslide and Rockfall) for details regarding climate change impacts on landslides.

Another secondary impact of an earthquake is dam failure. Earthen dams are highly susceptible to seismic events. The most common type of earthquake-induced dam failure is slumping or settlement of earth-fill dams where the fill has not been properly compacted. If the slumping occurs when the dam is full, then overtopping of the dam, with rapid erosion leading to dam failure is possible. Changes in weather patterns and increases in rainfall can lead to dams being full more often, increasing the risk of failure during an earthquake. Refer to Section 4.10 (Infrastructure Failure) for details regarding climate change impacts on dam failure.

4.5.2 VULNERABILITY ASSESSMENT

ShakeMap data prepared by the USGS and probabilistic earthquake data in Hazus version 5.1 were used to assess the earthquake hazard. The evaluation of the historic events utilizing the current environment provides an understanding of potential loss if the events were to happen today.

- The Kalapana 1975 magnitude 7.7 scenario with an epicenter approximately 26 miles south-southeast of Hilo. This scenario represents the Kalapana magnitude 7.2 earthquake on November 29, 1975.
- The Kaʻū magnitude 8.0 scenario with an epicenter approximately 4 miles northwest of Pāhala. This scenario represents the Kaʻū District magnitude 7.9 earthquake on April 3, 1868.
- The Lānaʻi magnitude 7.0* scenario with an epicenter approximately 13 miles north-northwest of *Lānaʻi* City. This scenario represents the Lānaʻi magnitude 6.8 earthquake on February 20, 1871.
- * Note: The M6.8 scenario (Lānaʻi M7.0 ShakeMap data) was recommended by subject matter experts at the beginning of the planning process. New analysis by SOEST and USGS revised the Lānaʻi earthquake magnitude to 7.5. The revised scenario may be used in the analysis performed for future updates.

- The NE Maui magnitude 7.0 scenario with an epicenter approximately 31 miles northeast of Kahului. This scenario represents the Maui magnitude 6.5 earthquake on January 23, 1938.
- The standard Hazus 100-year probabilistic event.

Assessment of State Vulnerability and Potential Losses

This section discusses statewide vulnerability of exposed state assets (state buildings and state roads), community lifelines and critical facilities to the earthquake hazard.

State Assets

The total replacement cost value of state buildings is an estimated $26 billion; all of which are exposed to an earthquake event. Table 4.5-6 summarizes these values by county. The potential damage estimated to state buildings associated with the 100-year probabilistic earthquake event is approximately $358 million, which represents approximately 1.4% of the inventory's total replacement cost value. The County of Hawai'i has the greatest estimated potential loss (7.2%) to state buildings.

Table 4.5-6. State Buildings Exposure and Potential Losses to the 100-year Probabilistic Earthquake Event

County	Total Value	Estimated Potential Loss	
		Value	Percent of Total
County of Kaua'i	$990,850,824	$2,061	<1%
City and County of Honolulu	$17,393,945,915	$18,380,927	0.1%
County of Maui	$3,097,491,689	$5,277,466	0.2%
County of Hawai'i	$4,638,567,141	$335,122,218	7.2%
Total	**$26,120,855,568**	**$358,782,672**	**1.4%**

Source: State of Hawaii Risk Management Office 2017; United States Geological Survey 2013; FEMA Hazus v5.1 2022

The estimated potential state building loss to the Ka'ū M8.0 and the Lāna'i M7.0 scenarios are summarized in Table 4.5-7, and results for the Kalapana M7.7 and the NE Maui M7.0 scenarios are summarized in Table 4.5-8 by county. The results by state agency for the 100-year probabilistic earthquake event and the four historic scenario events are included in Appendix F (State Profile and Risk Assessment Supplement).

Table 4.5-7. State Buildings Exposure and Potential Losses to the Ka'ū M8.0 and Lāna'i M7.0 Earthquake Event Scenarios

County	Total Value	Estimated Potential Loss			
		Ka'ū M8.0		Lāna'i M7.0	
		Value	Percent of Total	Value	Percent of Total
County of Kaua'i	$990,850,824	$0	0.0%	$0	0.0%
City and County of Honolulu	$17,393,945,915	$3,892,689	0.02%	$2,067,123	<1%
County of Maui	$3,097,491,689	$772,179	0.02%	$37,395,087	1.2%
County of Hawai'i	$4,638,567,141	$143,537,454	3.1%	$23,550	<1%
Total	**$26,120,855,568**	**$148,202,322**	**0.57%**	**$39,485,760**	**0.15%**

Source: State of Hawaii Risk Management Office 2017; USGS 2013; FEMA Hazus v5.1 2022

Table 4.5-8. State Buildings Exposure and Potential Losses to the Kalapana M7.7 and NE Maui M7.0 Earthquake Event Scenarios

County	Total Value	Estimated Potential Loss			
		Kalapana M7.7		NE Maui M7.0	
		Value	Percent of Total	Value	Percent of Total
County of Kauaʻi	$990,850,824	$0	0.0%	$0	0.0%
City and County of Honolulu	$17,393,945,915	$2,607,370	0.0%	$743,785	0.0%
County of Maui	$3,097,491,689	$361,115	0.0%	$3,897,232	0.1%
County of Hawaiʻi	$4,638,567,141	$112,266,079	2.4%	$47,651	0.0%
Total	**$26,120,855,568**	**$115,234,564**	**0.4%**	**$4,688,669**	**0.0%**

Source: State of Hawaii Risk Management Office 2017; United States Geological Survey 2013; FEMA Hazus v5.1 2022

Of the four historic scenarios evaluated, the Kaʻū M8.0 scenario has the greatest potential state building loss at approximately $148 million (see Table 4.5-7). The County of Hawaiʻi has the greatest estimated potential state building loss equating to $143.5 million (3.1%) of the four counties.

State roads can be damaged by moderate to significant earthquake shaking. Roads that are on soft ground or on embankments can experience extensive cracking, ripped apart, settlement and sloughing. This can result in a disruption of transportation systems, which limits post-disaster emergency response.

Table 4.5-9 shows the length of state roads located on the vulnerable NEHRP Class D and E soils for the Counties of Hawaiʻi and Maui. The County of Maui has the greatest number of miles (80.4 miles) located on NEHRP Class D and E soils. The County of Hawaiʻi has a total of 12.6 miles on Class D and E soils. A complete list of state roads exposed is included in Appendix F.

Table 4.5-9. State Road Exposure to NEHRP Class D and E Soils by County

County	Length (in miles)						
	Total Length of State Roads	NEHRP Class D Area	Exposed Length as % of Total	NEHRP Class E Area	Exposed Length as % of Total	NEHRP Class D and E Area	Exposed Length as % of Total
County of Kauaʻi	103.7	-	-	-	-	-	-
City and County of Honolulu	374.9	-	-	-	-	-	-
County of Maui	245.9	80.4	32.70%	0	0.00%	80.4	32.70%
County of Hawaiʻi	379.2	12.6	3.32%	0.17	0.04%	12.7	3.35%
Total	**1,103.70**	**93**	**8.43%**	**0.17**	**0.02%**	**93.1**	**8.44%**

Source: State of Hawaii Department of Transportation 2022; AECOM 2008; United States Geological Survey
Notes: The County of Kauaʻi and the City and County of Honolulu do not have spatially-delineated NEHRP soils available for this analysis.

Community Lifelines and Critical Facilities

All critical facilities in the State of Hawaiʻi are exposed to the earthquake hazard. Community lifelines and critical facilities need to remain in operation during and after a disaster event to provide essential services. To remain in operation, these facilities may depend on electrical power. Maintaining electrical power generation and distribution is essential; however, substations and switchyards are vulnerable to strong ground shaking. As part of the *Makani Pahili 2017 Temporary Emergency Power County Workshop Report*, the HI-EMA and county emergency managers developed a list of county and state critical facilities and essential services that require emergency power during response operations and a methodology to prioritize temporary emergency power in each county. These critical facilities are included in the Hazus analysis for the 2023 SHMP Update.

Table 4.5-10 and Table 4.5-11 summarize the estimated potential losses to critical facilities as a result of the 100-year probabilistic earthquake event by county and category. The County of Hawaiʻi has the greatest estimated loss ($436.5 million or 6.4% of the total value of critical facilities in the county). The greatest loss is to the Safety and Security category ($258 million), followed by Food, Water and Shelter ($146 million).

Refer to Appendix F, which lists the estimated potential loss to community lifelines and critical facilities for the four historic earthquake scenarios evaluated.

Table 4.5-10. Estimated Potential Losses to Community Lifelines and Critical Facilities to the 100-year Probabilistic Earthquake Event, by County

County	Total Replacement Cost Value	Estimated Potential Loss	
		Replacement Cost Value	Percent (%) of Total
County of Kauaʻi	$3,420,500,143	$5,165	0.0%
City and County of Honolulu	$22,973,873,078	$21,580,249	0.1%
County of Maui	$28,244,157,982	$71,346,221	0.3%
County of Hawaiʻi	$6,773,572,388	$436,545,861	6.4%
Total	**$61,412,103,591**	**$529,477,495**	**0.9%**

Source: Hawai'i Emergency Management Agency 2017; FEMA Hazus v5.1

Table 4.5-11. Community Lifelines and Critical Facilities Potential Losses to the 100-year Probabilistic Earthquake Event, by Category

Category	Total Number of Facilities	Total Replacement Cost Value	Estimated Potential Loss	
			Replacement Cost Value	Percent (%) of Total
Communications	188	$776,797,683	$7,095,329	0.9%
Energy	89	$3,093,949,530	$13,479,748	0.4%
Food, Water, Shelter	345	$11,847,189,588	$146,012,563	1.2%
Hazardous Material	12	$436,474,800	$10,142,360	2.3%
Health and Medical	193	$4,606,713,364	$72,129,550	1.6%
Safety and Security	486	$38,164,188,232	$258,089,610	0.7%
Transportation	56	$2,039,091,600	$14,024,179	0.7%
Additional Critical Facilities	106	$447,698,794	$8,504,156	1.9%
Total	**1,475**	**$61,412,103,591**	**$529,477,495**	**0.9%**

Source: Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020; FEMA Hazus v5.1

Fires may also follow earthquakes, often occurring in developed areas. They may be caused by broken power lines or leaking combustibles that find a source of ignition. Response may be affected due to losses incurred to critical facilities and services, including communication service, isolated or damaged equipment, water supply access and other competing emergency demands on available facilities and resources.

Assessment of Local Vulnerability and Potential Losses

This section provides a summary of vulnerability and potential losses to socially vulnerable and total populations, general building stock, and environmental resources and cultural assets by county.

The local HMPs were reviewed to integrate risk assessment results into the 2023 SHMP Update; a summary of information available is below.

- **County of Kauaʻi** – The County used magnitude, the Mercalli intensity scale, peak ground acceleration, the National Earthquake Hazard Reduction Program's soil maps, and two USGS earthquake mapping programs—ShakeMap and the National Seismic Hazard Map—to identify areas of peak seismic hazard (with additional mapping in Appendix L). The plan found that 34,695 buildings, with a replacement value of $20.4 billion, are at risk, as well as the entirety of the county population. There are over 663 critical facilities at risk from earthquakes in the County. The County HMP also included a list of residents who are most vulnerable to seismic hazards, including residents living below the poverty line and residents over the age of 65 (County of Kauaʻi 2020).
- **City and County of Honolulu** – The City and County HMP included a discussion of soil conditions and historic building design criteria to assess property risk on the island. The HMP includes an Average Annualized Loss estimate for the City and County of $21 million (City and County of Honolulu 2020).
- **County of Maui** – The County used magnitude, the Mercalli intensity scale, peak ground acceleration, the National Earthquake Hazard Reduction Program's soil maps, and the USGS to identify areas of peak seismic hazard. The HMP utilized HAZUS to conduct an inventory of potential residential losses, with nearly $54 billion residential property assets exposed to earthquakes. The County HMP also included a list of residents who are most vulnerable to seismic hazards, including single parent and dependent households, residents living below the poverty line, residents without adequate communication infrastructure and/or limited English proficiency, residents living in properties built prior to the 1950s, and residents with limited mobility (County of Maui 2020).
- **County of Hawaiʻi** – The County used magnitude, the Mercalli intensity scale, peak ground acceleration, the National Earthquake Hazard Reduction Program's soil maps, and two USGS earthquake mapping programs—ShakeMap and the National Seismic Hazard Map—to identify areas of peak seismic hazard. The risks to property from earthquakes in Hawaiʻi are the highest in the nation, with all structures in the plan area—82,796 buildings—at risk, as well as the entirety of the county population. There are over 52 critical facilities at risk from earthquakes in the County. The County HMP also included a list of residents who are most vulnerable to seismic hazards, including those on seismically sensitive soils, residents living below the poverty line, and residents over the age of 65 (County of Hawaiʻi 2020).

Socially Vulnerable and Total Populations

The degree of exposure is dependent on many factors, including the age and type of construction people live in, the soil types their homes are located on, and the intensity of the earthquake. Whether directly or indirectly impacted, residents may be faced with business closures, road closures that could isolate population, and loss of function of critical facilities and utilities.

Overall, the County of Kauaʻi lies in an area of reduced seismic risk. However, if a severe earthquake affects the City and County of Honolulu, the Counties of Kauaʻi, Hawaiʻi, and Maui would be impacted severely in the receipt of goods, services, and finances since many systems rely on the ports and harbors or institutions on the island of Oʻahu.

Table 4.5-12 displays the estimated population residing on the NEHRP Class D and E soils. Nearly 50% of the population in the County of Maui are located on Class D and E soils. As noted earlier, NEHRP soils are only delineated for the Counties of Maui and Hawaiʻi. This analysis does not include the number of tourists and visitors in the state whose lodgings may be located on NEHRP Class D and E soils. Therefore, this estimate may be underestimating exposure and vulnerability.

Table 4.5-12. 2020 U.S. Census Population Located on the NEHRP Class D and E Soils by County

County	Total Population	Total Population Located in Hazard Area	Population Exposed as Percent (%) of Total Population	Socially Vulnerable Population Located in Hazard Area	Socially Vulnerable Population Exposed as Percent (%) of Total Population
County of Kauaʻi	71,949	-	-	-	-
City and County of Honolulu	979,682	-	-	-	-
County of Maui	167,093	80,507	48%	2,764	1.65%
County of Hawaiʻi	201,350	6,681	3%	20,783	10.32%
Total	**1,420,074**	**87,188**	**6%**	**23,547**	**1.66%**

Source: *U.S. Census Bureau 2020; Centers for Disease Control and Prevention 2018; AECOM 2008; United States Geological Survey*
Note: *The County of Kauaʻi and the City and County of Honolulu do not have spatially-delineated NEHRP soils available for this analysis.*

While all people located in the NEHRP Class D and E Soils areas are considered exposed and potentially vulnerable, socially vulnerable populations include the very young, the elderly, and those experiencing poverty. These socially vulnerable populations are most susceptible based on many factors, including their physical and financial ability to react or respond during a hazard and the ability to be self-sustaining for prolonged periods of time after an incident because of limited ability to stockpile supplies. Socially vulnerable populations may live in structures that do not conform to seismic building codes; therefore, homes will sustain more damage during an event. In the County of Hawaiʻi, more than 10 percent of the population exposed to the earthquake hazard is considered socially vulnerable.

Residents may be displaced or require temporary to long-term sheltering because of an earthquake event. The number of people requiring shelter is generally less than the number displaced, as some displaced persons use hotels or stay with family or friends following a disaster event. Estimated shelter requirements as a result of the 100-year probabilistic event and the four historic scenario events were calculated using Hazus; results of these analyses are summarized in Table 4.5-13 and Table 4.5-14.

Table 4.5-13. Estimated Shelter Requirements for the 100-year Probabilistic Event

County	100-year Probabilistic Event	
	Displaced Households	Short-Term Sheltering Needs
County of Kauaʻi	0	0

County	100-year Probabilistic Event	
	Displaced Households	Short-Term Sheltering Needs
City and County of Honolulu	216	131
County of Maui	54	29
County of Hawai'i	1,488	1,083
Total	1,758	1,244

FEMA Hazus v5.1

Table 4.5-14. Estimated Shelter Requirements for the Ka'ū, Lāna'i Kalapana and NE Maui Scenarios

County	Ka'ū M8.0		Lāna'i M7.0		Kalapana 1975 M7.7		NE Maui M7.0	
	Displaced Households	Short-Term Sheltering Needs	Displaced Households	Short-Term Sheltering Needs	Displaced Households	Short-Term Sheltering Needs	Displaced Households	Short-Term Sheltering Needs
County of Kaua'i	0	0	0	0	0	0	0	0
City and County of Honolulu	0	0	0	0	0	0	0	0
County of Maui	0	0	9	6	0	0	0	0
County of Hawai'i	124	93	0	0	55	41	0	0
Total	124	93	9	6	55	41	0	0

Source: United States Geological Survey 2013, FEMA Hazus v5.1

Hazus version 5.1 estimates the number of people that may potentially be injured and/or killed by an earthquake depending on the time of day the event occurs. These estimates are provided for three times of day (2:00 a.m., 2:00 p.m., and 5:00 p.m.), representing the periods of the day that different sectors of the community are at their peak. The 2:00 a.m. estimate considers the residential occupancy at its maximum; the 2:00 p.m. estimate considers the educational, commercial, and industrial sector at their maximum; and the 5:00 p.m. estimate represents peak commuter time. Table 4.5-15 and Table 4.5-16 summarize the injuries and casualties estimated for the 100-year probabilistic event and the four earthquake scenarios.

Table 4.5-15. Estimated Injuries and Casualties for 100-year Probabilistic Event

Level of Severity	100-year Probabilistic Event		
	2 a.m.	2 p.m.	5 p.m.
Injuries	370	659	458
Hospitalization	73	171	113
Casualties	11	37	23

Source: FEMA Hazus v5.1

Table 4.5-16. Estimated Injuries and Casualties for Kaʻū, Lānaʻi Kalapana and NE Maui Scenarios

	Kaʻū M8.0			Lānaʻi M7.0			Kalapana 1975 M7.7			NE Maui M7.0		
Level of Severity	2 a.m.	2 p.m.	5 p.m.	2 a.m.	2 p.m.	5 p.m.	2 a.m.	2 p.m.	5 p.m.	2 a.m.	2 p.m.	5 p.m.
Injuries	25	59	40	8	19	10	18	32	23	1	3	2
Hospitalization	2	9	5	1	3	1	2	3	2	0	0	0
Casualties	0	1	1	0	0	0	0	0	0	0	0	0

Source: FEMA Hazus v5.1

Land Use Districts

Table 4.5-17 shows the area of NEHRP Class D and E soils in the combined state land use district in the County of Maui and the County of Hawaiʻi; refer to Appendix F (State Profile and Risk Assessment Supplement) for results by County. Agricultural District lands have the most square miles of Class D and E soils, as these soil types frequently overlap with floodplain areas, which are commonly highly productive agricultural lands. Nearly 7 percent of the Urban District Land in these two counties have Class D or E soils. Urban Districts are those areas that are most likely to be developed. NEHRP soils are used in the International Building Code (IBC) to classify sites, with Class A and E corresponding to the best and poorest soil conditions, respectively. The State of Hawaiʻi adopted the 2018 IBC on April 20, 2021, and included seismic designs required for buildings in the state based on NEHRP soil classifications (State of Hawaiʻi Department of Accounting and General Services 2023). Counties in the state have adopted or are in the process of adopting the 2018 IBC (see Section 5 for more information).

Table 4.5-17. State Land Use Districts on NEHRP Class D and E Soils

Land Use District	Total (square miles)	Square Miles NEHRP Class D and E Soils	Percent (%) of Total Area
Agricultural	2,973.6	118.50	3.99%
Conservation	3,202.9	110.50	3.45%
Rural	16.3	3.30	20.20%
Urban	319.1	21.90	6.86%
Total	6,511.95	254.20	3.90%

Source: AECOM 2008; United States Geological Survey; State Land Use Commission, Hawaii Statewide GIS Program 2021; Honolulu County GIS 2022

Notes: The County of Kauaʻi and the City and County of Honolulu do not have spatially-delineated NEHRP soils available for this analysis.

General Building Stock and Economy

Similar to the analyses presented earlier, the general building stock data was overlaid with the earthquake hazard area to assess vulnerability. The total replacement cost value of general building stock is an estimated $372 billion, all of which are exposed to an earthquake event. Table 4.5-18 summarizes these values by county. The potential damage estimated to general building stock as a result of a 100-year probabilistic earthquake event is approximately $3.1 billion statewide. The County of Hawaiʻi may experience the greatest damages ($2.65 billion or 4.5% of their total general building stock inventory replacement cost).

Table 4.5-18. General Building Stock Exposure and Potential Losses to the 100-year Probabilistic Earthquake Event

County	Total Replacement Cost Value	Estimated Potential Loss	
		Replacement Cost Value	Percent (%) of Total
County of Kauaʻi	$24,246,497,228	$616,228	0.0%
City and County of Honolulu	$239,152,051,766	$339,206,046	0.1%
County of Maui	$50,796,693,140	$128,472,802	0.3%
County of Hawaiʻi	$58,395,349,136	$2,654,461,478	4.5%
Total	**$372,590,591,270**	**$3,122,756,555**	**0.8%**

Source: NIYAM IT 2022; United States Army Corps of Engineers 2022; FEMA Hazus v5.1

Of the four historic scenarios evaluated, the Kaʻū M8.0 scenario would result in the greatest estimated potential building loss, approximately $372 million in damages statewide (see Table 4.5-19). The County of Hawaiʻi is estimated to experience the greatest loss, followed by the City and County of Honolulu and County of Maui, respectively. The estimated potential building losses resulting from all four historic scenarios are summarized in Table 4.5-19 and Table 4.5-20 by county.

Table 4.5-19. General Building Stock Exposure and Potential Losses to the Kaʻū M8.0 and Lānaʻi M7.0 Earthquake Event Scenarios

County	Total Replacement Cost Value	Estimated Potential Loss			
		Kaʻū M8.0		Lānaʻi M7.0	
		Value	Percent of Total	Value	Percent of Total
County of Kauaʻi	$24,246,497,228	$0	<1%	$0	<1%
City and County of Honolulu	$239,152,051,766	$20,447,622	<1%	$14,617,141	<1%
County of Maui	$50,796,693,140	$10,970,739	<1%	$144,614,004	0.3%
County of Hawaiʻi	$58,395,349,136	$524,483,419	1.0%	$182,916	<1%
Total	**$372,590,591,270**	**$555,901,780**	**0.1%**	**$159,414,061**	**<1%**

Source: NIYAM IT 2022; United States Army Corps of Engineers 2022; USGS 2013; FEMA Hazus v5.1

Table 4.5-20. General Building Stock Exposure and Potential Losses to the Kalapana M7.7 and NE Maui M7.0 Earthquake Event Scenarios

County	Total Replacement Cost Value	Estimated Potential Loss			
		Kalapana M7.7		NE Maui M7.0	
		Value	Percent of Total	Value	Percent of Total
County of Kauaʻi	$24,246,497,228	$0	0.0%	$0	0.0%
City and County of Honolulu	$239,152,051,766	$13,686,577	<1%	$4,067,819	<1%
County of Maui	$50,796,693,140	$4,985,259	<1%	$55,064,967	0.1%
County of Hawaiʻi	$58,395,349,136	$324,284,927	0.6%	$904,868	<1%
Total	**$372,590,591,270**	**$342,956,763**	**0.1%**	**$60,037,654**	**<1%**

Source: NIYAM IT 2022; United States Army Corps of Engineers 2022; USGS 2013; FEMA Hazus v5.1

Earthquakes have the potential to impact economies at both the local and regional scale. Losses can include structural and non-structural damage to buildings, loss of business function, damage to inventory, relocation costs, wage loss, and rental loss caused by the repair and replacement of buildings. Table 4.5-21 summarizes the estimated potential economic loss as calculated by Hazus for the four historic earthquake scenarios evaluated.

Table 4.5-21. Estimated Potential Economic Losses for the State of Hawaiʻi (Millions of Dollars) for the Kaʻū, Lānaʻi Kalapana and NE Maui Scenarios

	Kalapana 1975 M7.7	Kaʻū M8.0	Lānaʻi M7.0	NE Maui M7.0
Income Losses				
Wage	$21.8	$31.4	$5.3	$2.1
Capital-Related	$16.8	$23.8	$4.5	$1.8
Rental	$15.2	$21.7	$4.4	$1.6
Relocation	$28.5	$42.7	$7.7	$2.0
Subtotal	**$82.2**	**$119.6**	**$21.9**	**$7.5**
Capital Stock Losses				
Structural	$52.7	$79.2	$22.5	$4.2
Non-Structural	$193.9	$296.2	$94.5	$35.4
Content	$96.3	$141.1	$42.5	$20.5
Inventory	$1.7	$2.4	$0.4	$0.5
Subtotal	**$344.7**	**$518.9**	**$159.9**	**$60.6**
Total	**$426.9**	**$638.5**	**$181.7**	**$68.1**

Source: FEMA Hazus v5.1

Roads that cross earthquake-prone soils have the potential to be significantly damaged during an earthquake, potentially impacting commodity flows. Access to major roads is crucial to life and safety after a disaster as well as to response and recovery. Further, water and sewer infrastructure would likely suffer considerable damage in the event of an earthquake.

Due to its location and isolation, the state faces unique challenges in addressing disaster debris. With limited landfill capacity, advanced planning for large amounts of debris is critical. The Hazus earthquake model estimates volume of debris that may be generated as a result of an earthquake event to enable the state to prepare for and efficiently manage debris removal and disposal. Debris estimates are divided into two categories: (1) reinforced concrete and steel that require special equipment to break up before transport, and (2) brick, wood, and other debris that can be loaded directly onto trucks with bulldozers (FEMA 2022). Table 4.5-22 summarizes the estimated debris generated by the 100-year probabilistic event and the four earthquake scenarios in Hazus 5.1.

Table 4.5-22. Estimated Debris Generated for each Earthquake Scenario

Scenario	Debris Type	
	Brick/Wood (tons)	Concrete/ Steel (tons)
100-year Probabilistic Event	309,935	571,270
Kalapana 1975 M7.7	25,812	40,545
Kaʻū M8.0	42,639	65,229
Lānaʻi M7.0	9,083	11,256
NE Maui M7.0	3,484	2,474

Source: FEMA Hazus 5.1

Environmental Resources

Earthquakes can lead to numerous, widespread, and devastating environmental impacts. Hazardous materials releases can occur during an earthquake from fixed facilities or transportation-related incidents. During an earthquake, structures storing these materials could rupture and leak into the surrounding area or an adjacent waterway, having a disastrous effect on the environment. Facilities holding hazardous materials are of concern because of possible isolation of neighborhoods surrounding them. Transportation corridors can be disrupted during an earthquake, leading to the release of materials to the surrounding environment. Table 4.5-23 summarizes environmental resources on NEHRP D or E soils.

Table 4.5-23. Environmental Resources Located on NEHRP Class D or E Soils

Environmental Resource	Statewide		
	Total Square Miles of Resources	Square Miles in High-Risk Area	Percent (%) of Total Resource Area
Critical Habitat [a]	950.6	703.4	74.0%
Wetlands	3,636.7	199.1	5.5%
Parks and Reserves	2,777.7	2,308.1	83.1%
Reefs [b]	54.8	0.3	0.6%
Total [c]	**7,419.8**	**3,211.0**	**43.3%**

Source: Hawaiʻi Wildfire Management Organization, Division of Forestry and Wildlife; U.S. Fish and Wildlife Service, Pacific Islands Office, 2022, U.S. Fish and Wildlife Service 2021; 2017, Hawaiʻi State Department of Land and Natural Resources, Division of Forestry and Wildlife 2022, NOAA raster nautical charts 2020, State of Hawaiʻi Department of Land and Natural Resources, Division of State Parks 2021

Notes:

a. Critical area mileage includes the combined area of coverage of individual critical habitat areas.

b. Reefs include artificial and coral reefs.

c. Total square miles includes environmental assets within 3 nautical miles of each county and may be over-reported as some environmental asset areas may overlap.

Additional environmental impacts may include but are not limited to:

- Induced flooding or landslides
- Poor water quality
- Damage to vegetation
- Breakage in sewage or toxic material containments

Cultural Assets

Consistent with Native Hawaiian culture, Hawaiian Home Lands include areas from mauka to makai (from the mountain to the sea). The population and structures located on Hawaiian Home Lands are more vulnerable to earthquake events if located on NEHRP Class D and E soils (see Table 4.5-24). The County of Maui has 6.4% of its Hawaiian Home Lands on this type of soil. Table 4.5-25 summarizes cultural resources located on NEHRP Class D and E soils.

Table 4.5-24. Hawaiian Home Lands on NEHRP Class D and E Soils

County	Area (in square miles)						
	Total Area of Hawaiian Home Lands	NEHRP Class D Area	Percent (%) of Total	NEHRP Class E Area	Percent (%) of Total	Total NEHRP Class D and E Area	Percent (%) of Total
County of Kauaʻi	32.1	-	-	-	-	-	-
City and County of Honolulu	10.6	-	-	-	-	-	-
County of Maui	102.6	6.6	6.4%	0.0	0.0%	6.6	6.4%
County of Hawaiʻi	191.5	5.1	2.7%	2.6	1.3%	7.7	4.0%
Total	**336.7**	**11.7**	**3.5%**	**2.6**	**0.8%**	**14.3**	**4.2%**

Source: *Hawaii State Department of Hawaiian Homelands 2021; AECOM 2008; United States Geological Survey*
Note: *The County of Kauaʻi and the City and County of Honolulu do not have spatially-delineated NEHRP soils available for this analysis.*

Table 4.5-25. Cultural Resources Located on NEHRP Class D or E Soils, Statewide

Cultural Resource Site Type	Area (in square miles)						
	Total Square Miles	Cultural Resources in NEHRP Class D Area	Percent (%) of Total	Cultural Resources in NEHRP Class E Area	Percent (%) of Total	Cultural Resources in NEHRP Class D and E Area	Percent (%) of Total
Archaeology	90.9	9.8	10.8%	0.6	0.7%	10.4	11.5%
Burial Sensitivity Area	2.1	0.1	7.1%	0.0	0.0%	0.1	7.1%
Historic Building	2.7	0.2	8.1%	0.0	0.0%	0.2	8.1%
Historic District	849.4	58.1	6.8%	1.6	0.2%	59.7	7.0%
Historic Object	9.6	0.0	0.5%	0.0	0.0%	0.0	0.5%
Historic Structure	20.7	0.0	0.2%	0.0	0.0%	0.0	0.2%
Total	**975.4**	**68.4**	**7.0%**	**2.2**	**0.2%**	**70.6**	**7.2%**

Future Changes that May Impact State Vulnerability

Understanding future changes that impact vulnerability in the state can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The State of Hawaiʻi considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

NEHRP Class D and E soil areas were overlain on areas that may experience significant changes in development or redevelopment in future years (see Table 4.5-26 below; refer to Section 3 for more information on projected development areas). Because only the County of Hawaiʻi and the County of Maui have this data available, the analysis was only conducted using Maui Development Project Areas and Enterprise Zones in these counties. About 22% of the area in the Maui Development Projects are in the hazard area and 9% of Enterprise Zone areas have Class D or E soils. Generally, new development will be more resistant to damage from earthquake events than older construction as building code seismic design standards have improved over time and modern codes, such as the IBC, include provisions for classifying soils.

Table 4.5-26. Maui Development Projects and Enterprise Zones Located in NEHRP Class D or E Soils

County	Area (square miles)					
	Maui Development Projects (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area	Enterprise Zones (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area
County of Maui	27.6	6	21.7%	1,059.8	94.7	8.9%
County of Hawai'i	0	0	0	1,274.9	45.4	3.6%
Total	**27.6**	**6**	**21.7%**	**2,334.7**	**140.1**	**6.0%**

Source: Maui County Planning Department 2016; Community Economic Development Program, Department of Business, Economic Development & Tourism, County Planning Departments 2021; AECOM 2008; United States Geological Survey

Note: NEHRP soil classification has not been conducted in the County of Kaua'i or in the City and County of Honolulu

Section 4.6 Flood

Flood

Floods caused by heavy or sustained rainfall and coastal high tides and surges cause more water to accumulate in an area than its natural or human-made drainage systems can support, which results in flood flow velocities that contain water filled debris and surge mudflow. Statistics below reflect event-based 1% annual chance flooding.

CHANGES SINCE 2018

+2

Declared Disasters

+19

Significant Events

COUNTIES MOST VULNERABLE

Kauaʻi Honolulu Maui Hawaiʻi

SOCIALLY VULNERABLE POPULATION

1.11%

Of Total Population

15,800

Persons

CLIMATE PROJECTIONS

Coastal flooding from hurricanes and tropical storms will increase as sea levels rise

Heavy or extreme rain events will increase, causing more frequent or intense flooding

Event-based coastal flooding with sea level rise would alter the extent of the area impacted by flooding from storm events, increasing beach erosion

HAZARD RANKING

Low Medium High

COMMUNITY LIFELINES

153

Total

Food, Water, Shelter

Greatest

SQUARE MILES

489

State Buildings

147

Environmental Resources

4

Hawaiian Home Lands

48

Cultural Resources

85.5

Miles of State Road

CONTENTS

TABLES

FIGURES

[1] *Section Cover Photo: Flooding in the Hanalei River Valley, Kauaʻi. Photo by Anthony Quintano/Civil Beat*

SECTION 4. RISK ASSESSMENT

4.6 FLOOD

2023 SHMP Update Changes

- The flood hazard now combines event-based and chronic coastal flooding in the State of Hawaiʻi.
- Flood events that occurred in the State of Hawaiʻi from January 1, 2018, through December 31, 2022, were researched for this 2023 SHMP Update.
- New and updated figures from federal and state agencies are incorporated.
- This section now includes a discussion of how floods impact socially vulnerable populations and community lifelines.
- In Environmental Resources, reefs (both artificial and coral) are analyzed in their own category.
- Six types of cultural resources (archaeology, burial sensitivity area, historic building, historic district, historic object, and historic structure) are added to the vulnerability assessment.

4.6.1 HAZARD PROFILE

The State of Hawaiʻi is a mountainous tropical archipelago, making floods a frequent occurrence (National Science Foundation n.d.). Flooding in the state is caused by numerous sources, including rainfall from storms, storm surge, tsunamis, dam failures, and tidal flooding. Coastal flooding will continue to worsen as the sea level continues to rise. Refer to Figure 4.6-1 for a schematic diagram of the sea level rise exposure area (SLR-XA).

This section includes the event-based coastal and inland flood hazard and the chronic coastal flood hazard, which includes passive flooding, annual high waves, coastal erosion, and tidal flooding, including king tides. Flooding caused by dam failure is discussed in Section 4.10 (Infrastructure Failure), and storm surge is discussed in Section 4.9 (Hurricane). The assessment of mid- to late-century sea level rise on chronic coastal flooding is discussed in Section 4.2 (Climate Change and Sea Level Rise).

Hazard Description

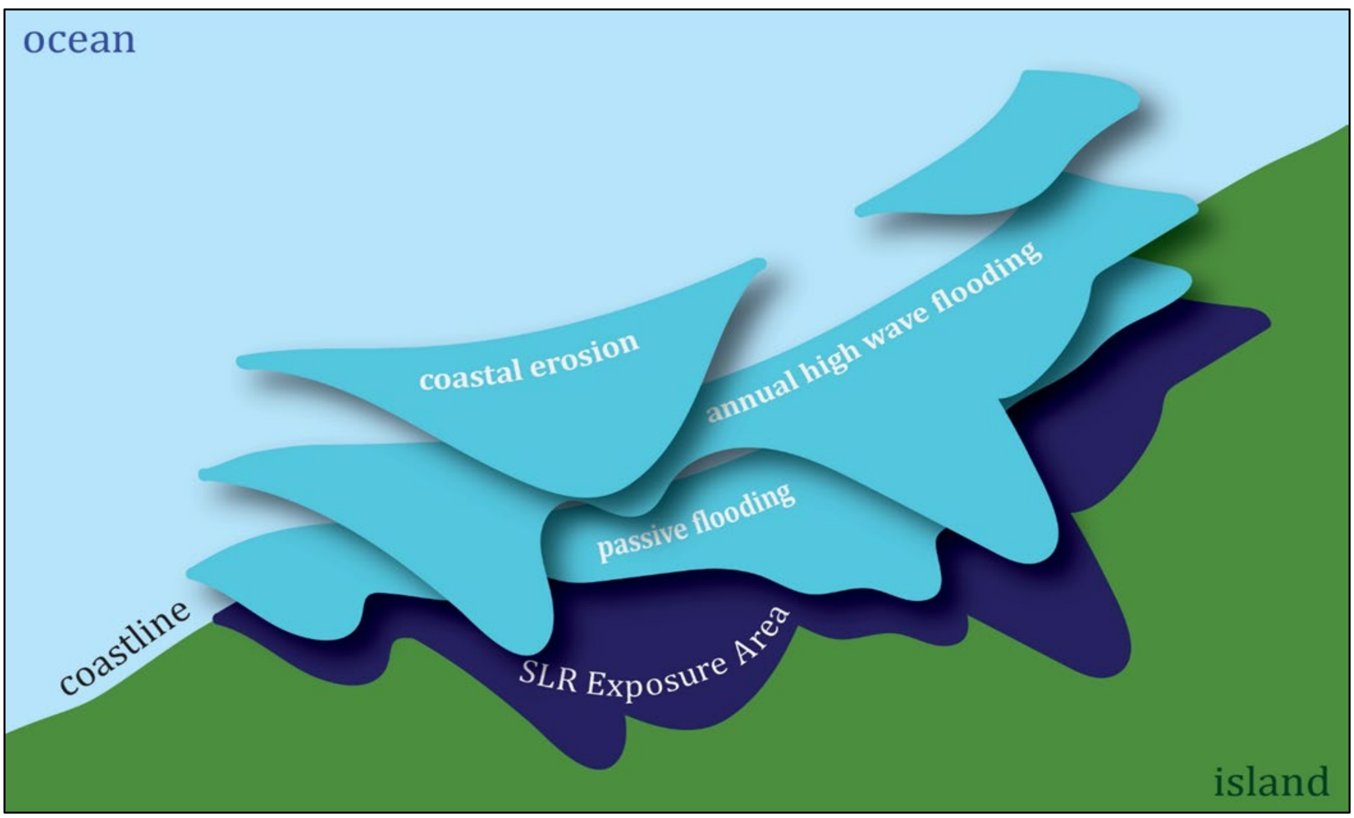
Event-Based Flooding

Event-based floods are the result of storms that cause temporary inundation of land from excessive rainfall or wave action. Flooding also occurs as a result of other event-types such as storm events which are discussed in other sections of the risk assessment. For the purposes of the 2023 SHMP Update, event-based flood include both coastal and inland flooding as depicted on Flood Insurance Rate Maps (FIRMs).

Key Terms

- **Event-Based Flood** – The 1% annual chance flood as depicted on the FEMA Flood Insurance Rate Maps, also known as the Special Flood Hazard Area (inclusive of V- and A-zones).
- **V-Zones** – Areas subject to coastal flooding with velocity hazard (wave action of 3 feet or greater); includes V- and VE-zones.
- **A-Zones** – Special flood hazard areas that are not subject to wave heights of 3 feet or greater; includes A-, AE-, AO-, and AH-zones.
- **LiMWA** – The inland limit of the area expected to receive 1.5-foot or greater breaking waves during the 1% annual chance flood event.
- **Chronic Coastal Flood** – The combined effects of annual high wave flooding, passive flooding, and coastal erosion that are being exacerbated by sea level rise. The SLR-XA with 1.1 feet of sea level rise (SLR-XA-1.1), as defined in the 2017 Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report, approximates current or near-term exposure to chronic coastal flooding in the State of Hawaiʻi. Chronic coastal flooding represented by the SLR-XA-1.1 for the Islands of Molokaʻi and Hawaiʻi is based on modeling passive flooding only due to limitations in data (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017).

Figure 4.6-1. Chronic Coastal Flooding as the Cumulative Impact of Passive Flooding, Annual High Wave Flooding, and Coastal Erosion

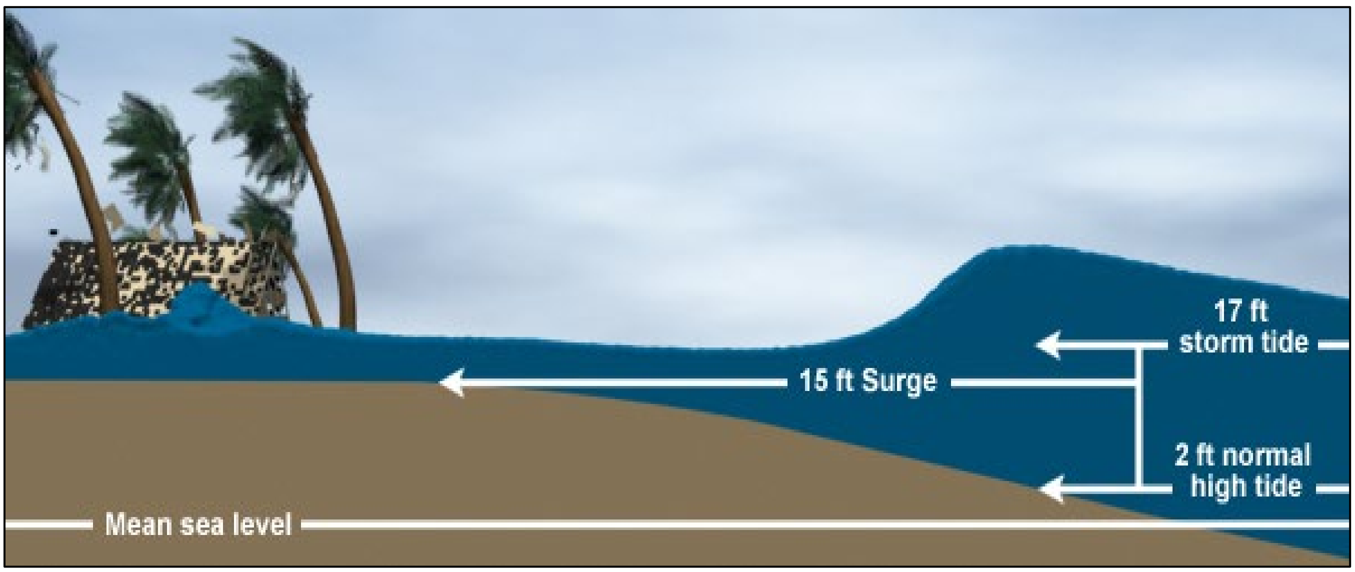


Source: (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017)

Event-Based Coastal Flooding

Coastal flooding in the State of Hawaiʻi generally occurs along the coasts of oceans, bays, and estuaries and is caused by seawater over and above normal tide action as a result of the storm surge (see Figure 4.6-2). Hurricanes and severe storms cause most coastal flooding (National Hurricane Center n.d.). During these events, high winds and surf can push water several feet and even hundreds of yards inland. Event-based coastal flooding is limited to discussion of such flooding from a 1% annual chance storm. Refer to Section 4.9 (Hurricane) for additional discussion on hurricanes and storm surge from less frequent and more severe events.

Figure 4.6-2. Storm Surge



Source: (National Hurricane Center n.d.)

Inland Flooding

Inland flooding is a general term used to describe non-coastal flooding. In the State of Hawaiʻi, inland flooding is caused by rainfall events, which cause three types of inland flooding:

- Riverine flooding—Riverine flooding is when streams and rivers exceed the capacity of their natural or constructed channels to accommodate water flow and water overflows the banks, spilling out into adjacent low-lying, dry land (FEMA n.d.).
- Overland sheet flow—Overland sheet flow occurs primarily in areas with undefined drainage ways and flood waters simply flow over land.
- Ponding of standing water in poorly drained low-lying areas—Poorly drained low-lying areas are a problem when flooding occurs even when rainfall is not heavy. Such drainage issues can be naturally occurring or human-caused. When human-caused, such flooding is sometimes referred to as urban flooding (see Figure 4.6-3).

Figure 4.6-3. Rainfall Flooding on Kauaʻi

Source: (Dennis Fujimoto / The Garden Island 2021)

Chronic Coastal Flooding

The SLR-XA-1.1 represents the present-day or near-term exposure to chronic coastal flooding, defining the state's vulnerability to chronic coastal flooding (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017). The latest scientific literature suggests that 1.1 feet of sea level rise could be reached intermittently in the State of Hawaiʻi over the next couple of decades and sustained before midcentury. Long-term records from tide stations around the State of Hawaiʻi are already showing that the sea level is rising around the islands (refer to Figure 4.2-6 in the Climate Change and Sea Level Rise section). As seen in Figure 4.6-4, coastal areas are already experiencing an increase in frequency of chronic coastal flooding components (passive inundation, high wave flooding, coastal erosion, and tidal flooding, including king tides).

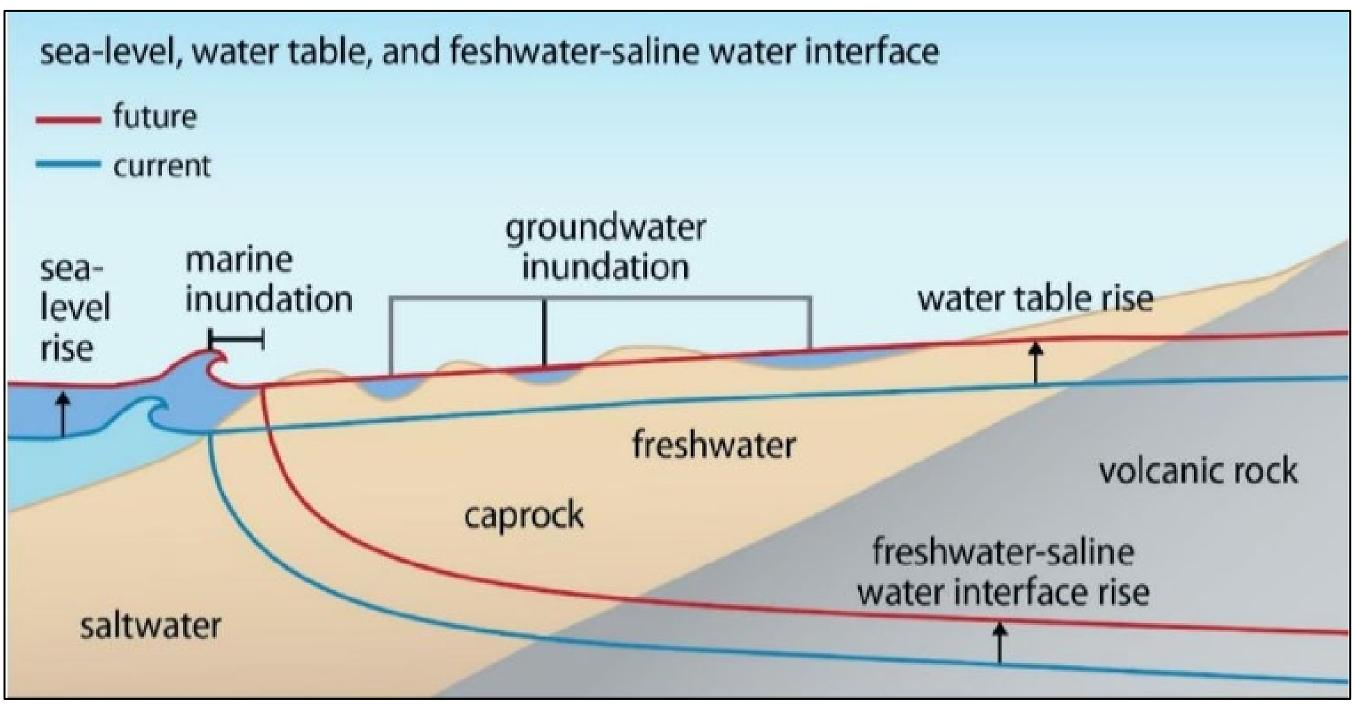
Passive Flooding

Passive flooding, also known as hydrostatic flooding, is depicted by bathtub modeling. Passive flooding includes marine flooding over the shoreline by stillwater flow into the lands that lie below the water level. The model also depicts low-lying areas indirectly flooded by sea level rise through water table rise and intrusion through storm drains. Passive flooding is exacerbated by rainfall as it prevents drainage, and as such, runoff and marine waters combine to produce larger impacts. Passive flooding provides an initial assessment of low-lying areas susceptible to flooding by sea level rise but does not include the effects of waves or coastal erosion. Passive flooding includes areas that are hydrologically connected to the ocean (marine flooding) and low-lying areas that are not hydrologically connected to the ocean (groundwater) (Figure 4.6-5) (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017).

Figure 4.6-4. Wave Inundation at Honoapi'ilani Highway, Maui

Source: (Pacific Islands Ocean Observing System 2022)

Figure 4.6-5. Passive Marine and Groundwater Flooding

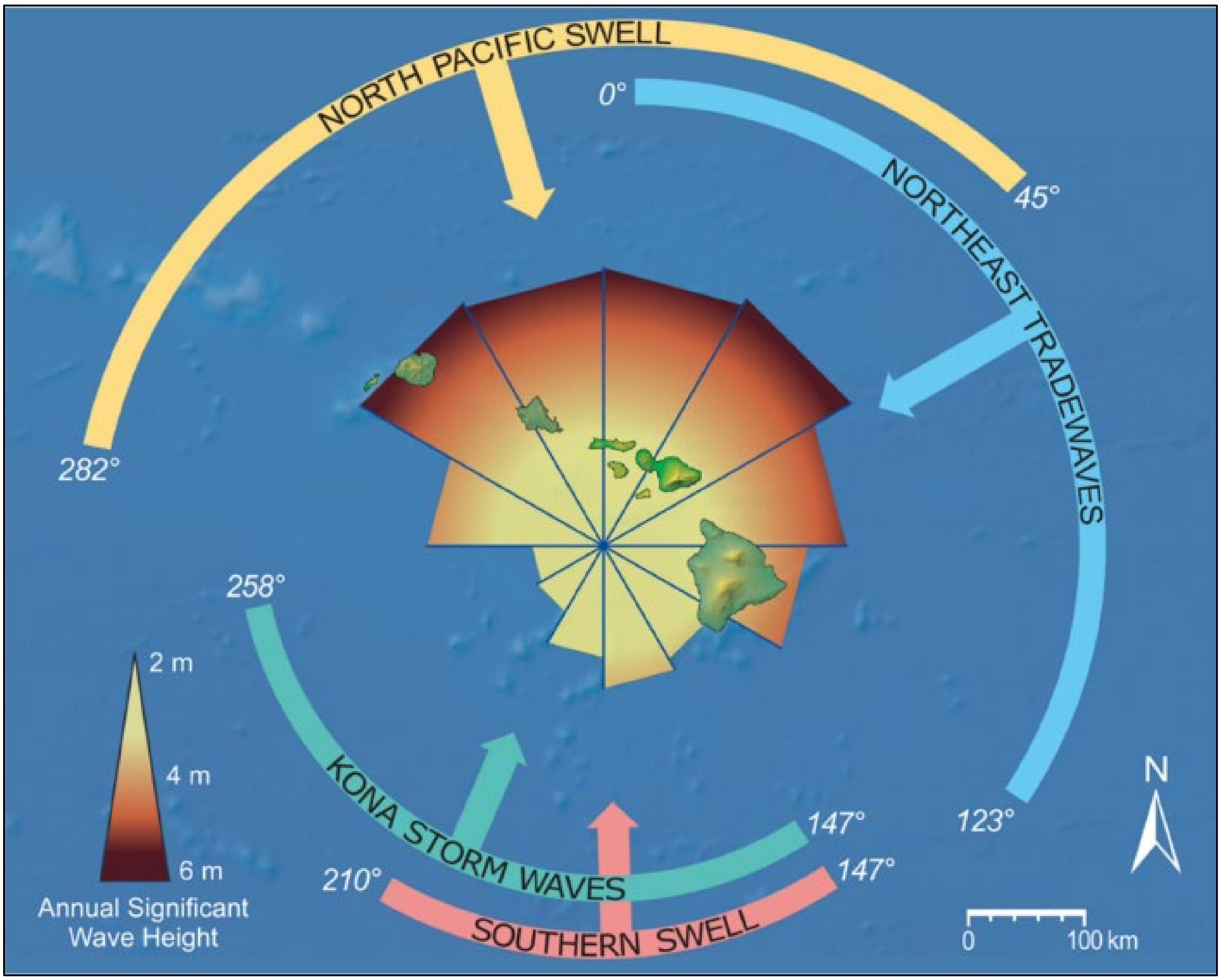


Source: (Hawai'i Climate Change Mitigation and Adaptation Commission 2017)

Annual High Wave Flooding

Storms or high winds over the open ocean can generate large waves that trigger high surf in coastal areas. Each year, waves that reach Hawaii's shorelines originate from four primary sources: North Pacific swell, northeast trade wind swell, South Pacific swell, and kona storm waves from a southerly direction. Figure 4.6-6 illustrates the primary wave sources and a wave rose depicting annual significant wave heights and direction. As shown in the wave rose, annual swell heights off north-exposed shores typically reach 6 meters (20 feet) or more in winter months. Breaking waves can be double that size or more on outer reefs.

Figure 4.6-6. Dominant Swell Regimes for the Hawaiian Islands



Source: (McDonald, et al. 2022)

Hazards associated with high waves include debris overwash, flooding, erosion, and turbulence and strong currents in the surf zone. Because the contact between deep water and the shallow margins around the Hawaiian Islands is abrupt, surface waves can grow very tall very quickly (University of Hawaiʻi 2022). High waves in Hawaiʻi are also generated by approaching storms, including tropical storms and hurricanes in the summer and fall, as well as winter kona storms in winter months. These types of wave events are discussed in the Event-Based Flood portion of this section and Section 4.9 (Hurricane).

Coastal Erosion

Coastal erosion is the wearing away of material, typically sand, from the shoreline by waves and currents. The loss of sand causes the beach to become narrower and lower in elevation. Coastal erosion is typically measured as the horizontal movement or rate of change in the position of a shoreline over time. It is generally associated with high wave events, storms, and elevated water levels. Coastal erosion may be exacerbated by human activities such as shoreline hardening and sand mining. Natural recovery after erosive episodes can take months to years. A beach that is undergoing a long-term trend of chronic erosion will typically not recover fully after a storm or high waves, exposing shorefront development to further damage and land loss in subsequent events. Studies utilizing historical and recent aerial photographs find that 70% of beaches in the state are chronically eroding (Anderson, et al. 2018).

Seasonal coastal erosion (or episodic coastal erosion) occurs when beaches and other coastal areas are exposed to seasonally high waves. In the State of Hawaiʻi, seasonal erosion occurs on all coasts but is most pronounced on north and west coasts, which are exposed to large winter swell and alternating wave directions between winter and summer. Unusually large wave events or high wave season can cause severe coastal erosion on any coast.

Sources of Erosion

The following are details regarding the sources of coastal erosion that may impact the State of Hawaiʻi:

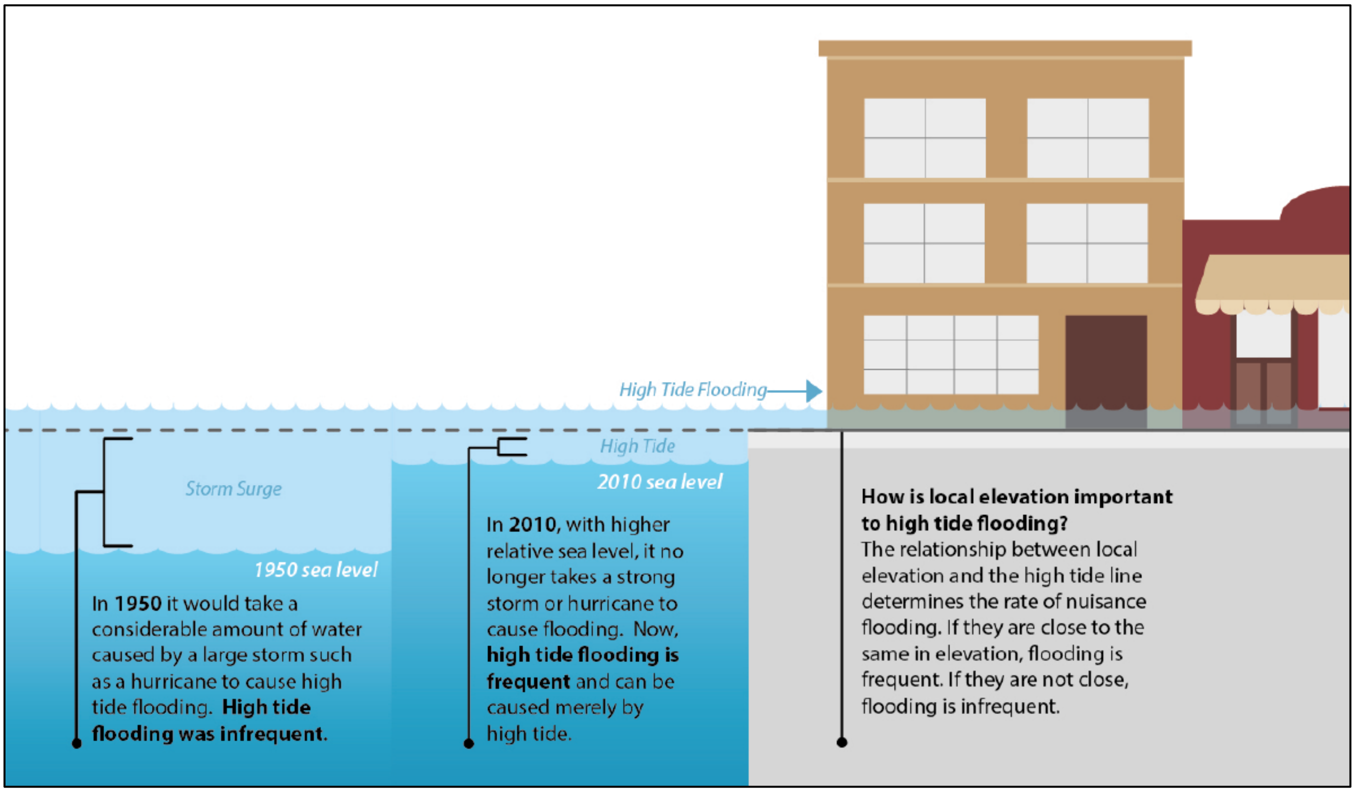
- High Waves and Strong Currents—High waves and strong currents will typically cause a beach to narrow and steepen as sand is carried offshore or down the coast and deposited in areas of lower energy. In Hawaiʻi, fringing reefs play an important role in directing and modulating wave and current energy as waves then shoal and break further offshore. Erosion trends are highly variable along the shoreline and from one season to the next. For example, some sections of beach on the North Shore of Oʻahu, which are exposed to very large winter waves, widen during winter months and experience erosion during summer months when smaller trade wind waves dominate due to shifts in alongshore sand transport.
- Coastal Armoring—Coastal managers and property owners often attempt to stabilize coastal land and protect infrastructure along the coast by building shoreline armoring structures to stop land loss and protect shorefront development. These structures include seawalls and sloping rock revetments. Rock groins have also been used to stabilize beaches by slowing alongshore migration of sand.
- Coastal armoring can be an effective means of limiting property damage from coastal erosion and high waves. However, coastal armoring has had widespread negative impacts on beach environments in Hawaiʻi. Seawalls and revetments trap sediment behind the structure that would otherwise be released by ongoing erosion to nourish the beach, leading to beach narrowing and loss on chronically eroding shores. These structures also tend to accelerate erosion on adjoining unprotected shorelines, increasing hazards for neighboring properties. Over 13 miles of beach has been completely lost to erosion fronting coastal armoring in Hawaiʻi (Anderson, et al. 2018). Groins, breakwalls, and other coastal engineering structures are used in Hawai'i to stabilize beaches and protect infrastructure such as harbors but can also cause localized erosion, if not designed and sited properly, by changing wave and current patterns and trapping sediment on the updrift side of structures.

- Dune Leveling and Grading—Coastal dunes provide a critical reservoir of sand for beach during high waves and storms and can provide natural protection from flooding and damage by high waves, rising sea levels and strong storms. However, in the State of Hawaiʻi, many beachfront dunes have been graded down for development or degraded by the historical practice of sand mining. Deflated beaches and flattened dunes reduce the natural buffering capabilities of the beach system and are themselves a degraded environment with little to offer the normal coastal ecosystem and its host of organisms with beach-dependent life stages (including turtles, various marine larvae, and certain reef fishes) (DLNR Coastal Lands Program n.d.).
- Sand Mining—Sand mining from beachfront dunes is a presently outlawed, historic practice that refers to the process of collecting large amounts of coastal sands typical for use in construction or agriculture. The beaches in the State of Hawaiʻi, especially the beaches on the Islands of Maui and Oʻahu, were subjected to sand mining for lime processing which was then baked to produce lime for use as a building material. Sand mining is in large part responsible for the historical retreat of both the vegetation line and the beach foreshore along some beaches. Besides loss of vegetation and beach foreshore, sand mining impacts beaches negatively by decreasing sand volumes, steepening the morphology of the shoreline, and reducing the ability of beach profiles to respond to seasonal wave stresses, increasing erosion and marine flooding hazards to shorefront development (Pilkey, et al. 2022).
- Canalization—Many streams that flow intermittently from Hawaiian mountain ranges to the coast are subject to flash flooding during heavy rainfall events. To prevent coastal zone flooding, many of the most hazardous of these streams have been canalized into concrete canals or gutters so that flooding is contained. Where canals and similar infrastructure open onto the coastal zone, the channel mouths tend to trap sand that is moving along the shoreline. The buildup of sand within the channel mouths increases the upstream flood hazard and creates a sand deficiency on the adjacent beach. Public works departments often clear these accumulations and dispose of the sand in various ways, including returning beach-quality sand to the beaches. Unless these sands are returned to the immediate beach area, the long-term dredging and clearing is nothing less than a sand mining effort, and it will have a similar detrimental impact on the adjacent beach. This process has the potential to reduce available sand volumes and create chronic erosion where none previously existed. By placing cleared sands onto adjacent beaches, it is important to be aware of prevailing sediment transport patterns so that returned sand can function in a manner that will provide nourishment. To ensure proper adjacent beach replenishment, it is necessary to conduct reviews of the ambient littoral processes and develop schedules of transport direction around each channel mouth, with guidelines on the placement of returned sand (DLNR Coastal Lands Program n.d.).

Tidal Flooding/King Tides

Tidal flooding, also known as sunny day flooding or high tide flooding, is the temporary inundation of low-lying areas during exceptionally high tides (Figure 4.6-7). King tides is a non-scientific term used to describe exceptionally high tides that occur in summer and winter when the moon is at its closest point to the Earth. Astronomical king tides are predictable but additional impacts on top of king tides, such as high waves and additional elevated water levels, can be hard to foresee more than a week in advance (University of Hawaiʻi Sea Grant College Program 2018). King tides combined with long-term global sea level rise, plus an additional high water level anomaly, resulted in the highest observed tide at Honolulu on August 21, 2017 (Yoon 2021). This type of flooding is predicted to occur more frequently and severely in coming decades with increasing sea level rise.

Figure 4.6-7. High Tide Flooding



Source: (National Oceanic and Atmospheric Administration n.d.)

LOCATION

Event-Based Flooding

FEMA conducts flood studies that use historical records to determine the probability of occurrence for different flood levels in a community. FIRMs show the location of these flood hazard areas. This mapping reflects risk from both coastal and major inland flooding but does not generally reflect risk from urban flooding as it has been defined in the 2023 SHMP Update. There is no statewide system for mapping risk from urban flooding. As a result, the location, extent, and vulnerability of the event-based flood hazard is analyzed using the special flood hazard areas (SFHA) depicted on each county's FIRM, which shows flood zones for rainfall flooding, coastal flooding, shallow flooding, and distinguishes areas where detailed studies have been conducted to determine flood elevations.

The special flood hazard area serves as the regulatory boundary in which each county's flood damage prevention ordinance is enforced. The flood damage prevention ordinance requires that development in the community's SFHAs meet certain standards to reduce damage from flooding, such as being elevated above the base flood elevation. The SFHA shows the horizontal extent of a flood that has a 1% chance of being equaled or exceeded in any given year (e.g., a 1% annual chance flood), while the base flood elevation shows the vertical height of flooding from a 1% annual chance flood at any given location within the SFHA.

The source of flooding used to determine base flood elevations within the SFHA for each county may include a combination of tsunami inundation, freshwater flooding from rain events, and storm surge as FIRMs differentiate flood zones based on flooding characteristics with a 1% annual chance of occurrence and do not differentiate based on flood source (e.g., tsunami, hurricane). Refer to the individual county's Flood Insurance Study (FIS) for details on the hydrologic analyses performed.

Table 4.6-1 displays the total area of each county that is located in the SFHA as calculated by using the National Flood Hazard Layer DFIRM data, effective February 26, 2021. Approximately 2.8% of the entire state is located within the mapped SFHA. The City and County of Honolulu has the largest SFHA area, with 6.9% of its land located in the SFHA. Figure 4.6-8 through Figure 4.6-11 illustrate the SFHAs throughout the State of Hawaiʻi.

Table 4.6-1. Area Located in the Special Flood Hazard Area by County

County	Area (square miles)		
	Total Area	SFHA	SFHA as Percent (%) of Total Area
County of Kauaʻi	624.3	35.0	5.61%
City and County of Honolulu	598.6	41.1	6.86%
County of Maui	1,176.3	48.5	4.12%
County of Hawaiʻi	4,039.6	53.1	1.31%
Total	6,438.8	177.7	2.76%

Source: FEMA Map Service Center 2021[a]; U.S. Census Bureau 2021
Note:
a. National Flood Hazard Layer DFIRM data obtained from the FEMA Map Service Center, effective February 26, 2021, with latest Letter of Map Amendment January 4, 2021

Chronic Coastal Flooding

Chronic coastal flooding is occurring throughout the Hawaiian Archipelago. Maps showing exposure to chronic coastal flooding in the main Hawaiian Islands, depicted as the SLR-XA-1.1, as well as the individual component hazards (passive flooding, erosion, wave overwash), can be found on the Hawaiʻi Sea Level Rise Viewer (http://www.pacioos.hawaii.edu/shoreline/slr-hawaii/).

Areas that are more susceptible to chronic coastal flooding include low-lying areas along the coast as well as inland areas which are susceptible to groundwater flooding or flooding through coastal storm drains. All exposed coasts around the islands are subject to high wave events at various times of the year. North and west-exposed shores of the islands are subject to extraordinary wave heights each winter, ranging between 20 and 40 feet from swells generated by storms moving across the North Pacific. The south shore, on average, sees waves of 4 to 8 feet each summer from swells generated by distant storms in the South Pacific. High waves in Hawaiʻi are also generated by approaching storms, including tropical storms and hurricanes in the summer and fall, as well as winter kona storms associated with passing storm fronts. Strong trade wind events also stir up high waves that influence the east-facing shorelines.

The extent of chronic coastal flooding varies by county. Table 4.6-2 shows the hazard area in square miles and the percent of the total area located in the chronic coastal flood hazard area based on the SLR-XA-1.1. The City and County of Honolulu have the largest percent (0.95%) of land in the chronic coastal flood hazard area.

Figure 4.6-8. Special Flood Hazard Areas in the County of Kaua'i

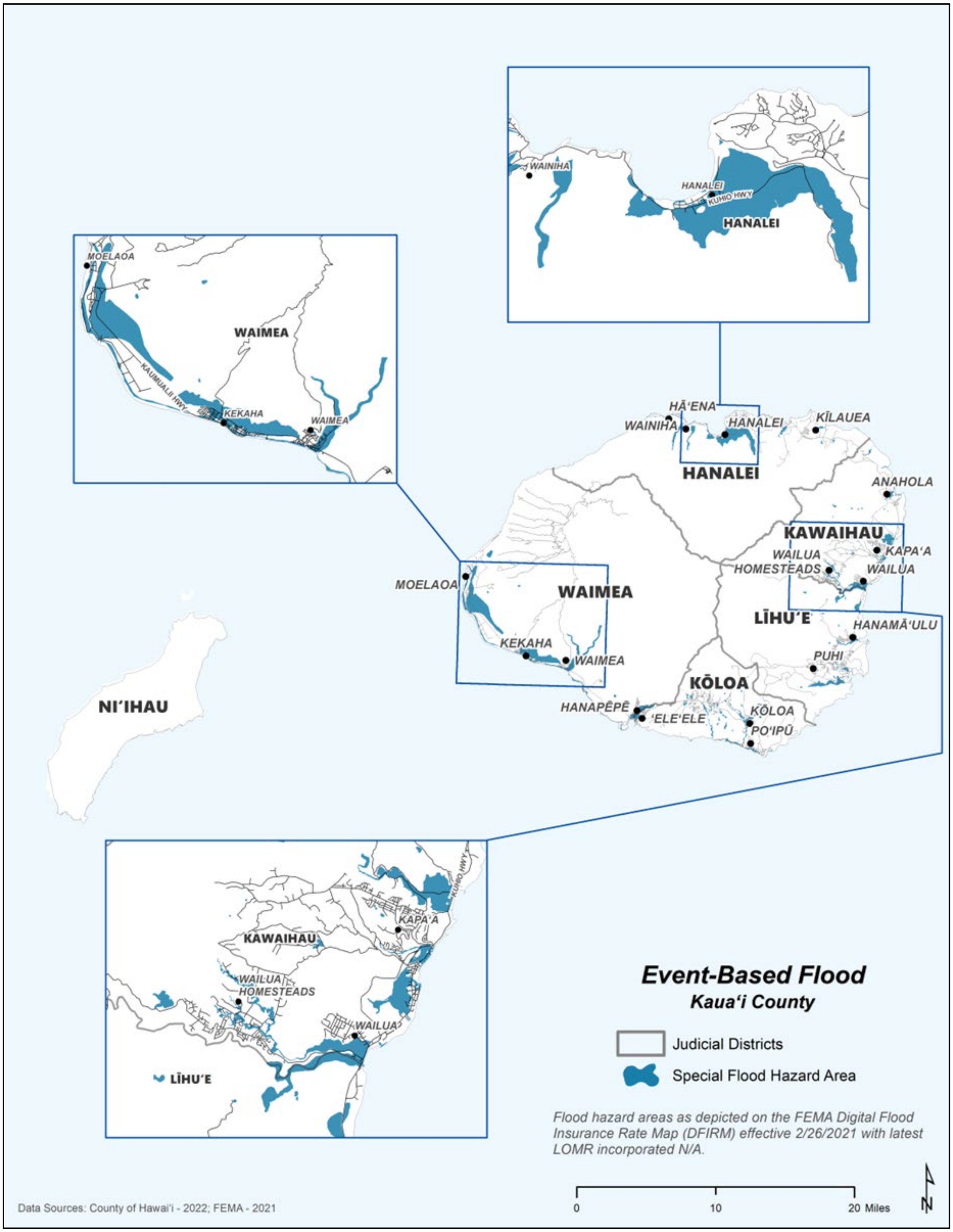


Figure 4.6-9. Special Flood Hazard Areas in the City and County of Honolulu

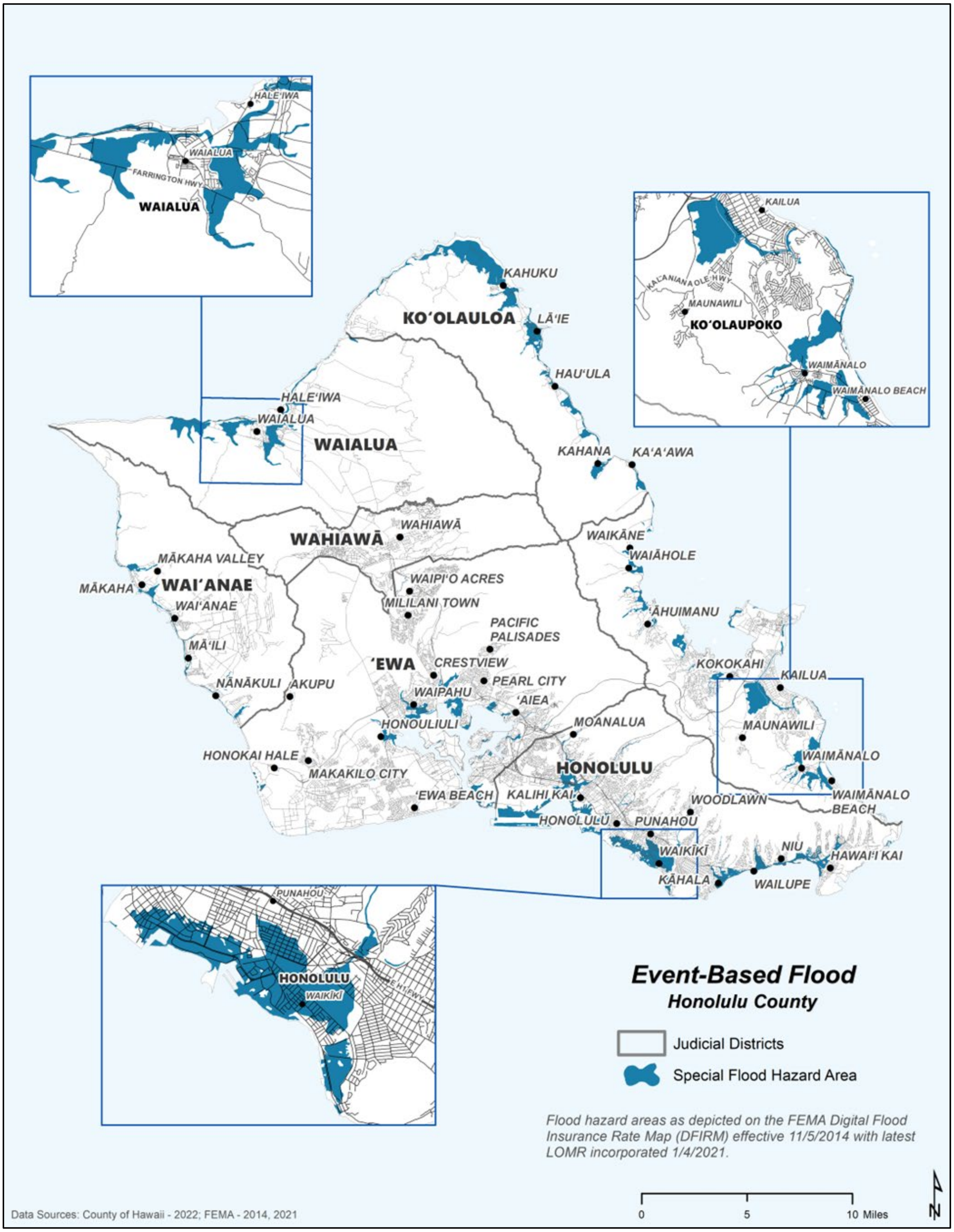


Figure 4.6-10. Special Flood Hazard Areas in the County of Maui

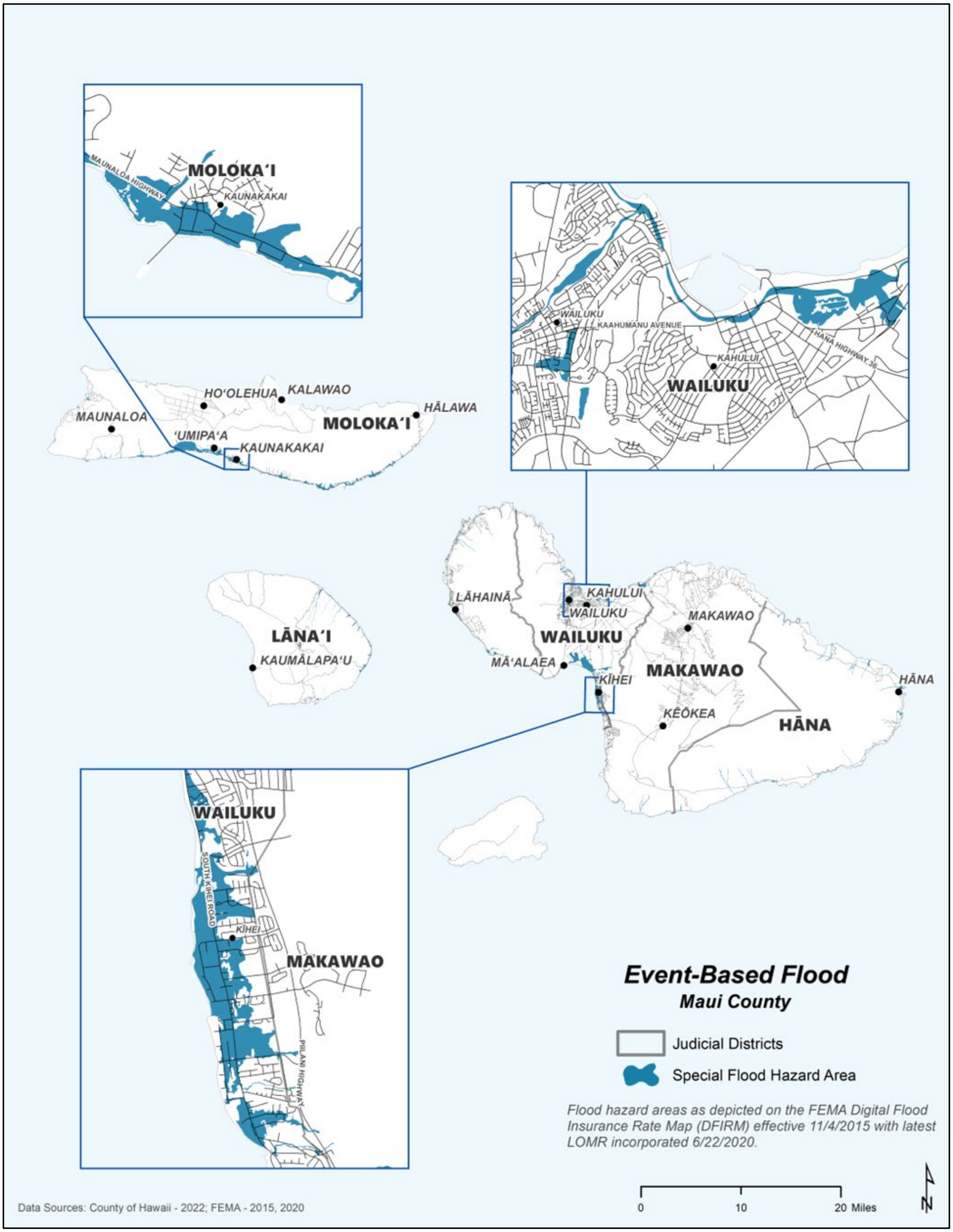


Figure 4.6-11. Special Flood Hazard Areas in the County of Hawai'i

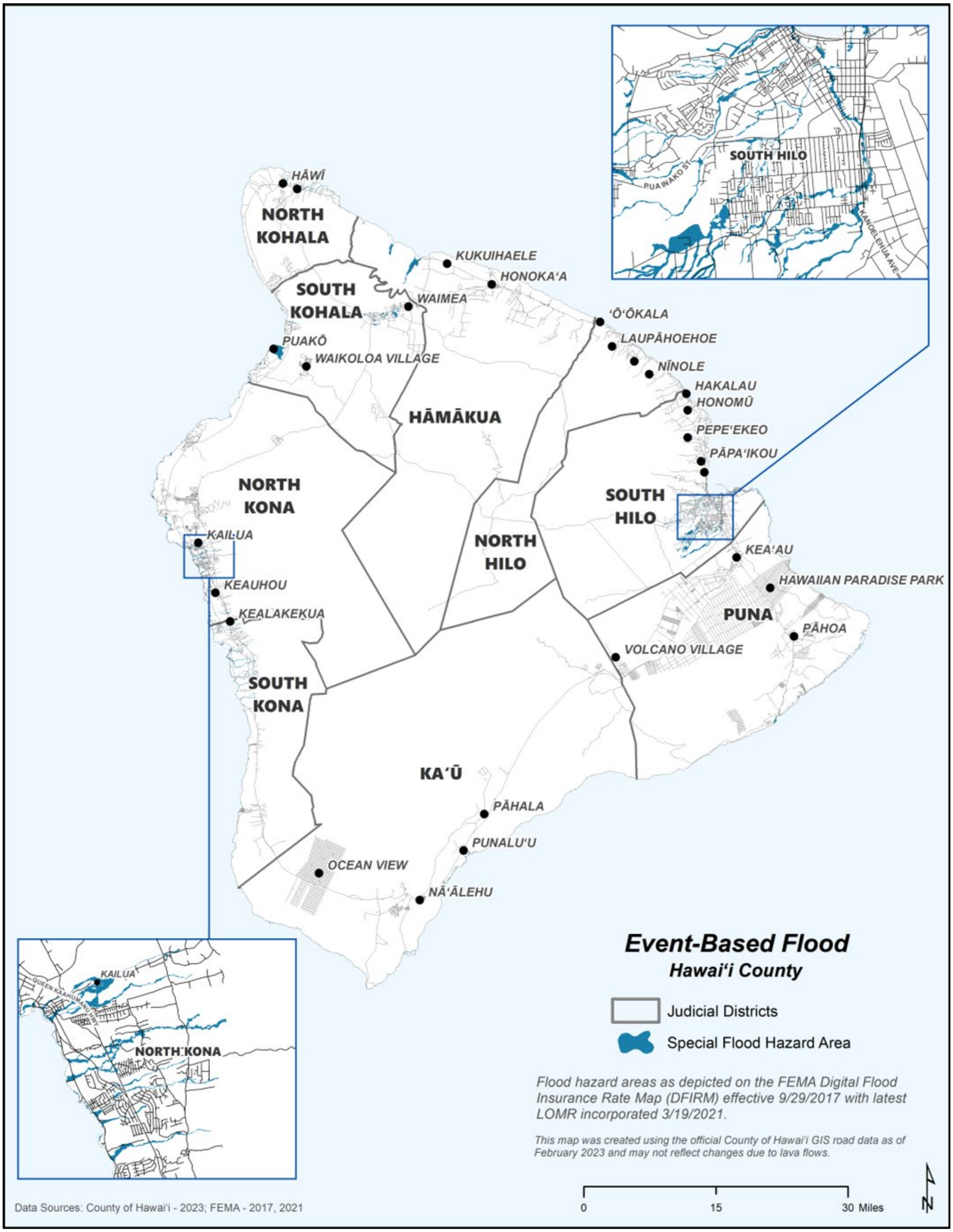


Table 4.6-2. Chronic Coastal Flood Hazard Area (SLR-XA-1.1) by County

County	Area		
	Total Area (square miles)	Chronic Coastal Flood Area (square miles)	Hazard Area as % of Total Area
County of Kaua'i	624.3	4.6	0.74%
City and County of Honolulu	598.6	5.7	0.95%
County of Maui	1,176.3	4.7	0.40%
County of Hawai'i	4,039.7	3.4	0.08%
Total	**6,438.8**	**18.4**	**0.29%**

Source: Hawai'i Climate Change Mitigation and Adaptation Commission 2017; Census Bureau 2021

EXTENT

Event-Based Flooding

The principal factors affecting flood damage are flood depth and velocity. The deeper and faster flood flows become, the more damage they can cause. Shallow flooding with high velocities can cause as much damage as deep flooding with slow velocity. The special flood hazard area on a community's FIRM is divided into different zones, generally referred to as A-zones and V-zones. These zones represent characteristics of flooding pertaining largely to depth and velocity.

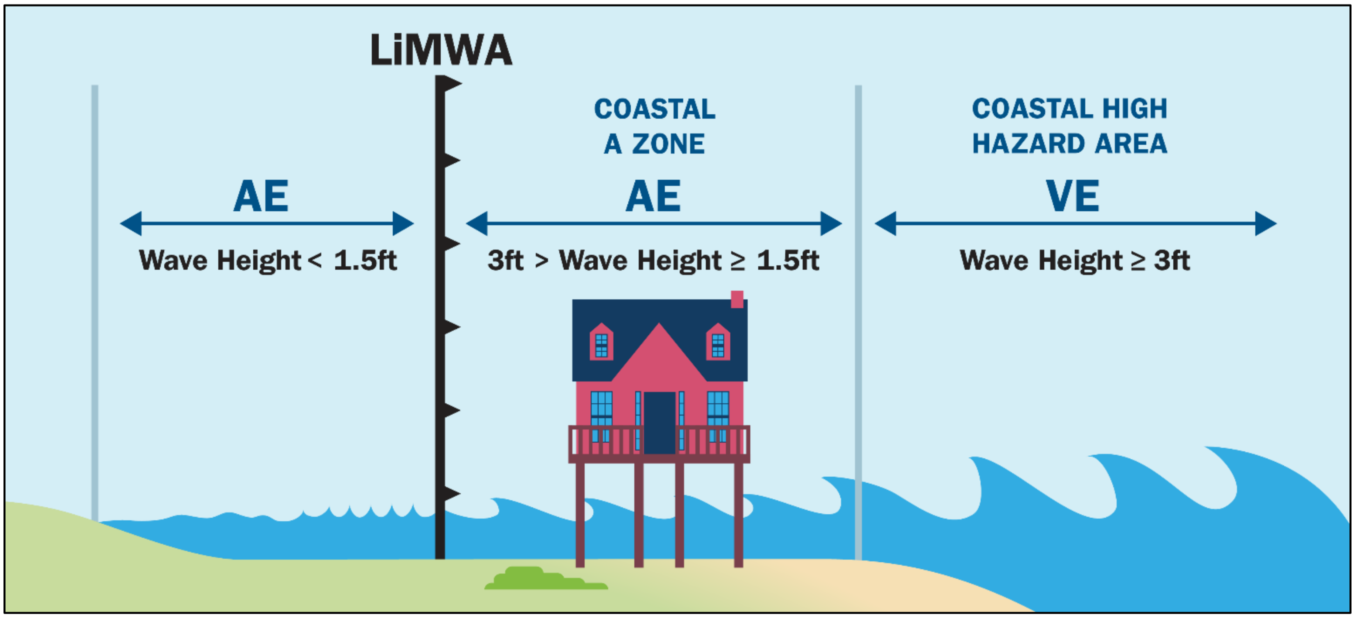
Event-Based Coastal Flooding

Flood severity from coastal flooding is generally determined by wave runup and setup. The degree of damage caused depends on the tidal cycle occurring at the time of the event. During high tides, water levels can be significantly higher than low tide and can inundate further inland causing more extensive damage. The area of impact of storm surge floods is confined to regions along the immediate coastlines and typically extends to a few hundred feet inland (National Hurricane Center n.d.).

On each county's FIRM, areas that have a 1% annual chance of experiencing wave heights of 3 feet or greater are shown as V-zones. These areas have been traditionally known as coastal high hazard areas, and there are stringent requirements in place to ensure that buildings constructed in these areas can withstand the velocities associated with this degree of wave action. Recent studies conducted after large-scale flood events, such as following Hurricane Katrina, have shown that wave heights as small as 1.5 feet can cause considerable damage to structures and other development. This means that V-zones depicted on FIRMs do not include all areas with a 1% annual chance of experiencing wave action velocities significant enough to cause serious structural damage. Some A-zones, commonly referred to as Coastal A-zones, may also be subject to these velocities. Requirements to withstand these wave impacts are not part of required building codes in the Coastal A-zones.

Because of this new information on structure vulnerability, FEMA now delineates an area known as the Limit of Moderate Wave Action (LiMWA) that can be shown on a FIRM when the FIS that provides the basis for the FIRM is updated. The LiMWA generally bisects an A-zone, which shows areas that have a 1% annual chance of flooding and less than 3 feet of expected wave heights. Areas seaward of the LiMWA may experience wave heights of 1.5 feet or greater. Areas landward of the LiMWA may still be flooded by ocean waves or other sources; however, the height of waves will be less than 1.5 feet in a 1% annual chance storm (see Figure 4.6-12). At the time of the 2023 SHMP Update, none of the county's FIRMs show the LiMWA (Department of Land and Natural Resources 2022).

Figure 4.6-12. Coastal Flooding on Flood Insurance Rate Maps



Source: (FEMA 2021)

Inland Flooding

Factors influencing inland flooding conditions include rainfall intensity and duration; rain shed area, topography and steepness, soil type, soil moisture before an event, and ground cover (National Weather Service n.d.). The frequency and severity of inland flooding that occurs along a stream or river is measured using a discharge probability, which is the probability that a certain discharge (flow) level will be equaled or exceeded in a given year. Flood studies use historical records to determine the probability of occurrence for the different discharge levels, which are then used to determine the extent of flooding. Inland flooding that has a 1% annual chance of exceedance is shown on FIRMs as A-zones. Because the county FIRMs do not show LiMWAs as described above, there is no simple way to differentiate between coastal and riverine A-zones besides making an educated guess based on location.

- **Minor Flooding**—minimal or no property damage, but possibly some public threat or inconvenience.
- **Moderate Flooding**—some inundation of structures and roads near streams. Some evacuations of people and/or transfer of property to higher elevations are necessary.
- **Major Flooding**—extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations (NOAA n.d.).

Prolonged rainfall may result in an accumulation of water, creating flooding conditions that last several days or even weeks. Alternatively, flooding can occur very quickly in instances of high rainfall intensity. When flooding emerges quickly over a matter of hours, it is known as flash flooding. Flash floods are characterized by rapid rise in water level, high velocity, large amounts of debris, and concentration in stream beds that are often normally small or even dry (National Weather Service n.d.).

Warning Time

It is unusual for a flood to occur without warning. Warning time for floods are typically between 24 and 48 hours. Flood warnings and watches are issued by the local National Weather Service (NWS) office. The NWS will update the watches and warnings and will notify the public when they are no longer in effect.

The NWS issues the following coastal flood advisories, warnings, and watches (National Weather Service n.d.):

- **Coastal Flood Advisory** is issued when minor or nuisance coastal flooding is occurring or imminent.
- **Coastal Flood Watch** is issued when moderate to major coastal flooding is possible. Such flooding could potentially pose a serious risk to life and property.
- **Coastal Flood Warning** is issued when moderate to major coastal flooding is occurring or imminent. This flooding will pose a serious risk to life and property.

The NWS issues the following inland flood advisories, watches, and warnings (National Weather Service n.d.):

- **Flood Watch**—A Flood Watch means heavy rain leading to flash flooding is possible. People in the area of a flash flood watch should be prepared for heavy rains and potential flooding. Flood Watches may be issued up to 48 hours before flash flooding is expected.
- **Flood Advisory**—A Flood Advisory means nuisance flooding is occurring or imminent. A Flood Advisory may be upgraded to a Flash Flood Warning if flooding worsens and poses a threat to life and property.
- **Flash Flood Watch**—A Flash Flood Watch means flash flooding is possible due to either 1) causes other than heavy rain (e.g., dam or levee failure), or 2) heavy rain on burn scars leading to the threat of flash flooding and debris flows.
- **Flash Flood Warning**—A Flash Flood Warning means that flooding is occurring or will develop quickly. If a Flash Flood Warning is issued for an area, the population needs to take shelter and/or move to high ground as necessary. Never drive or walk across a flooded roadway.

Duration of a flood event means the time between the start and end of the flood or the event that caused the flood. This can be difficult to define for floods, particularly inland floods, as they recede slowly and do not vanish completely; flood water moves from one area to another (M&E Studies n.d.). Additionally, the duration of a flood depends on the type of flood. Flash flooding occurs within six hours of a rain event, while other types of flooding are longer-term events and may last a week or more (National Weather Service n.d.).

Flood Control Structures

Flood control structures can significantly alter the extent of flooding in an area. Major flood control structures in the state include dams and levees. For details regarding dams, refer to Section 4.10 (Infrastructure Failure). The following provides information regarding levees located in the state.

Levees are usually earthen embankments or concrete floodwalls, which have been designed and constructed to contain, control, or divert the flow of water to reduce the risk of temporary flooding. Vertical concrete floodwalls may be erected in urban areas where there is insufficient land for an earthen levee. They are designed to provide a specific level of protection and can be overtopped in larger flood events. Levees require regular maintenance to retain their level of protection. Over time, levees decay and require maintenance. When levees fail or overtop, they can cause catastrophic impacts and lead to major flooding and impacts. Areas protected from flooding by levees certified to the 1% annual chance event are not located in SFHAs.

According to the U.S. Army Corps of Engineers (USACE), there are 28 levees in the state that are approximately 14 miles in total length (see Table 4.6-3). These 14 miles are located across the state with: 3.35 miles in the County of Hawaiʻi, 4.14 miles in the City and County of Honolulu, 2.7 miles in the County of Kauaʻi, and 4.14 miles in the County of Maui. Of the 28 levees, 22 have a risk rating of low and 6 are unknown. For more detailed information on these levees, please refer to the Flood Insurance Studies for each county.

Table 4.6-3. Levees in the State of Hawaiʻi

County	System Name (and Acronym)	Length (in miles)	Construction Date	Date of Last Assessment	Risk
Kauaʻi	Waimea River—RB, All Levees (WRR1)	1.44	January 1, 1950	March 15, 2017	Low
Kauaʻi	Hanapēpē Stream—RB Levee (HRRB)	0.85	January 11, 1966	April 18, 2017	Low
Kauaʻi	Hanapēpē Stream—LB Levee (HRLB)	0.41	January 11, 1966	April 18, 2017	Low
Honolulu	Fort Shafter Flats Flood Mitigation Project	0.31	2013	Not Screened	N/A
Honolulu	Waimalu Stream—NF Debris Basin and Channel (WSNB)	0.54	Unknown	Not Screened	N/A
Honolulu	Kalauao Stream—RB (NOKA)	0.2	April 12, 1966	Not Screened	N/A
Honolulu	Kuliʻouʻou Stream—RB & Channel (KIBR)	0.83	January 2, 1970	November 29, 2018	Low
Honolulu	Kuliʻouʻou Stream—LB & Channel (KIBL)	0.26	January 2, 1970	November 29, 2018	Low
Honolulu	Kawainui Marsh—6850 linear feet Levee, Floodwall and Oneawa Channel (KMFL)	1.5	January 8, 1966	October 27, 2016	Low
Honolulu	Kahawainui Stream—RB Levee (KSLR)	0.5	January 1, 1990	November 29, 2018	Low
Maui	ʻĪao Stream—Channel at Bottom and LB (ISAL)	0.28	January 10, 1981	May 3, 2018	Low
Maui	Kaunakakai Stream—RB Levee (KSRB)	0.21	January 1, 1950	November 21, 2017	Low
Maui	Kaunakakai Stream—LB Levee (KSUL)	0.72	January 1, 1950	November 21, 2017	Low
Maui	Kahoma Stream—RB, Channel and Levee (KORB)	0.09	January 4, 1990	June 20, 2017	Low
Maui	Kahoma Stream—LB, Channel and Levee (KOLB)	0.3	January 4, 1990	June 20, 2017	Low
Maui	ʻĪao Stream—Levee I, H, Channel at Bottom—LB (ISIL)	0.76	January 10, 1981	May 3, 2018	Low
Maui	ʻĪao Stream—Levee G, LB (ISLG)	0.27	January 10, 1981	November 9, 2017	Low
Maui	ʻĪao Stream—Levee F, LB (ISLF)	0.2	January 10, 1981	November 9, 2017	Low
Maui	ʻĪao Stream—Levee A, B, C, D, E, H, I, Channel and Revt X, RB (ISLE)	1.31	January 10, 1981	May 11, 2016	Low
Hawaiʻi	Keōpū Drainageway*	0.11	Unknown	Not Screened	N/A
Hawaiʻi	Wailoa Stream RB—Diversion Levee 1, 2, 3, 4 & Channel (WSRB)	0.99	January 8, 1965	June 20, 2017	Low
Hawaiʻi	Wailoa Stream LB (WALB)	0.23	January 8, 1965	February 28, 2018	Low
Hawaiʻi	Wailoa Stream—Diversion Levee LB 5 (WSL5)	0.07	January 8, 1965	July 31, 2018	Low
Hawaiʻi	Pāʻauʻau Stream—All (PALV)	0.4	January 10, 1984	December 18, 2017	Low
Hawaiʻi	Alenaio Stream LB—Levee, Floodwall C & Lined Channel (ASFC)	0.25	January 11, 1997	July 7, 2016	Low
Hawaiʻi	Alenaio Stream—Floodwall A, B—RB & Lined Channel (ASFA)	0.27	January 11, 1997	July 7, 2016	Low
Hawaiʻi	Kamuela Stream Levee	0.33	Unknown	Not Screened	N/A
Hawaiʻi	Lanimaumau	0.7	Unknown	Not Screened	N/A

Source: (U.S. Army Corps of Engineers n.d.)
Note:
The length, construction date, date of last assessment, and risk rating is for levee structure.
** Inactive levee*
LB Left Bank
RB Right Bank

Chronic Coastal Flooding

The severity of any flood depends upon the type, cause, duration, and existing conditions (i.e., drainage design and pathways for water to exit). Flooding from severe rain events coupled with high tide flooding increases the severity of chronic coastal flooding.

Warning Time

As defined, chronic coastal flooding includes a range of daily, monthly, and annual occurrences. Warning times for high wave and tide events are available as high surf advisories and high tide advisories.

The NWS Honolulu Forecast Office uses the criteria for the issuance of high surf advisories and warnings in coordination with civil defense agencies and water safety organizations in the State of Hawaiʻi (Table 4.6-4). Satellite observations, numerical forecasts, and offshore wave buoys help provide adequate warning to approaching high waves with damaging potential throughout the State of Hawaiʻi. The NWS Honolulu Forecast Office issues surf forecasts for the State of Hawaiʻi. Surf heights are forecast heights of the face, or front, of waves. It is based on the significant wave height, the average height of the one-third largest waves, at the locations of the largest breakers. Some waves may be more than twice as high as the significant wave height.

Table 4.6-4. High Surf Advisory/Warning Criteria

Location	Advisory	Warning
North-Facing Shores	15 feet	25 feet
West-Facing Shores - Island of Hawaiʻi	8 Feet	12 Feet
West-Facing Shores - Remaining Islands	12 Feet	20 Feet
South-Facing Shores	10 Feet	15 Feet
East-Facing Shores	10 Feet	15 Feet

Source: (National Weather Service 2021)
Note:
All surf height observations and forecasts are for the full-face surf height, from the trough to the crest of the wave.

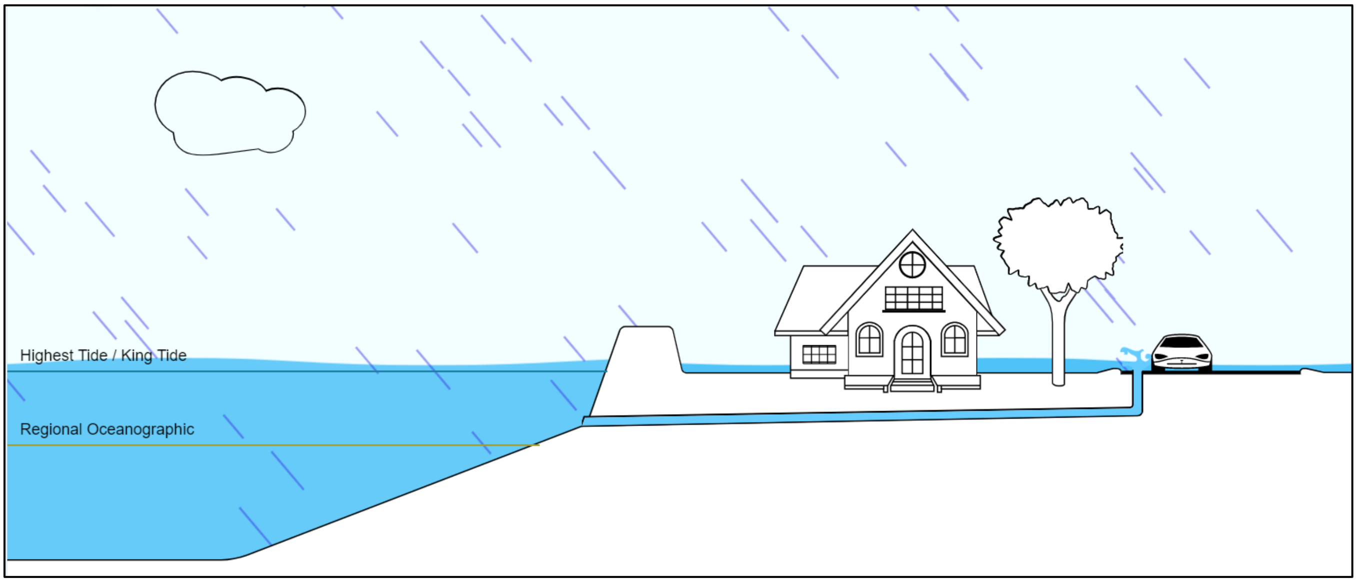
High tide flooding and king tides are fairly predictable due to their occurrence during new or full moons. The National Oceanic and Atmospheric Administration's (NOAA) tide predictions for the State of Hawaiʻi, are based on the astronomical tide calendar and takes into account the gravitational pull of the moon and sun on the Earth's oceans. Using this information helps provide predictions as to when high tide flooding and king tides may occur and impact low-lying and coastal areas. However, as shown in Figure 4.6-13, impacts from king tides may be compounded by additional high water levels, high waves, storms, and rainfall flooding, which may be predicted only days to a week prior to arrival (NOAA Office for Coastal Mangement 2022).

PREVIOUS OCCURRENCES AND LOSSES

Event-Based Flooding

Many sources provided flooding information regarding previous occurrences and losses associated with flooding events throughout the State of Hawaiʻi. The 2018 SHMP discussed specific flooding events that occurred in the State of Hawaiʻi through 2017. For this 2023 SHMP Update, event-based flood events were summarized between January 1, 2018, and December 31, 2022.

Figure 4.6-13. King Tide Compounded by Rainfall Flooding



Source: (NOAA Office for Coastal Mangement 2022)

Table 4.6-5 includes details of significant flooding events that occurred in the state between 2018 and 2022. These events do not include tropical storms or hurricanes that may also cause flooding; refer to Section 4.9 (Hurricane) for a listing of these events. Major events include those that resulted in losses or fatalities, as reported by the NOAA National Centers for Environmental Information (NCEI), events that resulted in the activation of the state and/or county Emergency Operations Center (EOC), and/or events that led to a FEMA disaster declaration. For events prior to 2018, please refer to Appendix E (Hazard Profile Supplement).

According to the NOAA NCEI storm events database, the State of Hawaiʻi experienced 96 flash flooding events and 654 heavy rain events that led to flooding between 2018 and 2022. These events caused two deaths and three injuries. Total property damage of $107.3 million and crop damage of $1.8 million were reported.

Disaster and Emergency Declarations

The following disaster declarations or emergency proclamations related to the event-based flood hazard have been issued for Hawaiʻi:

- **Federal disaster (DR) or emergency (EM) declarations, 1955–2022**: 20 events, classified as flooding, heavy rains, high surf, mudslides, landslides, or severe storms
- **Hawaiʻi state emergency Proclamations, 2018–2022**: 6 proclamations classified as flood
- **USDA agricultural disaster declarations, 2012–2022**: 2 events classified as flood

Table 4.6-6 lists the event-based flood events that have affected the State of Hawaiʻi and were declared a FEMA disaster between 2018 and 2022. This list does not include tropical storm or hurricane disaster declarations that may have resulted in flooding; refer to Section 4.9 (Hurricane) for a listing of these events. For details regarding all declared disasters to date, refer to Section 4.1 (Overview). Refer to Appendix D (Map Atlas), which illustrates the number of flood-related federally declared disasters by county since 1955.

Table 4.6-5. Significant Event-Based Flood Events in the State of Hawaiʻi, 2018 to 2022

Date(s) of Event	Event Type and Federal Disaster Declaration (if applicable)	Counties Affected	Description
January 26, 2018	Heavy Rain	Hawaiʻi	Two hikers on the Wailuku River were swept away as waters rose from the precipitation. The man was able to make it to the riverbank, but the woman could not be located and was presumed drowned.
February 18, 2018	Flash Flood, High Winds	Hawaiʻi	Flooding rain damaged a store in Honokaʻa, and a man was killed in Holualoa when the farm structure he was in blew off its foundation.
April 2018	DR-4365 Severe Storms, Flooding, Landslides, and Mudslides	Kauaʻi and Honolulu	Heavy rains and flooding caused damages and losses to areas in the City and County of Honolulu and the County of Kauaʻi. According to NOAA, a rain gauge on Kauai's North Shore recorded 49.69 inches of rain in 24 hours. In the County of Kauaʻi, heavy rain caused extensive damage to the slopes adjacent to Kūhiō Highway and impacted the communities of Wainiha and Hāʻena. Multiple landslides led to the closure of the road. Numerous road closures were reported in the impacted areas. Many homes were damaged or destroyed. American Red Cross conducted damage assessments and distributed clean-up kits to residents in Aina Haina, Niu Valley, Kuliʻouʻou, Waimānalo, and Kailua. In the County of Kauaʻi, the American Red Cross opened five shelters. Ten residents from Wainiha were airlifted to be taken to a shelter. Between April 13 and 19, the American Red Cross provided shelter to 110 individuals in the County of Kauaʻi. $19.8 million in damages were reported. Governor Ige declared the District of Hanalei in the County of Kauaʻi a disaster area. A federal disaster declaration was issued for Kauaʻi and Honolulu Counties. Funding obligations included nearly $1.6 million in Individual Assistance, $15.5 million in Public Assistance, and nearly 2.8 million in Hazard Mitigation Assistance.
November 3, 2018	Heavy Rain, Flash Flood	Hawaiʻi	Thirteen hikers were stranded by flash flooding near Waimea. Two suffered minor injuries.
November 16, 2019	Flash Flood, Thunderstorm Wind	Kauaʻi, Hawaiʻi	Flash flooding on Kauaʻi and Hawaiʻi. Kūhiō Highway was closed at Hanalei Bridge and became impassable at the Twin Bridges in Wainiha due to water overflowing the rivers. A woman was rescued by the Kauaʻi Fire Department after being swept away by the flood waters.
March 28, 2020	Heavy Rain, Flash Flood	Kauaʻi	Kūhiō Highway was closed in two locations: near the Hanalei Bridge when the river overflowed its banks and in Wailua as debris piled up against the Wailua River Bridge. Homes and businesses sustained $30.6 million in reported damages.
February 18, 2021	Heavy Rain	Kauaʻi, Honolulu, Maui, Hawaiʻi	Downpours over East Maui contributed to the death of a 26-year-old woman who was swept out to sea when Waioka Pond near Hāna became swollen by waters coming down the slope from near the Haleakala summit.
February 26, 2021	Heavy Rain	Honolulu, Maui, Hawaiʻi	Heavy rain cause ponding on roadways and small stream and drainage ditch flooding. Two hikers in East Maui were killed after being swept out to the ocean by a surging stream.
March 8-9, 2021	DR-4604 Severe Storms, Flooding, and Landslides	Kauaʻi, Honolulu, Maui	Heavy showers and thunderstorms caused flash flooding that washed out bridges and roads; more than 100 homes were damaged or destroyed. The Hāna Highway in East Maui was closed, and water topped a dam in the same area, but no dam failure occurred. Kamehameha Highway and other roads in Honolulu County were flooded. Kūhiō Highway was closed near the Hanalei Bridge in Kauaʻi, and the Keapana Bridge in Kapaʻa became impassible. $47.1 million in structure damage and $1.8 in crop damage was reported. A federal disaster declaration was issued for Maui County, with nearly $6 in Public Assistance grants obligated.

Date(s) of Event	Event Type and Federal Disaster Declaration (if applicable)	Counties Affected	Description
May 1, 2022	Heavy Rain, Thunderstorms, Flash Flood	Maui, Hawaiʻi	A flash flood occurred on Maui between mile markers 31 and 39 along Piʻilani Highway. A culvert was washed out. Additional stream and ditch flooding and ponding on roadways occurred in other parts of Maui and Hawaiʻi Counties. $1.2 million in damages were reported.

Source: (FEMA 2022, NOAA 2022)
Notes:
With flood documentation for the State of Hawaiʻi being so extensive, not all sources have been identified or researched. Additionally, loss and impact information for many events could vary depending on the source. Therefore, this table may not include all events that have occurred in the state and the accuracy of monetary figures discussed is based only on the available information identified during research for this 2023 SHMP Update.
The State of Hawaiʻi did experience flooding as a result of Hurricane Hector 2018, Hurricane Lane 2018 (DR-4194), Tropical Storm Olivia 2018, Tropical Storm Erick 2019, Hurricane Douglas 2020, and Hurricane Linda 2021. Flooding from hurricanes is discussed further in Section 4.9 (Hurricane).

Table 4.6-6. Flood-Related Federal Declarations (2018 to 2022)

Year	Event Type	Date Declared	Federal Designation	Counties Affected
2018	Severe Storms, Flooding, Landslides, and Mudslides	May 8, 2018	DR-4364	Honolulu and Kauaʻi
2021	Severe Storms, Flooding, and Landslides	May 13, 2021	DR-4604	Maui

Source: (FEMA 2022)
Note:
Hurricane Lane 2018 (DR-4194), is in Section 4.9 (Hurricane).

Repetitive Loss Properties

Properties that are located within the SFHA and have federally backed mortgages or were constructed using federal or federally-related financial assistance are required to purchase flood insurance. When an insured property is damaged by flooding, they typically file a claim. If the insured property has had at least two paid flood losses of more than $1,000 each in any 10-year period since 1978, they are referred to as a Repetitive Loss (RL) property (FEMA 2020). An insured property is known as a Severe Repetitive Loss (SRL) property if: (1) the insured property has had four or more paid flood losses of $5,000 (amount of each claim) and a total amount of claims payments of $20,000; or (2) the insured property has had at least two separate claims that have been paid with the cumulative amount of claim payments exceeding the market value of the building (FEMA 2020).

Chronic Coastal Flooding

The 2018 SHMP discussed specific coastal erosion and high wave flooding events that occurred in the State of Hawaiʻi through 2017. For this 2023 SHMP Update, high wave flooding, coastal erosion, and tidal flooding/king tides were summarized between January 1, 2018, and December 31, 2022. For events prior to 2018, please refer to Appendix E (Hazard Profile Supplement). Table 4.6-7 includes details regarding significant chronic coastal flooding that occurred in the state between 2018 and 2022. Major events include those that resulted in losses or fatalities, as reported by NOAA NCEI, events that resulted in the activation of the state or county EOC, and events that led to a FEMA disaster declaration.

Table 4.6-7. Significant Chronic Coastal Flooding Events in Hawaiʻi, 2018 to 2022

Date(s) of Event	Event Type	Counties Affected	Description
March 21-22, 2018	High Surf	Kauaʻi, Honolulu, Maui, Hawaiʻi	Both lanes of Bayfront Highway in Hawaiʻi County were shut down because of water and debris washing ashore, and county parks were closed from Coconut Island eastward through Keaukaha as water was coming into the parking areas.
June 4-6, 2018	High Surf	Kauaʻi, Honolulu, Maui, Hawaiʻi	A swell from the Southern Hemisphere generated surf of 6 to 12 feet along the south-facing shores on all the islands. Two 21-year-old women on Oʻahu required hospitalization for arm and leg injuries.
January 27-31, 2019	High Surf	Kauaʻi, Honolulu, Maui, Hawaiʻi	High surf of 8–15 feet was recorded along east-facing shores. Bayfront Highway on Hawaiʻi Island was closed because of debris and water on the roadway from the high surf.
December 7-8, 2019	High Surf	Kauaʻi, Honolulu, Maui, Hawaiʻi	The high surf caused an overwash along Bayfront Highway on Hawaiʻi Island, leaving debris on the roadway. A foot of standing water was observed on Coconut Island in Hilo.
December 1-3, 2020	High Surf, Erosion	Kauaʻi, Honolulu, Maui	A large swell from the northwest generated surf of 20 to 30 feet, with sets to 40 feet. Ocean safety personnel performed many rescues and issued warnings to surfers and beachgoers because of the dangerous surf conditions. Significant erosion was reported at Sunset Beach on Oʻahu's North Shore due to the elevated surf.
October 8-11, 2021	High Surf	Kauaʻi, Honolulu, Maui, Hawaiʻi	The combination of a trade wind swell and a swell from the Southern Hemisphere generated surf of 6–12 feet along the east- and south-facing shores of all the islands. A 24-year-old man was swept off a rocky ledge by large waves in East Oʻahu. He was presumed drowned as the search ended after three days without success.
January 21-24, 2022	High Surf	Kauaʻi, Honolulu, Maui, Hawaiʻi	A large northwest swell generated surf of 15–25 feet, with occasional sets above 30 feet. Three individuals were injured, one critically, in the rough surf.
February 25-27, 2022	High Surf, Erosion	Kauaʻi, Honolulu, Maui, Hawaiʻi	A large swell from the west-northwest generated surf of 20–30 feet, with occasional sets to 40 feet. Beach erosion caused by many episodes of high surf over the years undercut a home which collapsed on Oʻahu's North Shore between Rocky Point and Sunset Beach. Damages of $115,000 were reported.
July 13-19, 2022	High Surf	Kauaʻi, Honolulu, Maui, Hawaiʻi	A large, long-period swell from the Southern Hemisphere generated surf of 10–20 feet along the south-facing shores of all the Hawaiian Islands. Hoʻone Road in Poipu on the island of Kauai was temporarily closed after sustained damage from the high surf. $7,000 in property damages were recorded.

Source: (NOAA 2022)

With flood documentation for the State of Hawaiʻi being extensive, not all sources have been identified or researched. Additionally, loss and impact information for many events could vary depending on the source. Therefore, Table 4.6-7 may not include all events that have occurred in the state and the accuracy of monetary figures discussed is based only on the available information identified during research for this 2023 SHMP Update.

According to the NOAA NCEI storm events database, the State of Hawaiʻi experienced 1,889 chronic coastal flooding events between 2018 and 2022. These events caused one death and five injuries. Total property damage of $122,000 was reported.

Disaster and Emergency Declarations

The following disaster declarations or emergency proclamations related to the chronic coastal flood hazard have been issued for Hawaiʻi:

- **Federal disaster (DR) or emergency (EM) declarations, 1955 – 2022**: 5 events, classified as severe storms, high wave flooding, flooding, heavy rains, and land/mudslides
- **Hawaiʻi state emergency Proclamations, 2018 – 2022**: none
- **USDA agricultural disaster declarations, 2012 – 2022**: none

During the 2018 SHMP Update performance period, the state has not had any declared disasters or emergencies related to the chronic coastal flood hazard. For details regarding all declared disasters, refer to Section 4.1 (Overview) and Appendix D (Map Atlas).

Probability of Future Hazard Events

Event-Based Flooding

Overall Probability

Flooding is common in the State of Hawaiʻi and can take place any time of the year; however, flooding is more frequent during the rainy season which runs from October through April. Based on the history of flood events and the evidence of climate change and sea level rise, flood events may become more frequent throughout the State of Hawaiʻi.

The recurrence interval of a flood, or flood frequency, is the average number of years between floods of a certain size. The actual number of years between floods of any given size varies because of the natural variations in climate and weather events (U.S. Geological Survey 2018). As discussed previously, FIRM maps identify a flood hazard area as the area that would be inundated by a flood with a 1% chance of occurring annually (FEMA 2021). These measurements reflect statistical averages only; it is possible for two or more floods with a 1% annual or greater chance to occur in a short time period. Table 4.6-8 describes the recurrence intervals and probabilities of occurrence for flood events.

Table 4.6-8. Recurrence Intervals and Probabilities of Occurrence

Recurrence Interval (in years)	Probability of Occurrence in Any Given Year	Percent Chance of Occurrence in Any Given Year
100	1 in 100	1%
50	1 in 50	2%
25	1 in 25	4%
10	1 in 10	10%
5	1 in 5	20%
2	1 in 2	50%

Source: (U.S. Geological Survey n.d.)

For the 2023 SHMP Update, the most up-to-date information was collected to calculate the probability of future occurrence of event-based flood events, of all magnitudes, in the State of Hawaiʻi. Information from FEMA and NOAA NCEI were used to identify the number of event-based flood events that occurred between 2018 and 2022. Using these resources ensures the most accurate probability estimates possible. Based on these historic statistics, the State of Hawaiʻi has a 100% chance of an event-based flood, of any magnitude, occurring any given year and can experience approximately 19 event-based flood events and 131 heavy rain events that lead to flooding each year. The state has a 40% chance (or two declarations every five years) of receiving a FEMA declaration for event-based floods in any given year. However, some areas in the state are more flood prone than others, and the frequency and size of flood events varies.

Climate Change Impacts

Climate projections for the State of Hawaiʻi indicate an overall decline in rainfall; however, the state will experience an increase in heavy rain events, causing more frequent or intense flash flooding, infrastructure damage, runoff, and sedimentation. Sea level is also projected to rise, increasing the risk of coastal flooding from hurricanes and tropical storms. Event-based coastal flooding with sea level rise would increase the extent of the area subject to flooding from storm events where streams and rivers empty into the ocean. Beach and wetland systems may not be able to adapt to rising sea levels and could be lost if not able to migrate inland. Their loss reduces the coast's ability to buffer impacts from storms and flooding (U.S. Environmental Protection Agency 2016). Overall, it is highly likely that changing future conditions will exacerbate current conditions and increase future event-based flood risk for inland and coastal areas statewide.

For additional information on impacts resulting from climate change and sea level, refer to Section 4.2 (Climate Change and Sea Level Rise) and Section 4.9 (Hurricane).

Chronic Coastal Flood

Overall Probability

Over time, recurring flooding at the highest tides in low-lying areas leads to chronic flooding and then to permanent flooding and permanent loss. Overall, the probability of future chronic coastal flooding will increase with increasing sea level rise and punctuated by severe flood events that will be clustered in time around high tides and/or periods of elevated water levels.

Chronic beach erosion leads to shoreline erosion and loss of shorefront property, resulting in loss of natural protection from coastal flooding and inundation. Coastal erosion will increase with increasing sea level rise in coming decades which will contribute to permanent loss and submergence of coastal lands. Shoreline recession and beach loss due to coastal erosion is already a severe problem along the State of Hawaii's coastline, threatening shorefront development and infrastructure. Statewide, 70% of the State of Hawaii's shorelines have retreated over years to decades (Anderson, et al. 2018). The frequency of episodic erosion events is related to the return period of a coastal storm, hurricane or tropical storm. However, the impacts of episodic erosion events will increase with climate change and sea level rise.

High wave flooding events occur frequently on exposed coasts of all islands in the State of Hawaiʻi. Events that actually cause damage to property or loss of human life are far less common. During the time period from January 1, 2018, to December 31, 2022, high surf conditions and impacts occurred annually in the State of Hawaiʻi. Based on the history of high wave flooding in the state, the State of Hawaiʻi can expect high wave flooding events on an ongoing basis, with increasing impacts from climate change and sea level rise.

The probability of tidal flooding/king tides is predictable based on lunar cycles. However, impacts from king tide events depend on wave conditions, weather, and any additional water level anomalies. Low-lying areas in the State of Hawaiʻi have the highest probability of experiencing regular flooding from tides and king tides. As the sea level rises, these areas will become more vulnerable to regular flooding at high tides. The greatest potential for flooding from king tides alone is predictable and occurs in summer and winter months around new and full moons when the moon is at its closest point to the Earth (University of Hawaiʻi Sea Grant College Program 2018).

Climate Change Impacts

The frequency, extent and severity of chronic coastal flooding will increase with sea level rise. Sea level rise of 3 feet or more by the end of this century appears increasingly likely (National Oceanic and Atmospheric Administration 2022). For the 2023 SHMP Update, mid- to late-century sea level rise on chronic coastal flooding was assessed using the SLR-XA with 3.2 feet of sea level rise (SLR-XA-3.2). Statewide impacts are discussed further in Section 4.2 (Climate Change and Sea Level Rise). Overall, the loss of land and structures will take the form of incrementally eroding beaches, waterfront property inundated by increasingly high tides and by seasonal waves that reach farther inland, and low-lying areas becoming wetlands because of rising water tables and reduced drainage. However, these chronic processes will be punctuated by less frequent but more severe events such as storms, extreme high wave events, or high water level events. The estimated total amount of land loss is less than 1% of the state's total land area; however, much of this land is located in high-density urban, commercial, and industrial districts leading to great potential economic, societal, and environmental impacts for the state (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017).

4.6.2 VULNERABILITY ASSESSMENT

Event-Base Flooding

To assess the state's risk to the event-based flood hazard, a spatial analysis was conducted using the best available spatially-delineated flood hazard areas. To determine exposure, the hazard areas were overlaid with the assets to determine the total number and replacement cost value located in the hazard areas. If the asset is in the hazard area, it is deemed exposed to the hazard and potentially vulnerable to loss. FEMA's Hazus flood model was used to estimate potential losses to structures from event-based flooding by looking at the depth of flooding at each structure location.

EVENT-BASED FLOOD HAZARD AREA DEFINITION

Special Flood Hazard Area (SFHA)—The 1% annual chance flood as depicted on the FEMA Flood Insurance Rate Maps (inclusive of V- and A-zones).

Exposure represents assets located in the SFHA.

Estimated potential losses are calculated for the 1% annual chance flood event for assets located in the SFHA.

To evaluate vulnerability to event-based flooding, the SFHA was used. Estimated 1% annual chance flood depth grids were generated utilizing 3D Analyst tools in ArcGIS for A-zones and V-zones. The depth grids were integrated into Hazus version 5.1, and the flood model was run to estimate potential losses to state buildings and critical facilities as user-defined facilities and the default general building stock in Hazus.

According to DLNR, the flood maps need to be updated due to new development. In addition, there are large sections in the City and County of Honolulu and the County of Hawaiʻi that have not been studied. Therefore, the estimated results below may be underestimating vulnerability.

As discussed previously, structures located in coastal high hazard areas (V-zones) are at considerable risk of structural damage due to wave action velocities. In order to highlight this added degree of risk, as well as the additional construction requirements in these areas, exposure and vulnerability estimates presented in the following sections show both V-zone risks and the combined risk (A-zone and V-zone) for the special flood hazard area.

When interpreting the information presented, it is important to remember that the entire state is unlikely to experience impacts from a 1% annual chance flood event in all SFHAs at the same time.

Chronic Coastal Flooding

Chronic Coastal Flood Hazard Area Definition

SLR-XA 1.1—To assess vulnerability to chronic coastal flooding the area generated by modeling of passive flooding, annual high wave flooding and coastal erosion (known as the SLR-XA) with 1.1 feet of sea level rise was used. The hazard area is called SLR-XA-1.1.

To assess the state's risk to the chronic coastal flood hazard, the SLR-XA-1. 1, developed for the *Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report,* was used. Overall, vulnerability to chronic coastal flooding is assessed as chronic flooding with the potential permanent loss of assets and displacement of population located in the SLR-XA-1.1 hazard area.

Assessment of State Vulnerability and Potential Losses

Event-Based Flooding

This section discusses statewide vulnerability of areas susceptible to event-based flooding and potential losses to state assets (state buildings and state roads) and critical facilities.

State Assets

The exposure analysis for the event-based flooding hazard determined there are 489 state buildings (8.02%) located in the SFHA, of which 97 are located in the V-zone. As noted earlier, buildings located in the V-zone are at considerable risk of structural damage due to wave velocity. The City and County of Honolulu has the greatest total replacement cost value exposed to the SFHA ($635.8 million). The Department of Education has the greatest total replacement cost value exposed ($478.5 million). Table 4.6-9 summarizes the state buildings located in the SFHA by county. Table 4.6-10 summarizes state buildings' exposure and potential loss to event-based flooding by agency.

Table 4.6-9. State Buildings Located in the Special Flood Hazard Area by County

County	State Buildings in the SFHA (A- and V-Zones)		State Buildings in the V-Zone	
	Number	Total Replacement Cost Value	Number	Total Replacement Cost Value
County of Kaua'i	82	$126,300,316	2	$117,931
City and County of Honolulu	320	$635,827,829	69	$32,866,631
County of Maui	50	$160,108,533	18	$34,915,727
County of Hawai'i	37	$43,844,062	8	$3,931,360
Total	**489**	**$966,080,739**	**97**	**$71,831,649**

Source: FEMA Map Service Center 2021[a]; State of Hawaii Risk Management Office 2017
Note:
a. National Flood Hazard Layer DFIRM data obtained from the FEMA Map Service Center, effective February 26, 2021 with latest Letter of Map Amendment January 4, 2021

Table 4.6-10. State Buildings Exposure and Potential Loss to the 1% Annual Chance Flood Event by Agency

Agency	Total Number of State Buildings	Total Replacement Cost Value	State Buildings Located in the SFHA				Potential Loss to the 1% Annual Chance Flood Event	
			Number	Percent (%) of Total Buildings	Replacement Cost Value	Percent (%) of Total Value	Estimated Potential Loss	Percent (%) of Total
Dept of Accounting & General Services	66	$953,963,738	6	9.09%	$50,683,417	5.31%	$1,292,066	0.1%
Dept of Agriculture	70	$147,607,399	5	7.14%	$5,736,536	3.89%	$11,771	0.0%
Dept of Attorney General	15	$108,425,480	1	6.67%	$2,254,706	2.08%	$0	0.0%
Dept of Budget & Finance	16	$28,968,679	1	6.25%	$138,422	0.48%	$0	0.0%
Dept of Business, Economic Development and Tourism	25	$645,480,379	2	8.00%	$26,786,125	4.15%	$8,787,528	1.4%
Dept of Commerce & Consumer Affairs	2	$40,197,360	0	0.00%	$0	0.00%	$0	0.0%
Dept of Defense	69	$267,352,836	17	24.64%	$70,600,137	26.41%	$24,722,355	9.2%
Dept of Education	4,090	$10,598,205,739	266	6.50%	$478,499,519	4.51%	$22,966,821	0.2%
Dept of Hawaiian Home Lands	12	$110,427,352	1	8.33%	$5,489,080	4.97%	$2,505,204	2.3%
Dept of Health	44	$387,068,440	1	2.27%	$429,251	0.11%	$60,274	0.0%
Dept of Human Resources Development	1	$5,973,872	0	0.00%	$0	0.00%	$0	0.0%
Dept of Human Services	130	$480,212,294	8	6.15%	$11,373,036	2.37%	$2,047,882	0.4%
Dept of Labor and Industrial Relations	22	$90,076,209	2	9.09%	$2,600,740	2.89%	$0	0.0%
Dept of Land and Natural Resources	90	$101,441,821	28	31.11%	$13,847,149	13.65%	$1,224,374	1.2%
Dept of Public Safety	154	$440,774,415	14	9.09%	$33,728,750	7.65%	$3,431,909	0.8%
Dept of Taxation	1	$7,174,162	0	0.00%	$0	0.00%	$0	0.0%
Dept of Transportation	68	$2,935,208,214	25	36.76%	$93,067,111	3.17%	$1,197,404	0.0%
Hawai'i State Ethics Commission	1	$984,533	0	0.00%	$0	0.00%	$0	0.0%

Agency	Total Number of State Buildings	Total Replacement Cost Value	State Buildings Located in the SFHA				Potential Loss to the 1% Annual Chance Flood Event	
			Number	Percent (%) of Total Buildings	Replacement Cost Value	Percent (%) of Total Value	Estimated Potential Loss	Percent (%) of Total
Hawaiʻi Health Systems Corporation	106	$1,230,852,871	1	0.94%	$936,734	0.08%	$0	0.0%
Hawaiʻi Housing Finance & Development Corporation	86	$360,851,671	1	1.16%	$39,460,800	10.94%	$6,031,270	1.7%
Hawaiʻi Public Housing Authority	273	$982,981,701	42	15.38%	$53,507,728	5.44%	$1,445,595	0.1%
Hawaiʻi State Legislature	2	$48,555,381	0	0.00%	$0	0.00%	$0	0.0%
Hawaiʻi State Public Library System	53	$525,584,082	8	15.09%	$15,206,807	2.89%	$1,637,290	0.3%
Judiciary	41	$534,877,354	1	2.44%	$2,284,530	0.43%	$0	0.0%
Legislative Reference Bureau	1	$2,996,162	0	0.00%	$0	0.00%	$0	0.0%
Office of Hawaiian Affairs	11	$54,125,645	5	45.45%	$17,170,287	31.72%	$3,120,281	5.8%
Office of the Auditor	2	$1,921,180	0	0.00%	$0	0.00%	$0	0.0%
Office of the Governor	1	$2,996,162	0	0.00%	$0	0.00%	$0	0.0%
Office of the Lieutenant Governor	2	$4,588,849	0	0.00%	$0	0.00%	$0	0.0%
Office of the Ombudsman	1	$1,818,060	0	0.00%	$0	0.00%	$0	0.0%
Research Corporation of the University of Hawai'i	3	$4,189,026	1	33.33%	$463,328	11.06%	$171,583	4.1%
University of Hawai'i	637	$5,014,974,503	53	8.32%	$41,816,547	0.83%	$7,242,144	0.1%
Total	**6,095**	**$26,120,855,568**	**489**	**8.02%**	**$966,080,739**	**3.70%**	**$87,895,751**	**0.3%**

Source: FEMA Map Service Center 2021[a]; State of Hawaii Risk Management Office 2017; FEMA Hazus v5.1
Note:
a. National Flood Hazard Layer DFIRM data obtained from the FEMA Map Service Center, effective February 26, 2021 with latest Letter of Map Amendment January 4, 2021

Hazus estimates $87.9 million in damages to state buildings as a result of the 1% annual chance flood. This does not include the cost of damage to roads or utilities, which could be considerable. The City and County of Honolulu is estimated to experience the greatest loss ($78 million, or 0.5% of the county's total building replacement cost value), with more than $8 million of the total loss located in the V-zone. Table 4.6-11. The Department of Education and the Department of Defense occupy buildings with the greatest potential loss, nearly $23 billion and $24.7 billion in damages, respectively which equate to more than half of the state building estimated loss.

Statewide, there are 85.5 miles of state roads exposed to event-based flooding. There is a major public safety hazard when residents attempt to drive on flooded roadways. Many state roads serve as evacuation routes to higher ground. Not only will these roads be closed during a flood event and potentially isolate communities, the flood waters may accelerate the degradation of these roads, leading to increased repair and replacement costs. Bridges exposed to flood events can be extremely vulnerable due to the forces transmitted by the velocity and by the impact of debris carried by the water.

Table 4.6-11. State Building Estimated Potential Loss to the 1% Annual Chance Flood Event by County

County	Total Replacement Cost Value	Estimated Potential Loss to the 1% Annual Chance Flood Event (A- and V-Zones)		Estimated Potential Loss in the V-Zone Only	
		Replacement Cost Value	Percent (%) of Total	Replacement Cost Value	Percent (%) of Total
County of Kaua'i	$990,850,824	$8,512,936	0.9%	$17,290	0.0%
City and County of Honolulu	$17,393,945,915	$78,383,895	0.5%	$8,214,065	0.0%
County of Maui	$3,097,491,689	$0	0.0%	$0	0.0%
County of Hawai'i	$4,638,567,141	$998,920	0.0%	$221	0.0%
Total	**$26,120,855,568**	**$87,895,751**	**0.3%**	**$8,231,575**	**0.0%**

Source: FEMA Map Service Center 2021[a]; State of Hawaii Risk Management Office 2017; FEMA Hazus v5.1
Note:
a. National Flood Hazard Layer DFIRM data obtained from the FEMA Map Service Center, effective February 26, 2021 with latest Letter of Map Amendment January 4, 2021

Table 4.6-12 shows the length of state roads in the SFHA by county. The City and County of Honolulu has the greatest number of miles (44.9 miles) exposed, followed by the County of Maui (20.7 miles). A complete list of state roads, located in the A- and V-zones, and by individual road name, is included in Appendix F (State Profile and Risk Assessment Supplement).

Table 4.6-12. State Road Exposure to the 1% Annual Chance Flood Event by County

County	Length (in miles)		
	Total Length	Length in the SFHA	Percent (%) of Total Length
County of Kaua'i	103.7	15.5	14.95%
City and County of Honolulu	374.9	44.9	11.98%
County of Maui	245.9	20.7	8.42%
County of Hawai'i	379.2	4.4	1.16%
Total	**1,103.70**	**85.5**	**7.75%**

Source: State of Hawaii Department of Transportation 2022; FEMA Map Service Center 2021[a]
Note:
a. *National Flood Hazard Layer DFIRM data obtained from the FEMA Map Service Center, effective February 26, 2021 with latest Letter of Map Amendment January 4, 2021*

Community Lifelines and Critical Facilities

Critical transportation hubs and critical infrastructure located are exposed to the event-based flood hazard. Utility lines commonly follow roads, and those located underground may be impacted, resulting in disruption of services. Table 4.6-13 summarizes the total number of community lifelines and additional critical facilities by category located in the SFHA by county. The City and County of Honolulu has the greatest number of community lifelines (68) exposed, followed by the County of Maui (42). Table 4.6-14 summarizes the community lifeline and critical facility exposure and potential losses by category. Safety and security has the greatest estimated potential loss at $3.87 billion, followed by food, water, and shelter with greater than $1.87 billion.

Table 4.6-13. Community Lifelines and Critical Facilities Located in the 1% Annual Chance Flood Event, by County

County	Community Lifeline Categories								Additional Critical Facilities
	Communications	Energy	Food, Water, Shelter	Hazardous Material	Health & Medial	Safety & Security	Transportation	Total in the 1% Annual Chance Flood Event	
County of Kaua'i	2	1	7	0	0	8	0	18	2
City and County of Honolulu	12	14	20	0	2	15	2	65	3
County of Maui	2	1	17	0	4	8	8	40	2
County of Hawai'i	0	2	13	1	0	1	5	22	1
Total	**16**	**18**	**57**	**1**	**6**	**32**	**15**	**145**	**8**

Source: Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020; Hawai'i Climate Change Mitigation and Adaptation Commission 2017

Table 4.6-14. Community Lifeline and Critical Facility Exposure and Potential Losses to the 1% Annual Chance Flood Event, by Category

Category	Total Number of Facilities by Category	Total Replacement Cost Value of Facilities by Category	Community Lifelines and Critical Facilities Located in the SFHA				Estimated Potential Loss to the 1% Annual Chance Flood Event (A- and V-Zones)	
			Number of Facilities	Percent (%) of Total Facilities	Replacement Cost Value	Percent (%) of Total Value	Replacement Cost Value	Percent (%) of Total
Communications	188	$776,797,683	16	8.51%	$51,867,477	6.68%	$9,174,631	1.2%
Energy	89	$3,093,949,530	18	20.22%	$633,568,650	20.48%	$63,540,298	2.1%
Food, Water, Shelter	345	$11,847,189,588	57	16.52%	$1,874,147,290	15.82%	$269,439,273	2.3%
Hazardous Material	12	$436,474,800	1	8.33%	$36,294,000	8.32%	$187,845	0.0%
Health and Medical	193	$4,606,713,364	6	3.11%	$148,607,658	3.23%	$3,296,056	0.1%
Safety and Security	486	$38,164,188,232	32	6.58%	$3,872,254,354	10.15%	$44,666,514	0.1%
Transportation	56	$2,039,091,600	15	26.79%	$546,303,600	26.79%	$47,815,784	2.3%
Additional Critical Facilities	106	$447,698,794	8	7.55%	$27,907,140	6.23%	$3,359,748	0.8%
Total	**1,475**	**$61,412,103,591**	**153**	**10.37%**	**$7,190,950,168**	**11.71%**	**$441,480,149**	**0.7%**

Source: Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020; FEMA Map Service Center 2021; FEMA Hazus v5.1[a]

Note:

a. National Flood Hazard Layer DFIRM data obtained from the FEMA Map Service Center, effective February 26, 2021, with latest Letter of Map Amendment January 4, 2021

Chronic Coastal Flooding

This section discusses statewide vulnerability of exposed state assets (state buildings and state roads) and critical facilities to the chronic coastal flooding hazard.

State Assets

The exposure analysis determined there are eight state buildings located in the chronic coastal hazard area, of which the greatest number are in the City and County of Honolulu (6 buildings with a replacement cost value of $31.5 million). Over time, recurring flooding at these locations may lead to the permanent loss of these structures. Only replacement cost value was available for state buildings; this was the best available data and therefore, this value is reported as the estimated total loss. However, a more accurate reflection of loss to the chronic coastal flood hazard would be the combined value of the land and structure. Table 4.6-15 summarizes the state buildings located in the chronic coastal flood area by county. Table 4.6-16 summarizes the state buildings by state agency.

Table 4.6-15. State Buildings Loss to the SLR-XA-1.1 by County

County	Total Number of State Buildings	Total Value	Located in the SLR-XA-1.1			
			Number	% of Total	Total Value	% of Total
County of Kaua'i	531	$990,850,824	0	0%	$0	0.000%
City and County of Honolulu	3,472	$17,393,945,915	6	<0.1%	$31,502,653	0.121%
County of Maui	831	$3,097,491,689	2	<0.1%	$370,372	0.001%
County of Hawai'i	1,261	$4,638,567,141	0	0%	$0	0.000%
Total	**6,095**	**$26,120,855,568**	**8**	**0.13%**	**$31,873,025**	**0.122%**

Source: State of Hawai'i Risk Management Office 2017; Hawai'i Climate Change Mitigation and Adaptation Commission 2017

Table 4.6-16. State Building Loss to the SLR-XA-1.1 by Agency

Agency	Total Number of State Buildings	Total Value	Number of State Buildings in SLR-XA-1.1	Percent (%) of Total Buildings	Value in the SLR-XA-1.1	Percent (%) of Total Value
Dept of Accounting & General Services	66	$953,963,738	0	0.00%	$0	0.00%
Dept of Agriculture	70	$147,607,399	1	1.43%	$2,350,211	1.59%
Dept of Attorney General	15	$108,425,480	0	0.00%	$0	0.00%
Dept of Budget & Finance	16	$28,968,679	0	0.00%	$0	0.00%
Dept of Business, Economic Development and Tourism	25	$645,480,379	0	0.00%	$0	0.00%
Dept of Commerce & Consumer Affairs	2	$40,197,360	0	0.00%	$0	0.00%
Dept of Defense	69	$267,352,836	0	0.00%	$0	0.00%
Dept of Education	4,090	$10,598,205,739	0	0.00%	$0	0.00%
Dept of Hawaiian Home Lands	12	$110,427,352	0	0.00%	$0	0.00%
Dept of Health	44	$387,068,440	0	0.00%	$0	0.00%

Agency	Total Number of State Buildings	Total Value	Number of State Buildings in SLR-XA-1.1	Percent (%) of Total Buildings	Value in the SLR-XA-1.1	Percent (%) of Total Value
Dept of Human Resources Development	1	$5,973,872	0	0.00%	$0	0.00%
Dept of Human Services	130	$480,212,294	2	1.54%	$3,234,562	0.67%
Dept of Labor and Industrial Relations	22	$90,076,209	0	0.00%	$0	0.00%
Dept of Land and Natural Resources	90	$101,441,821	2	2.22%	$370,372	0.37%
Dept of Public Safety	154	$440,774,415	0	0.00%	$0	0.00%
Dept of Taxation	1	$7,174,162	0	0.00%	$0	0.00%
Dept of Transportation	68	$2,935,208,214	1	1.47%	$3,754,467	0.13%
Hawai'i State Ethics Commission	1	$984,533	0	0.00%	$0	0.00%
Hawai'i Health Systems Corporation	106	$1,230,852,871	0	0.00%	$0	0.00%
Hawai'i Housing Finance & Development Corporation	86	$360,851,671	0	0.00%	$0	0.00%
Hawai'i Public Housing Authority	273	$982,981,701	1	0.37%	$5,340,000	0.54%
Hawai'i State Legislature	2	$48,555,381	0	0.00%	$0	0.00%
Hawai'i State Public Library System	53	$525,584,082	0	0.00%	$0	0.00%
Judiciary	41	$534,877,354	0	0.00%	$0	0.00%
Legislative Reference Bureau	1	$2,996,162	0	0.00%	$0	0.00%
Office of Hawaiian Affairs	11	$54,125,645	0	0.00%	$0	0.00%
Office of the Auditor	2	$1,921,180	0	0.00%	$0	0.00%
Office of the Governor	1	$2,996,162	0	0.00%	$0	0.00%
Office of the Lieutenant Governor	2	$4,588,849	0	0.00%	$0	0.00%
Office of the Ombudsman	1	$1,818,060	0	0.00%	$0	0.00%
Research Corporation of the University of Hawai'i	3	$4,189,026	0	0.00%	$0	0.00%
University of Hawai'i	637	$5,014,974,503	1	0.16%	$16,823,413	0.34%
Total	**6,095**	**$26,120,855,568**	**8**	**0.13%**	**$31,873,025**	**0.12%**

Source: State of Hawai'i Risk Management Office 2017; Hawai'i Climate Change Mitigation and Adaptation Commission 2017
Total Value = Replacement Cost of facility; does not include land value which may be underestimating the loss due to the SLR-XA-1.1

Roads provide a vital transportation link between populated areas on the Hawaiian Islands. Approximately 15 miles of state roads are located within the SLR-XA-1.1 hazard area. These state roads will become potentially impassable, jeopardize critical access and isolate communities. Loss of road use may result in regional issues such as loss of commerce and increased traffic on other roads and highways. Utility lines commonly follow roads, and those located underground may be impacted, resulting in disruption of services.

Table 4.6-17 shows the length of state roads in the hazard area by county. The City and County of Honolulu has the greatest length of roads (6.4 miles) exposed, followed by the County of Maui (4.7 miles) and the County of Kauai (3.7 miles). A complete list of state roads exposed to the chronic coastal flood hazard is included in Appendix F.

Table 4.6-17. State Road Exposure to the SLR-XA-1.1 by County

County	Length (in miles)		
	Total Length	Length of Road in the SLR-XA-1.1	Percentage (%) of Total Length
County of Kaua'i	103.7	3.7	3.57%
City and County of Honolulu	374.9	6.4	1.71%
County of Maui	245.9	4.7	1.91%
County of Hawai'i	379.2	0.2	0.05%
Total	**1,103.70**	**15**	**1.36%**

Source: *State of Hawai'i DOT 2017; Hawai'i Climate Change Mitigation and Adaptation Commission 2017*

Community Lifelines and Critical Facilities

Table 4.6-18 summarizes the total number of community lifelines and critical facilities, by county, located in the chronic coastal flooding by county. The County of Maui has five community lifelines located in the chronic coastal flood hazard area. Table 4.6-19 summarizes the community lifeline and critical facility exposure by category.

Table 4.6-18. Community Lifelines and Critical Facilities Located in the SLR-XA-1.1, by County

County	Community Lifeline Categories								Additional Critical Facilities
	Communications	Energy	Food, Water, Shelter	Hazardous Material	Health & Medial	Safety & Security	Transportation	Total in the SLR-XA	
County of Kaua'i	0	0	0	0	0	0	0	0	0
City and County of Honolulu	0	0	1	0	0	2	0	3	0
County of Maui	1	0	3	0	0	1	0	5	0
County of Hawai'i	0	0	0	0	0	0	0	0	0
Total	**1**	**0**	**4**	**0**	**0**	**3**	**0**	**8**	**0**

Source: *Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020; Hawai'i Climate Change Mitigation and Adaptation Commission 2017*

Table 4.6-19. Community Lifeline Exposure and Potential Losses to Chronic Coastal Flooding, by Category

Category	Total Number of Facilities by Category	Total Value	Number of Facilities in SLR-XA-1.1	Percent (%) of Total Lifelines	Value in the SLR-XA-1.1	Percent (%) of Total Value
Communications	188	$776,797,683	1	0.53%	$9,296,169	1.20%
Energy	89	$3,093,949,530	0	0.00%	$0	0.00%
Food, Water, Shelter	345	$11,847,189,588	4	1.16%	$145,176,000	1.23%
Hazardous Material	12	$436,474,800	0	0.00%	$0	0.00%
Health and Medical	193	$4,606,713,364	0	0.00%	$0	0.00%
Safety and Security	486	$38,164,188,232	3	0.62%	$2,748,370,036	7.20%
Transportation	56	$2,039,091,600	0	0.00%	$0	0.00%
Total	**1,369**	**$60,964,404,797**	**8**	**0.58%**	**$2,902,842,204**	**4.76%**

Source: *Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020; Hawai'i Climate Change Mitigation and Adaptation Commission 2017*

Overall, the food, water and shelter category has the greatest exposure to the chronic coastal flood hazard. Similar to state buildings, only replacement cost value of the facility was available for community lifelines and does not include the value of the land; therefore, this value is reported as the total loss. However, a more accurate reflection of loss to the chronic coastal flood hazard would be the combined value of the land and structure using tax-assessed data. Further, the loss of service of that community lifeline or critical facility would increase the total loss from the hazard.

Critical transportation hubs and critical infrastructure located on the coast are exposed to chronic coastal flooding. As summarized in Section 4.2 (Climate Change and Sea Level Rise), the primary transportation arteries for the entry of people and goods to the state are the Daniel K. Inouye International Airport and Honolulu Harbor. In addition, each island has critical points of entry for people and goods which are considered vulnerable to chronic coastal flooding if located along the coast. Interruption of interisland and transoceanic shipping and travel would impact residents, visitors and all forms of economic activity (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017).

Assessment of Local Vulnerability and Potential Losses

Event-Based Flooding

This section provides a summary of vulnerability and potential losses to population, general building stock, and environmental resources and cultural assets by county. A spatial exposure analysis was conducted using the SFHA and potential losses were estimated using Hazus. These results are summarized below.

Additionally, the local HMPs were reviewed to integrate risk assessment results into the 2023 SHMP Update; a summary of information available is below.

- **County of Kauaʻi** –The County HMP includes Inland Flood as a standalone hazard. The HMP identifies five types of inland flood hazard, including riverine floods, flash floods, rain bombs, overland sheet flow, and dam failure floods. Kauaʻi County participates in the National Flood Insurance Program and has 45 FEMA-identified repetitive loss properties. There are 61 critical facilities within the Special Flood Hazard Area (SFHA); there are 6,796 residents living within the SFHA. The HMP also identifies socially vulnerable populations particularly impacted by flood events, including economically disadvantaged populations, residents over the age of 65, and residents under 1 (County of Kauaʻi 2020).
- **City and County of Honolulu** – The county provided a qualitative overview of flood risk, including descriptions of flood sources and types of coastal and inland floods. The HMP includes NOAA rainfall intensity maps. The city and county both participate in the NFIP; there are 114 Repetitive Loss properties in the county (City and County of Honolulu 2020).
- **County of Maui** – The county provided a qualitative overview of flood risk, including types of coastal and inland floods and principal sources of flood risk. Maui County is a Class 7 CRS community. Around 3.3% of the county lies within the SFHA, including 38 critical facilities; there are 34 Repetitive Loss properties within the county. The HMP also provides maps of transportation routes that could be impacted by flooding and a list of residents who are most vulnerable to flood risk, including single parent and dependent households, residents living below the poverty line, residents without adequate

communication infrastructure and/or limited English proficiency, residents living in properties built prior to the 1950s, and residents with limited mobility (County of Maui 2020).

- **County of Hawaiʻi** – The county provided a qualitative overview of flood risk, including National Flood Insurance Program statistics for the county. Hawaiʻi County is a CRS Class 7 community. Major floods happen in the rainy winter, accounting for approximately 84% of floods in the county. The HMP lists principal flooding sources, identified from FEMA's Flood Insurance Study for the area, as well as areas prone to flash flooding. Only 0.3 percent of the entire County (7,358 acres) is located within the mapped 1 percent annual chance floodplain, exposing 4,754 residents. There are 45 Repetitive Loss properties in the county, and 19 critical facilities are exposed to a 1 percent annual flood event. The HMP also identifies socially vulnerable populations particularly impacted by flood events, including economically disadvantaged populations, residents over the age of 65, and residents under 16 (County of Hawaiʻi 2020).

Socially Vulnerable and Total Populations

Socially vulnerable populations are most susceptible based on many factors, including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Economically disadvantaged populations are likely to evaluate their risk and make decisions based on the major economic impact to their family and may not have funds to evacuate.

The aftermath of flooding events present numerous threats to public health and safety, including unsafe food, contaminated drinking and washing water and poor sanitation, mosquitoes and animals, mold and mildew, carbon monoxide poisoning, and mental stress and fatigue. Current loss estimation models such as Hazus are not equipped to measure public health impacts. The best preparation for these effects includes awareness that they can occur, education of the public on prevention, and planning to deal with them during responses to flooding events.

Over 91,400 residents statewide reside in the SFHA; nearly 16,000 of those residents are considered socially vulnerable populations (Table 4.6-20). These residents may be displaced by the flooding of their homes, requiring them to seek temporary shelter with friends and family or in emergency shelters. The City and County of Honolulu has the greatest number of people (73,711) located in the SFHA. This analysis does not include the number of tourists and visitors in the state; therefore, this estimate may be underestimating exposure and vulnerability.

The City and County of Honolulu has the largest socially vulnerable population exposed to the SFHA (13,226). Appendix F summarizes the population exposure to the A-Zone and V-Zone areas.

Table 4.6-20. 2020 U.S. Census Population Located in the SFHA by County

County	Population				
	Total Population	Population in the SFHA	Population Exposed as % of Total Population	Socially Vulnerable Population in the SFHA	Socially Vulnerable Population Exposed as % of Total Population
County of Kaua'i	71,949	3,526	4.90%	211	0.29%
City and County of Honolulu	979,682	73,711	7.52%	13,226	1.35%
County of Maui	167,093	9,206	5.51%	1,225	0.73%
County of Hawaiʻi	201,350	5,019	2.49%	1,138	0.57%

County	Population				
	Total Population	Population in the SFHA	Population Exposed as % of Total Population	Socially Vulnerable Population in the SFHA	Socially Vulnerable Population Exposed as % of Total Population
Total	1,420,074	91,462	6.44%	15,800	1.11%

Source: U.S. Census Bureau 2020; Centers for Disease Control and Prevention 2018; FEMA Map Service Center 2021[a]
Note:
a. National Flood Hazard Layer DFIRM data obtained from the FEMA Map Service Center, effective February 26, 2021 with latest Letter of Map Amendment January 4, 2021

Floods and their aftermath present numerous threats to public health and safety:

- **Vehicles in flood waters**—Flood waters can carry large amounts of debris, potentially increasing the damage they do.
- **Unsafe food**—Floodwaters can contain disease-causing bacteria, dirt, oil, human and animal waste, and farm and industrial chemicals. Their contact with food items, including food crops in agricultural lands, can make that food unsafe to eat.
- **Contaminated drinking and washing water and poor sanitation**—Flooding impairs clean water sources with pollutants; pollutants also infiltrate into the groundwater contaminating potable water. Flooded wastewater treatment plants and private sewage disposal systems can be overloaded, resulting in backflows of raw sewage becoming a cause of disease.
- **Mosquitoes and animals**—Floods provide new breeding grounds for mosquitoes in wet areas and stagnant pools; deceased animals can carry viruses and diseases if not disposed of timely and properly.
- **Mold and mildew**—Excessive exposure to mold and mildew can cause flood victims, especially those with allergies and asthma, to contract upper respiratory diseases, triggering cold-like symptoms. Infants, children, elderly people, and pregnant women are considered most vulnerable to mold-induced health problems.
- **Carbon monoxide poisoning**—In the event of power outages, the use alternative fuels in enclosed or partially enclosed spaces can lead to carbon monoxide poisoning.
- **Hazards when reentering and cleaning flooded homes and buildings**—Flooded buildings can pose significant health and physical hazards to people entering them, including live electrical wires, gas leaks, flood debris, and hazardous materials.
- **Mental stress and fatigue**—People who live through a devastating flood can experience long-term psychological impact.

General Building Stock

Economic losses to the State of Hawaiʻi from event-based flooding include but are not limited to general building stock damage, agricultural losses, and business interruption. These losses will negatively affect the tax base. Damage to general building stock can be quantified using Hazus. Other economic components, such as loss of facility use, functional downtime, and social economic factors, are less quantifiable. For the purposes of this analysis, the general building stock damage is discussed further.

Low-lying urban areas have the greatest vulnerability to a flood event. To estimate the potential losses by county, the Hazus flood model and default general building stock provided by the model were used. Table 4.6-21 summarizes the estimated potential losses to the general building stock by county.

Table 4.6-21. General Building Stock Exposure and Potential Losses to the 1% Annual Chance Flood Event

County	Total Replacement Cost Value	Replacement Cost Value in the SFHA	% of Total in the SFHA	Estimated Potential Loss to the 1% Annual Chance Flood Event (A-and V-Zones)		Estimated Potential Loss to Buildings in the V-Zones	
				Replacement Cost Value	Percent (%) of Total	Replacement Cost Value	Percent (%) of Total
County of Kaua'i	$24,246,497,228	$3,406,707,898	14.05%	$575,360,000	2.37%	$107,754,000	0.44%
City and County of Honolulu	$239,152,051,766	$24,917,056,964	10.42%	$1,339,204,000	0.56%	$73,291,000	0.03%
County of Maui	$50,796,693,140	$4,307,043,691	8.48%	$240,731,000	0.47%	$134,247,000	0.26%
County of Hawai'i	$58,395,349,136	$2,321,499,927	3.98%	$92,079,000	0.16%	$43,949,000	0.08%
Total	**$372,590,591,270**	**$34,952,308,481**	**9.38%**	**$2,247,374,000**	**0.60%**	**$359,241,000**	**0.10%**

Source: NIYAM IT 2022; United States Army Corps of Engineers 2022; FEMA Map Service Center 2021[a]; FEMA Hazus v5.1
Note:
a. National Flood Hazard Layer DFIRM data obtained from the FEMA Map Service Center, effective February 26, 2021, with latest Letter of Map Amendment January 4, 2021

Hazus estimates $2.2 billion in statewide potential damages to the general building stock inventory associated with the 1% annual chance flood event. Although this loss represents less than 1% of the state's total building replacement cost value, the flooded areas include some of the most valued buildings in the state. The City and County of Honolulu is estimated to experience the greatest loss: $1.3 billion in building damages (repair or replacement costs), of which $73 million of the damages are in the V-zone. The cost to repair or replace buildings is estimated at $240 million in the County of Kauaʻi and $575 million in the County of Maui. Hazus estimates $92 million in building loss for the County of Hawaiʻi. Appendix F (State Profile and Risk Assessment Supplement) summarizes the exposure and potential losses to the 1% Annual Chance Flood A-Zone and V-Zone areas.

The National Flood Insurance Program (NFIP) data are also a useful tool to determine areas vulnerable to flood.

Table 4.6-22 summarizes the NFIP policies, claims, and RL and SRL buildings in each county. Currently, the City and County of Honolulu has the highest number of repetitive loss properties (132), followed by the Counties of Hawaiʻi and Kauaʻi (46 each). The County of Honolulu has the greatest total losses paid (nearly $56 million). Over the performance period of the 2018 SHMP, the number of repetitive loss properties has increased from 227 to 262 (an approximate 13% increase).

Table 4.6-22. NFIP Statistics for the State of Hawaiʻi

County	Number of Policies	Insurance In Force	Number of Paid Losses	Total Losses Paid	Repetitive Loss		Severe Repetitive Loss	
					2018 Total	2022 Total	2018 Total	2022 Total
County of Kaua'i	3,580	$922,928,100	1,406	$43,934,328	31	46	0	2
City and County of Honolulu	34,822	$8,637,960,700	2,732	$55,797,231	117	132	1	13

County	Number of Policies	Insurance In Force	Number of Paid Losses	Total Losses Paid	Repetitive Loss		Severe Repetitive Loss	
					2018	2022	2018	2022
					Total	Total	Total	Total
County of Maui	11,614	$2,795,483,600	589	$9,333,535	34	38	2	6
County of Hawai'i	3,980	$1,029,437,700	728	$19,654,298	45	46	6	32
Total	**53,996**	**$13,385,810,100**	**5,455**	**$128,719,392**	**227**	**262 [a]**	**9**	**53**

Source: FEMA PIVOT Database 2022
Notes:
Policies, insurance in force, and losses are as of September 30, 2022.
Repetitive and severe repetitive loss property statistics are as of August 31, 2022.
a. Includes severe repetitive loss properties

An analysis was conducted to summarize the current repetitive loss statistics across the state.

- 20.2% of the 262 Repetitive Loss properties have been identified as "Severe Repetitive Loss" by FEMA.
- The County with the greatest number of Severe Repetitive Loss properties is Hawai'i County with 32 (69.5 % of its total Repetitive Loss Properties).
- 25.7% of the Severe Repetitive Loss properties are located outside of the SFHA.
- 33.2% of the 262 Repetitive Loss properties in the state are located outside of the SFHA.
- The County with the most Repetitive Loss properties located outside the SFHA is Honolulu (40.9% of its total Repetitive Loss properties).
- 30.9% of the 262 Repetitive Loss properties are currently insured under the NFIP.
- 1.5% of the 262 Repetitive Loss properties have been identified as "mitigated".
- The County with the most "mitigated" Repetitive Loss properties is Maui (3), 7.9% of the total Repetitive Loss properties.
- The 262 identified Repetitive Loss properties have accounted for 703 total Losses totaling $24,835,397 claims paid by the NFIP.
- This amounts to an average claim paid of $24,241. This is below the National average flood insurance claim under the NFIP of just over $31,000 per claim.
- All 4 Counties within the state have identified RL properties.
- The County with the highest Average Loss per Repetitive Loss property is Kaua'i at $71,945 per claim.

Land Use Districts

Table 4.6-23 shows the square miles of SFHAs in each state land use district statewide; refer to Appendix F for results by county. Agricultural District lands and Urban District lands have the greatest area exposed to A-zone flooding in the state, 36.9 and 28.8 square miles, respectively. This is not surprising for two reasons: 1) productive agricultural lands tend to be located along steams as rivers as sediment build up and accumulation from prior flood events results in fertile soil, and 2) floodplain mapping is generally conducted in areas that are developed or are likely to be developed in the future.

Table 4.6-23. State Land Use Districts Located in the Special Flood Hazard Area

Land Use District	Total (square miles)	Square Miles in the SFHA	Percent (%) of Total Area
Agricultural	2,973.6	36.90	1.2%
Conservation	3,202.9	25.50	0.8%

Land Use District	Total (square miles)	Square Miles in the SFHA	Percent (%) of Total Area
Rural	16.3	2.10	12.9%
Urban	319.1	28.80	9.0%
Total	**6,511.95**	**93.30**	**1.4%**

Source: State Land Use Commission, Hawaii Statewide GIS Program 2021; Honolulu County GIS 2022; FEMA Map Service Center 2021[a]
Notes:
a. National Flood Hazard Layer DFIRM data obtained from the FEMA Map Service Center, effective February 26, 2021, with latest Letter of Map Amendment January 4, 2021
Total area was calculated from the State of Hawaiʻi State Land Use District GIS layer.
Original FEMA effective DFIRM boundary is maintained. This hazard area is not clipped to the coastline.
Total area may differ slightly between this and other calculations due to slight differences in the shoreline geography.

Environmental Resources

Environmental resources are valuable assets to the environment and overall economy in the state. Coral reefs and wetlands provide a coastal buffer and protect from wave and flood impacts. However, flooding may adversely impact the natural environment, including: beach erosion; loss or submergence of wetlands and other coastal ecosystems; saltwater intrusion; high water tables; loss of coastal recreation areas, beaches, protective sand dunes, parks, and open space; and loss of coastal structures (sea walls, piers, bulkheads, bridges, or buildings) (FEMA n.d.). Flash floods often result in increased sediment deposited in the nearshore environment negatively impacting coral reefs from sedimentation and stormwater runoff (U.S. Environmental Protection Agency 2022).

Environmental resource areas, including critical habitat (or habitats that are known to be essential for an endangered or threatened species), wetlands, and parks and reserves are vulnerable to event-based flooding. The area of each environmental resource located in the SFHA was calculated and is summarized in Table 4.6-24.

Table 4.6-24. Environmental Resources Located in the SFHA

Environmental Resource	Total Square Miles of Resource	Resource Area in the SFHA (square miles)	Percent (%) of the Total Resource Area
Critical Habitat[a]	951	3	0.3%
Wetlands	3,637	109	3.0%
Parks and Reserves	2,778	16	0.6%
Reefs[b]	55	19	34.3%
Total[c]	**7,420**	**147**	**2.0%**

Source: U.S. Fish and Wildlife Service, Pacific Islands Office, 2022, U.S. Fish and Wildlife Service 2021; Hawaii State Department of Land and Natural Resources, Division of Forestry and Wildlife 2022, NOAA raster nautical charts 2020, State of Hawaii Department of Land and Natural Resources, Division of State Parks 2021; FEMA Map Service Center 2021[d]
Notes:
Original FEMA effective DFIRM boundary is maintained. This hazard area is not clipped to the coastline.
a. Critical area mileage includes the combined area of coverage of individual critical habitat areas.
b. Reefs include artificial and coral reefs.
c. Total square miles include environmental assets within 3 nautical miles of each county and may be over-reported as some environmental asset areas may overlap.
d. National Flood Hazard Layer DFIRM data obtained from the FEMA Map Service Center, effective February 26, 2021, with latest Letter of Map Amendment January 4, 2021

Cultural Assets

Many Native Hawaiian cultural resources are located near the shoreline and may be impacted by event-based flooding. Structures that experience damage would result in displaced residents in need of shelter or new homes.

More than 4 acres of the Hawaiian Home Lands are in the 1% Annual Chance Flood areas (this includes the A-Zone, V-zone, and SFHA) in all four counties (see Table 4.6-25). Table 4.6-26 Summarizes cultural resources by square miles statewide that are located in the SFHA.

Table 4.6-25. Hawaiian Home Lands Located in the SFHA

County	Area (in square miles)		
	Total Area	Land in the SFHA	Percent (%) of Total Area
County of Kauaʻi	32.1	0.4	1.1%
City and County of Honolulu	10.6	0.2	2.3%
County of Maui	102.6	2.6	2.6%
County of Hawaiʻi	191.5	1.1	0.6%
Total	**336.7**	**4.3**	**1.3%**

Source: Hawaii State Department of Hawaiian Home Lands 2021; FEMA Map Service Center 2021[a]
Note:
a. National Flood Hazard Layer DFIRM data obtained from the FEMA Map Service Center, effective February 26, 2021, with latest Letter of Map Amendment January 4, 2021

Table 4.6-26. Cultural Resources Located in the SFHA

Cultural Resource Site Type	Area (in square miles)		
	Total Square Miles of Asset	Total Square Miles in SFHA Area	Percent (%) of Total Asset Area
Archaeology	90.9	9.3	10.3%
Burial Sensitivity Area	2.1	1.1	51.1%
Historic Building	2.7	0.3	10.7%
Historic District	849.4	36.2	4.3%
Historic Object	9.6	0.0	0.0%
Historic Structure	20.7	0.8	3.8%
Total	**975.4**	**47.7**	**4.9%**

Source: Department of Land and Natural Resources, Hawai'i State Historic Preservation Division 2022; FEMA Map Service Center 2021[a]
Notes:
Original FEMA effective DFIRM boundary is maintained. This hazard area is not clipped to the coastline.
a. *National Flood Hazard Layer DFIRM data obtained from the FEMA Map Service Center, effective February 26, 2021, with latest Letter of Map Amendment January 4, 2021*

Chronic Coastal Flooding

This section provides a summary of vulnerability and potential losses to population, general building stock, and environmental assets and cultural resources by county. Similar to the analysis for state assets, a spatial exposure analysis was conducted. As noted above, vulnerability to chronic coastal flooding is assessed as chronic flooding with the potential permanent loss of assets and displacement of population located in the SLR-XA-1.1 hazard area.

Socially Vulnerable and Total Populations

Socially vulnerable populations are most susceptible based on many factors, including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Economically disadvantaged populations are likely to evaluate their risk and make decisions based on the major economic impact to their family and may not have funds to evacuate.

The aftermath of flooding events presents numerous threats to public health and safety, including unsafe food, contaminated drinking and washing water and poor sanitation, mosquitoes and animals, mold and mildew, carbon monoxide poisoning, and mental stress and fatigue. Current loss estimation models such as Hazus are not equipped to measure public health impacts. The best preparation for these effects includes awareness that they can occur, education of the public on prevention, and planning to deal with them during responses to flooding events.

People living and working in the chronic coastal flood hazard area may be displaced as homes and businesses become flooded and permanently lost. According to the 2017 *Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report*, statewide, an estimated 4,160 people may be displaced as a result of the potential permanent loss to structures and land in the SLR-XA-1.1 hazard area (Table 4.6-27). The analysis indicates that the City and County of Honolulu has the greatest number of people that may be displaced, and the County of Kauaʻi has the greatest percent population that may be displaced (1.5%).

Table 4.6-27. Estimated Population Displaced by the Chronic Coastal Flood Hazard

County	Total Population	Displaced Population	Percent (%) of Total Population
County of Kauaʻi	71,949	1,000	1.50%
City and County of Honolulu	979,682	2,000	<1%
County of Maui	167,093	710	<1%
County of Hawaiʻi	201,350	450	<1%
Total	**1,420,074**	**4,160**	**<1%**

Source: Hawaiʻi Climate Mitigation and Adaptation Commission 2017

According to the 2018 SHMP, the greatest number of deaths, injuries and rescues in the Hawaiian Islands due to natural hazard events are from high waves breaking at the shoreline. High surf is typically described as waves ranging in height from 10 feet to 20 feet or more. These waves typically come from storms passing across the higher latitudes of the Northern and Southern Hemispheres in addition to tropical storms passing across the Central Pacific in proximity to the Hawaiian Islands.

Land Use Districts

Table 4.6-28 shows the number of square miles in each state land use district statewide exposed to the chronic coastal flood hazard areas; refer to Appendix F for results by county. Conservation District lands will experience the greatest total loss of area from chronic coastal flooding in the near-term. Conservation District lands contain valuable environmental resources. Additional discussion of exposure and vulnerability of these resource areas can be found in the subsection below. Urban District areas, where populations and development are concentrated, will lose the greatest percentage of total land area to chronic coastal flooding in the near-term.

Table 4.6-28. State Land Use Districts Located in the SLR-XA-1.1

Land Use District	Total (square miles)	Square Miles in the SLR-XA-1.1	% of Total Area
Agricultural	2,973.6	2.99	0.10%
Conservation	3,202.9	10.28	0.32%
Rural	16.3	0.24	1.47%
Urban	319.1	5.27	1.65%
Total	**6,511.9**	**18.78**	**0.29%**

Source: Hawai'i Climate Mitigation and Adaptation Commission 2017; State Land Use Commission, Hawaii Statewide GIS Program 2021; Honolulu County GIS 2022
Note:
Total area calculated from the State of Hawai'i State Land Use District GIS layer.
Hazard area clipped to coastline using 2020 Census County Boundary from State of Hawai'i GIS Program Geospatial Data Portal.
Total area may differ slightly between this and other calculations due to slight differences in the shoreline geography.

General Building Stock

The 2017 *Hawai'i Sea Level Rise Vulnerability and Adaptation Report* calculated the estimated potential loss to both structure and land by island; as both the structures and land may become permanently inundated due to the chronic coastal flood hazard over time. These calculations were totaled by county with an estimated economic loss of $1.96 billion statewide (Table 4.6-29).

Table 4.6-29. Estimated Structure and Property Value (Structure and Land) Loss from SLR-XA-1.1 by County

County	Number of Structures in the SLR-XA-1.1	Estimated Structure and Land Value Located in the SLR-XA-1.1
County of Kaua'i	170	$136,514,291
City and County of Honolulu	563	$936,636,782
County of Maui	331	$884,955,696
County of Hawai'i	3	$3,945,797
Total	**1,067**	**$1,962,052,566**

Source: NIYAM IT 2022; U.S. Army Corps of Engineers 2022; Hawai'i Climate Mitigation and Adaptation Commission 2017

Environmental Resources

The loss of natural resources statewide is difficult to quantify; however, their loss would deeply cost the state. Parks and beaches play a critical role in recreation, employment and the local economy. In addition, wetland areas and coastal habitats are important ecosystems for many species and provide other environmental benefits such as flood mitigation and may be altered through chronic coastal flood conditions. As discussed in Section 4.2 (Climate Change and Sea Level Rise), chronic coastal flooding has the potential to impact facilities that could release wastewater or hazardous materials and waste to nearshore waters and coastal habitats. Septic tanks, cesspools, and other on-site sewage disposal systems (OSDS) as well as other hazard materials/waste storage and disposal sites are located along the coast.

Environmental resource areas, including critical habitat (or habitats that are known to be essential for an endangered or threatened species), wetlands, and parks and reserves are vulnerable to chronic coastal flooding. The area of each environmental asset located in the SLR-XA-1.1 hazard area was calculated and summarized by asset (Table 4.6-30).

Table 4.6-30. Environmental Resources Located in the SLR-XA-1.1

Environmental Asset	Total Square Miles of Asset	Asset Area in the SLR-XA-1.1	Percent (%) of the Total Asset Area
Critical Habitat[a]	950.6	1.3	0.1%
Wetlands	3636.7	15.8	0.4%
Parks and Reserves	2777.7	4.7	0.2%
Reefs[b]	54.8	0.5	0.9%
Total[c]	**7419.8**	**22.3**	**0.3%**

Source: U.S. Fish and Wildlife Service, Pacific Islands Office, 2022; U.S. Fish and Wildlife Service 2021, 2017; Hawai'i State Department of Land and Natural Resources, Division of Forestry and Wildlife 2022; NOAA raster nautical charts 2020; State of Hawai'i Department of Land and Natural Resources, Division of State Parks 2021; Hawai'i Climate Mitigation and Adaptation Commission 2017

Note:

a. Critical area mileage includes the combined area of coverage of individual critical habitat areas.

b. Reefs include artificial and coral reefs.

c. Total square miles includes environmental assets within 3 nautical miles of each county and may be over-reported as some environmental asset areas may overlap.

Cultural Assets

Coastal portions of the Hawaiian Home Lands are vulnerable to chronic coastal flooding which may displace Native Hawaiian families that live in this area. Table 4.6-31 summarizes the area of the Hawaiian Home Lands located in the chronic coastal flood hazard area. In addition, many Native Hawaiian cultural and historical resources are located near the shoreline and threatened by flooding and beach erosion (Table 4.6-32). The 2017 *Hawai'i Sea Level Rise Vulnerability and Adaptation Report* summarizes cultural sites located in the SLR-XA-1.1 hazard area.

Table 4.6-31. Hawaiian Home Lands Located in the SLR-XA-1.1

County	Area (in square miles)		
	Total Area	Asset Area in the SLR-XA-1.1	Percent (%) of Total Area
County of Kaua'i	32.09	0.07	0.22%
City and County of Honolulu	10.61	0.04	0.38%
County of Maui	102.59	0.2	0.19%
County of Hawai'i	191.46	0.06	0.03%
Total	**336.75**	**0.37**	**0.11%**

Source: Hawai'i State Department of Hawaiian Homelands 2021; Hawai'i Climate Mitigation and Adaptation Commission 2017

Table 4.6-32. Cultural Resources Located in the SLR-XA

Cultural Resource Site Type	Area (in square miles)		
	Total Square Miles of Asset	Total Square Miles in SLR-XA-1.1 Area	Percent (%) of Total Asset Area
Archaeology	90.9	2.2	2.5%
Burial Sensitivity Area	2.1	0.3	13.9%
Historic Building	2.7	0.0	1.6%
Historic District	849.4	6.7	0.8%
Historic Object	9.6	0.0	0.0%
Historic Structure	20.7	0.2	0.7%
Total	975.4	9.4	1.0%

Source: Department of Land and Natural Resources, Hawai'i State Historic Preservation Division 2022; Hawai'i Climate Change Mitigation and Adaptation Commission 2017

Future Changes that May Impact State Vulnerability

Event-Based Flooding

Understanding future changes that impact vulnerability in the state can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The state considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

Potential or Projected Development

The SFHAs were overlain on areas that may experience significant changes in development or redevelopment in future years (see Table 4.6-33; refer to Section 3 for more information on projected development areas). The results of this assessment indicate none of the Hawaiʻi Community Development Authority (HCDA) Community Development Districts and only a very small amount of the Maui Development Projects are located in SFHAs. Approximately 68.7 square miles of the Enterprise Zones statewide are located in SFHAs. Most of the exposed area, 49.6 square miles, is located in A-zone SFHAs. Each county participates in the NFIP and has flood damage prevention regulations in place that regulate how development can occur in mapped SFHAs. Future development in these areas will require adherence to flood damage prevention standards. If new development occurs in areas that currently support natural and beneficial floodplain functions, such as in upland conservation areas, impacts to event-based flooding may be seen throughout the associated watershed.

Table 4.6-33. HCDA Community Development Districts, Maui Development Projects, and Enterprise Zones Located in SFHAs

County	Area (in square miles)								
	HCDA Community Development Districts (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area	Maui Development Projects (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area	Enterprise Zones (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area
A-Zone									
County of Kauaʻi	0	0	0.00%	0	0	0.00%	251	14.5	5.78%
City and County of Honolulu	7.4	0.6	8.11%	0	0	0.00%	297.3	13.3	4.47%
County of Maui	0	0	0.00%	27.6	0.2	0.72%	1,059.80	13.8	1.30%
County of Hawaiʻi	0	0	0.00%	0	0	0.00%	1,274.90	8.04	0.63%
Total	7.4	0.6	8.11%	27.6	0.2	0.72%	2,883.00	49.64	1.72%
V-Zone									
County of Kauaʻi	0	0	0.00%	0	0	0.00%	251	1.42	0.57%
City and County of Honolulu	7.4	0.08	1.08%	0	0	0.00%	297.3	3.4	1.14%
County of Maui	0	0	0.00%	27.6	0.02	0.07%	1,059.80	6.8	0.64%
County of Hawaiʻi	0	0	0.00%	0	0	0.00%	1,274.90	7.6	0.60%
Total	7.4	0.08	1.08%	27.6	0.02	0.07%	2,883.00	19.22	0.67%

County	Area (in square miles)								
	HCDA Community Development Districts (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area	Maui Development Projects (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area	Enterprise Zones (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area
Special Flood Hazard Area									
County of Kaua'i	0	0	0.00%	0	0	0.00%	251	15.97	6.36%
City and County of Honolulu	7.4	0.7	9.46%	0	0	0.00%	297.3	16.6	5.58%
County of Maui	0	0	0.00%	27.6	0.24	0.87%	1,059.80	20.5	1.93%
County of Hawai'i	0	0	0.00%	0	0	0.00%	1,274.90	15.6	1.22%
Total	7.4	0.7	9.46%	27.6	0.24	0.87%	2,883.00	68.67	2.38%

Source: Maui County Planning Department 2016; Hawaii Community Development Authority 2021; Community Economic Development Program, Department of Business, Economic Development & Tourism, County Planning Departments 2021; FEMA Map Service Center 2021[a]

Note:

a. *National Flood Hazard Layer DFIRM data obtained from the FEMA Map Service Center, effective February 26, 2021 with latest Letter of Map Amendment January 4, 2021*

Other Factors of Change

Climate change is certain to alter flood dynamics in the state. Changes in the timing and intensity of rainfall may impact inland and stormwater flooding, changes in wind and storm patterns may impact coastal flooding, and sea level rise will increase the areas exposed to coastal and some inland flooding as well as flood heights in some areas. For more information on how climate change will impact event-based flooding, please refer to Section 4.2 (Climate Change and Sea Level Rise).

Chronic Coastal Flooding

Understanding future changes that impact vulnerability in the state can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The state considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change.

Chronic coastal flood areas were overlain on areas that may experience significant changes in development or redevelopment in future years (see Table 4.6-34); refer to Section 3 for more information on projected development areas). Only very small amounts of the HCDA Community District Areas and Maui Development Projects intersect with these areas. Larger portions of the Enterprise Zone areas in each county are exposed; however, exposure is still less than 1% of the total area of these zones. Care should be taken to not increase development in these Chronic Coastal Flood Areas as the incidence of flooding and/or erosion will increase over time. It is likely, however, that existing rules and regulations in the state, such as shoreline setback regulations (see Section 5 for more information) already prohibit or strictly regulate most new development in these areas. It is possible that chronic flooding conditions may exist outside of existing regulated areas if chronic flooding is a result of stormwater system failure due to higher than design level tidal flooding or in very flat areas where chronic flooding may extend further inland. Potential or projected development exposed to risk from long-term coastal flooding as it will be further exacerbated by climate change is discussed in Section 4.2 (Climate Change and Sea Level Rise).

Table 4.6-34. HCDA Community Development Districts, Maui Development Projects, and Enterprise Zones Located the SLR-XA-1.1

County	Area (in square miles)								
	HCDA Community Development Districts	Total Area Exposed to Hazard	Hazard Area as % of Total Area	Maui Development Projects (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area	Enterprise Zones (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area
County of Kaua'i	0	0	0	0	0	0	251.0	2.7	1.08%
City and County of Honolulu	7.4	0.13	1.76%	0	0	0	297.3	2.3	0.77%
County of Maui	0	0	0	27.62	0.02	0.06%	1,059.8	4.0	0.38%
County of Hawai'i	0	0	0	0	0	0	1,274.9	2.5	0.20%
Total	**7.4**	**0.13**	**1.76%**	**27.62**	**0.02**	**0.06%**	**2,883**	**11.5**	**0.40%**

Source: Maui County Planning Department 2016; Hawaii Community Development Authority 2021; Community Economic Development Program, Department of Business, Economic Development & Tourism, County Planning Departments 2021; Hawai'i Climate Change Mitigation and Adaptation Commission 2017; U.S. Census Bureau 2021

Flood Hazard Mitigation Success Story

Credit: County of Kauaʻi

Weke Road in the Hanalei River Basin of Kauaʻi was washed out after the severe rainstorm in February 2018. The damage impeded access to residences and beaches in the area. DR-4365 Federal funding was used for the reconstruction project and included two mitigation measures:

- The road through the washed-out area was reconstructed with mechanically stabilized earth (MSE) walls
- Cement concrete was used for pavement instead of asphalt

This area of Kauaʻi is prone to severe flooding events. These mitigation measures strengthened the roadway to be more resilient to floods and erosion in the future.

Section 4.7 Hazardous Materials

Hazardous Materials

Hazardous materials are materials and solid waste that are harmful to humans, animals, and the environment. Incidents involving hazardous materials can happen at fixed sites, non-point source pollution, or as a result of incidents during material transportation and improper storage.

CHANGES SINCE 2018

+0

Declared Disasters

+2,201

Events

COUNTIES MOST VULNERABLE

SOCIALLY VULNERABLE POPULATION

22.3%

Of Total Population

316,257

Persons

CLIMATE PROJECTIONS

Future event-base flooding will be exacerbated by climate change

Sites that store hazardous materials that are at risk from current and future flooding that could cause the release of hazardous materials

Projected sea level rise will eventually cause the failure of on-site sewage disposal systems and degrade water quality

HAZARD RANKING

COMMUNITY LIFELINES

1,369

Total

6,095

State Buildings

SQUARE MILES

7,420

Environmental Resources

337

Hawaiian Home Lands

975

Cultural Resources

1,104

Miles of State Road

CONTENTS

TABLES

FIGURES

[1] *Section Cover Photo: Makapuʻu Beach inspection for hazardous materials. Photo by Lt. Kevin Cooper*

SECTION 4. RISK ASSESSMENT

4.7 HAZARDOUS MATERIALS

2023 SHMP Update Changes

- Hazardous materials incidents that occurred in the State of Hawaiʻi from January 1, 2018, through December 31, 2022, were researched for this 2023 SHMP Update.
- The profile and vulnerability assessment have been updated to include the most up-to-date information on the numbers of chemical facilities and Superfund sites, the addition of information on pipelines, and the consideration of both fixed-sites and in-transit hazardous materials.
- This section now includes a discussion of how hazardous materials impact socially vulnerable populations and community lifelines.

4.7.1 HAZARD PROFILE

Hazard Description

Hazardous materials, as defined by various federal agencies like the Environmental Protection Agency (EPA), are materials and solid waste that are harmful to humans, animals, and the environment. Incidents involving hazardous materials can happen at fixed sites (wastewater treatment plants, solid waste facilities), nonpoint source pollution, or as a result of incidents during material transportation and improper storage. Both can be disastrous if not managed properly.

Natural disasters can cause major damage to hazardous installations, hazardous substance releases, fires, and explosions, resulting in health effects, environmental pollution, and economic losses. Natural hazards that are generally considered minor, such as lightning, have been found to cause significant hazardous materials incidents (OECD n.d.). Natural hazard areas that are considered more severe, such as lava flow zones during an eruption, can amplify a hazardous materials release. Adhering to protocols in emergency response plans in such areas is required to protect the health, safety, and welfare of employees and other persons in the vicinity of a hazardous materials site (Puna Geothermal Venture 2022).

Hazardous materials are stored and transported statewide. The state faces an average of over 300 hazardous materials incidents each year. The majority are minor releases; however, there is always the potential for large and dangerous releases (HI-EMA 2022).

Because relevant legislation uses the term “hazardous substance,” but the emergency management and response community typically uses the term “hazardous materials,” for the purpose of this hazard profile, “hazardous materials” and “hazardous substances” are used interchangeably.

Hazardous Substances Defined by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

- Any hazardous substance designated under Section 311(b)(2) of the Clean Water Act (CWA), or any toxic pollutant listed under Section 307(a) of the CWA. There are about 400 substances designated as either hazardous or toxic under the CWA.
- Any hazardous waste having the characteristics identified or listed under Section 3001 of the Resource Conservation and Recovery Act (RCRA).
- Any hazardous air pollutant listed under Section 112(b) of the Clean Air Act (CAA). There are over 200 substances listed as hazardous air pollutants under the CAA.
- Any imminently hazardous chemical substance or mixture which the EPA Administrator has "taken action under" Section 7 of the Toxic Substances Control Act (TSCA).
- CERCLA section 102(a) also gives EPA authority to designate additional hazardous substances not listed under the statutory provisions cited above (U.S. Environmental Protection Agency 2022).

If released or misused, hazardous substances can cause death, serious injury, long-lasting health effects, and damage to structures and other properties as well as the environment. Many products containing hazardous substances are used and stored in homes, and these products are shipped daily on highways, waterways, and pipelines. There are two general types of hazardous material incidents:

- ***Fixed-site hazardous substances (materials and waste) incident*** is the uncontrolled release of materials from a fixed site capable of posing a risk to health, safety, and property as determined by the Resource Conservation and Recovery Act (RCRA). It is possible to identify and prepare for a fixed-site incident because federal and state laws require those facilities to notify state and local authorities about what is being used or produced at the site. Hazardous materials at fixed sites are regulated by the EPA.

  The EPA chooses to specifically list substances as hazardous and extremely hazardous rather than providing objective definitions. Hazardous substances, as listed, are generally materials that, if released into the environment, tend to persist for long periods and pose long-term health hazards for living organisms. Extremely hazardous substances, while also generally toxic materials, represent acute health hazards that, when released, are immediately dangerous to the lives of humans and animals and cause serious damage to the environment. When facilities have these materials in quantities at or above the threshold planning quantity (TPQ), they must submit "Tier II" information to appropriate state and/or local agencies to facilitate emergency planning.

- A ***hazardous materials transportation incident*** is any event resulting in uncontrolled release of materials during transport that can pose a risk to health, safety, and property as defined by the U.S. Department of Transportation (U.S. DOT) Materials Transport regulations. Transportation incidents are difficult to prepare for because there is little, if any, notice about what materials could be involved should an accident happen. Hazardous materials transportation incidents can occur anywhere within the state. Transportation of hazardous materials on highways involves tanker trucks or trailers and is responsible for the greater number of hazardous substance release incidents. Transportation of hazardous materials, such as imported petroleum products, occurs on navigable waters via ships and barges. Hazardous materials in transit are regulated by the U.S. DOT, and transportation of hazardous waste is regulated by the Hawaiʻi State Department of Health (DOH).

The U.S. DOT regulations define hazardous materials as a substance or material that the Secretary of Transportation has determined is capable of posing an unreasonable risk to health, safety, and property when transported in commerce and has designated as hazardous under Section 5103 of federal hazardous materials transportation law (49 U.S. Code [U.S.C.] 5103). The term includes hazardous substances, hazardous wastes, marine pollutants, elevated temperature materials, materials designated as hazardous in the Hazardous Materials Table (see 49 Code of Federal Regulations [CFR] 172.101), and materials that meet the defining criteria for hazard classes and divisions. When a substance meets the DOT definition of a hazardous material, it must be transported in accordance with safety regulations providing for appropriate packaging, communication of hazards, and proper shipping controls.

The Emergency Planning and Community Right-to-Know Act (EPCRA) was passed by Congress in 1986 (Title III of Superfund Amendments and Reauthorization Act (SARA). The EPCRA establishes requirements for federal, state, and local governments; Indian tribes; and industry regarding emergency planning and "Community Right-to-Know" reporting on hazardous and toxic chemicals. The Community Right-to-Know provisions help increase public's knowledge and access to information on chemicals at individual facilities, their uses, and releases into the environment. States and communities, working with facilities, can use the information to improve chemical safety and protect public health and the environment.

Key Provisions to the EPCRA

- **Emergency planning** – Local governments are required to prepare chemical emergency response plans, and to review plans at least annually. State governments are required to oversee and coordinate local planning efforts. Facilities that maintain Extremely Hazardous Substances (EHS) on-site in quantities greater than corresponding threshold planning quantities (TPQs) must also cooperate in preparing emergency plans.
- **Emergency release notification** – Facilities must immediately report accidental releases of EHSs and other hazardous substances, as defined under CERCLA. Any release of these substances in quantities greater than their corresponding reportable quantities must be reported to state and local officials.
- **Hazardous chemical storage reporting requirements** – Facilities handling or storing any hazardous chemicals, as defined under Occupational Safety and Health Administration (OSHA), must submit Safety Date Sheets (SDSs), to state and local officials and fire departments. Facilities must also submit an inventory form for these chemicals to state and local officials and local fire departments.
- **Toxic release inventory (TRI)** – Facilities must complete and submit a toxic chemical release inventory form (Form R) each year. Form R must be submitted for each of the over 600 TRI chemicals that are manufactured or other used above the applicable threshold quantities.

As part of the requirements for hazardous chemical storage reporting, facilities must submit an Emergency and Hazardous Chemical Inventory Form annually to the Local Emergency Planning Committee (LEPC), the State Emergency Response Commission (SERC), and the local fire department. Facilities provide either a Tier I or Tier II inventory form; however, most states require Tier II inventory forms. The forms need to be submitted on or before March 1 each year for information on chemicals present at the facility in the previous year.

In 1993, the State of Hawaiʻi enacted the Hawaiʻi Emergency Planning and Community Right-to-Know Act (HEPCRA) which is modeled after the federal EPCRA. Hawaiʻi Administrative Rules for implementing HEPCRA regulations became effective in November 2010. Similar to EPCRA, HEPCRA has four major provisions: (1) emergency response planning, (2) emergency release reporting, (3) hazardous chemical storage and Tier II reporting, and (4) toxic release inventory reporting. The Hawaiʻi DOH's Hazard Evaluation and Emergency Response (HEER) Office carries out the requirements of EPCRA as well as HEPCRA.

In addition to traditional hazardous materials stored or transported, on-site sewage disposal systems (OSDS) that provide wastewater treatment for multiple homeowners need to be maintained properly. The lack of maintenance or a physical impact to these systems can lead to an environmental release potentially contaminating nearby waterbodies and drinking water sources and compromising public health. The DOH's Clean Water Branch administers the Nonpoint Source management program, which includes the oversight of OSDSs, and develops the state's Nonpoint Source Management Plan with watershed-specific strategies to control pollution (Hawaiʻi State Department of Health 2021).

Location

Hazardous materials are widely stored and transported throughout the State of Hawaiʻi. An event involving hazardous materials release can occur anywhere; for this reason, the location of a hazardous materials release is classified as either being at a fixed site or in transit. A fixed-site hazardous materials release occurs at facilities that store and/or use hazardous materials and include refineries, warehouses, portside facilities and harbors, and Superfund sites. An in-transit hazardous materials release occurs while a hazardous material is being transported from one location to another along major highways, navigable waters, or via pipelines.

Fixed-Site Hazardous Materials

Serious hazardous materials incidents—those causing hospitalizations, deaths, and large-scale economic loss and environmental damage—are generally the result of a series of improbable events involving large quantities of material and are, thus, relatively rare and difficult to predict. Tier II reporting reveals the location and identity of large quantities of hazardous materials in storage and use. As of the date of this 2023 SHMP Update, there are 848 Tier II reporting facilities in the State of Hawaiʻi (Table 4.7-1).

Table 4.7-1. Hazardous SARA Tier II Reporting Facilities

County	Tier II Reporting Facilities
County of Kauaʻi	81
City and County of Honolulu	406
County of Maui	142
County of Hawaiʻi	219
Total	**848**

Source: (Hawaiʻi State Department of Health 2020)

Superfund Sites

In response to concerns regarding health and environmental risks, Congress established the Superfund program in 1980 to clean up sites in which hazardous materials were released and ultimately abandoned. The Superfund program is locally administered by the EPA in cooperation with the Hawaiʻi DOH HEER Office.

Federal regulations, including the 1980 CERCLA and SARA, required that a National Priorities List (NPL) of sites throughout the United States be maintained and revised at least annually (SARA amended CERCLA on October 17, 1986). The NPL is a list of sites of national priority among the known releases or threatened releases of hazardous substances, pollutants, or contaminants throughout the United States and its territories. The NPL is intended primarily to guide the EPA in determining which sites warrant further investigation. As of the date of this 2023 SHMP Update, there are three NPL (Superfund) sites in Hawaiʻi, all located in the City and County of Honolulu (U.S. Environmental Protection Agency 2022). In addition to the federal NPL sites, the Hawaiʻi DOH Response Program List of Priority Sites presents all sites in the state identified for potential or known non-emergency response actions managed by the HEER Office Site Discovery, Assessment, and Remediation Section Remedial Project Managers (RPMs). Sites are categorized as a potential hazard when sampling data indicate that contaminant concentrations exceed Hawaiʻi Environmental Action Levels. The list for the fiscal year 2020 includes 934 sites statewide that are managed within the HEER Office. Of those sites, 67 are listed as high priority, 225 as medium priority, 618 as low priority, and 13 as no further action unrestricted (Hawaiʻi State Department of Health 2020).

Both Superfund sites and identified high-priority sites increase the State of Hawaii's risk to impacts from other hazards, such as flooding, storm surge, and erosion, that can cause the migration or spread of hazardous materials throughout the environment. This will adversely impact both public and environmental health and addsignificant complications to recovery efforts following a disaster that impacts a Superfund site or high-priority site if identified hazardous materials are not properly contained.

In-Transit Hazardous Materials

Incidents involving hazardous substances in transit can occur anywhere in the state. The primary mode of vehicle transportation on island is via the highway network. The State of Hawaiʻi has a widespread highway network where hazardous materials may be transported.

Hazardous substances can also be transported via ships, barges, and pipeline in Hawaiʻi. Refinery feedstock and refined petroleum products are imported to the state via navigable waters. There are two crude oil refineries on the leeward coast of Oʻahu, in the vicinity of Campbell Industrial Park, that can produce a broad range of refined petroleum products. Because there are no inter-island pipelines to transport these products, refined petroleum products are loaded at Honolulu harbor terminals onto fuel barges for distribution to the other islands (U.S. Energy Information Administration 2022). Two barges transport propane gas from Oʻahu to the neighbor islands, and the gas is then routed by truck to various tanks and holders (Department of Commerce and Consumer Affairs 2022).

On the Island of O'ahu, petroleum is transported via pipeline from two crude oil refineries to other locations on the island (U.S. Energy Information Administration 2022). Figure 4.7-1 and Figure 4.7-2 show the gas transmission and hazardous liquids (refined petroleum products) pipelines. In addition, synthetic natural gas is distributed through nearly 1,000 miles of pipeline on Oʻahu (U.S. Energy Information Administration 2022).

With a hazardous substance release, whether accidental or intentional, several potentially exacerbating or The Red Hill Bulk Fuel Storage Facility is a military storage facility operated by the U. S. Navy on the Island of Oʻahu. It can store up to 250 million gallons of fuel in 20 underground tanks. Three gravity-fed pipelines run 2.5 miles to fueling piers at Pearl Harbor (U.S. Navy 2022). In 2021, about 21,000 gallons of jet fuel spilled, contaminating the underground aquifer and the Joint Base Pearl Harbor Hickam drinking water system, exposing thousands of people to JP-5 jet fuel in their drinking water. In March 2022, the Secretary of Defense announced the decision to defuel and permanently close the facility by 2027.

EXTENT

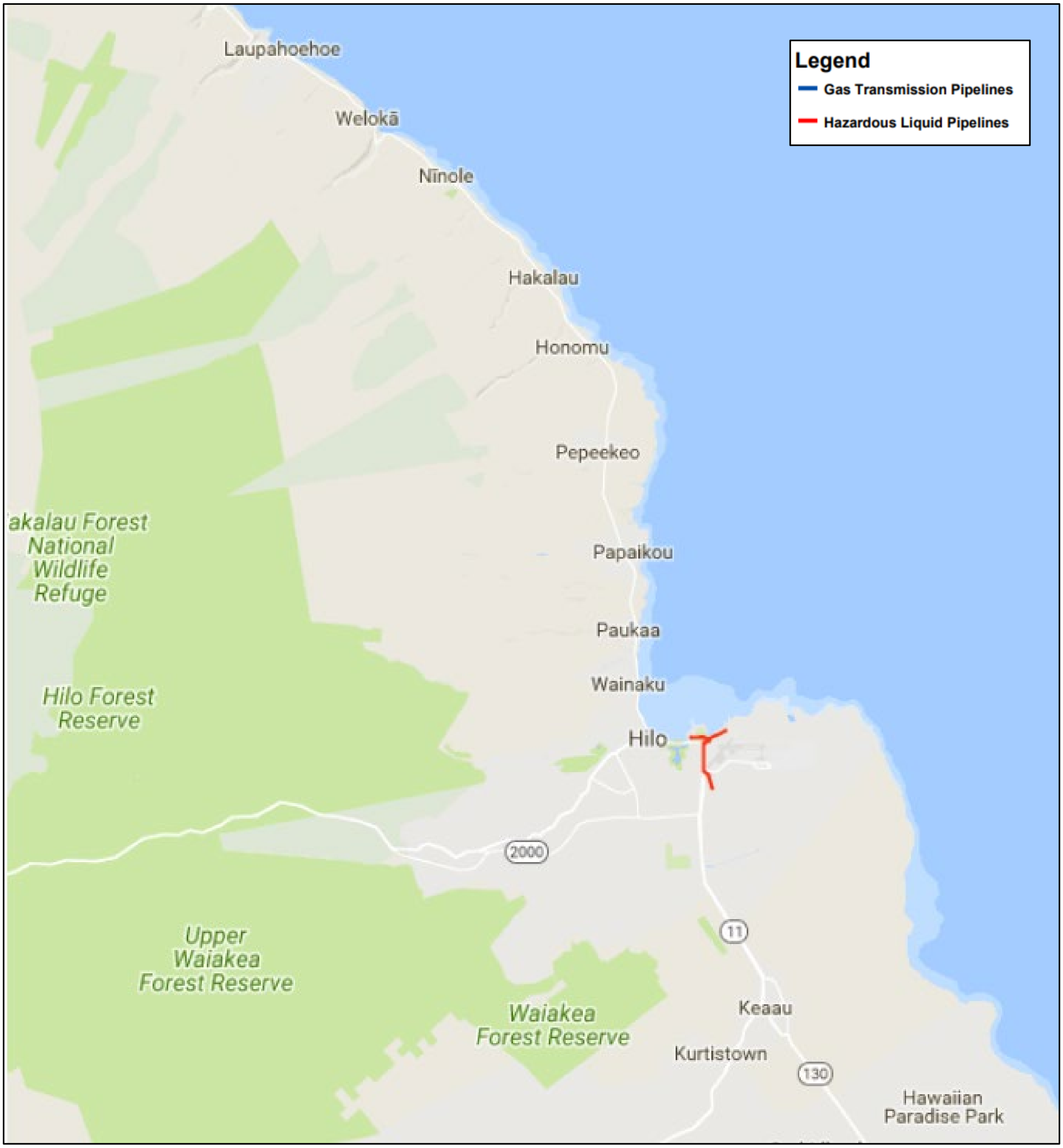
The extent of a hazardous substance release will depend on whether it is from a fixed or in-transit (mobile) source, the volume of substance released, duration of the release, the toxicity and properties of the substance, and the environmental conditions (for example, wind and precipitation, terrain, etc.).

Hazardous substance releases can contaminate air, water, and soils, possibly resulting in death and/or injuries and illnesses. Dispersion can take place rapidly when the hazardous substance is transported by water and wind. While often accidental, releases can occur as a result of human carelessness, intentional acts, or natural hazards. When caused by natural hazards, these incidents are known as secondary events. Such releases can affect nearby populations and contaminate critical or sensitive environmental areas.

mitigating circumstances will affect its severity of impact. Mitigating conditions are precautionary measures taken in advance to reduce the impact a release has on the surrounding environment. Primary and secondary containment or shielding by sheltering-in-place measures protects people and property from the harmful effects of a hazardous substance release. Exacerbating conditions, characteristics that can enhance or magnify the effects of a hazardous substance release, include:

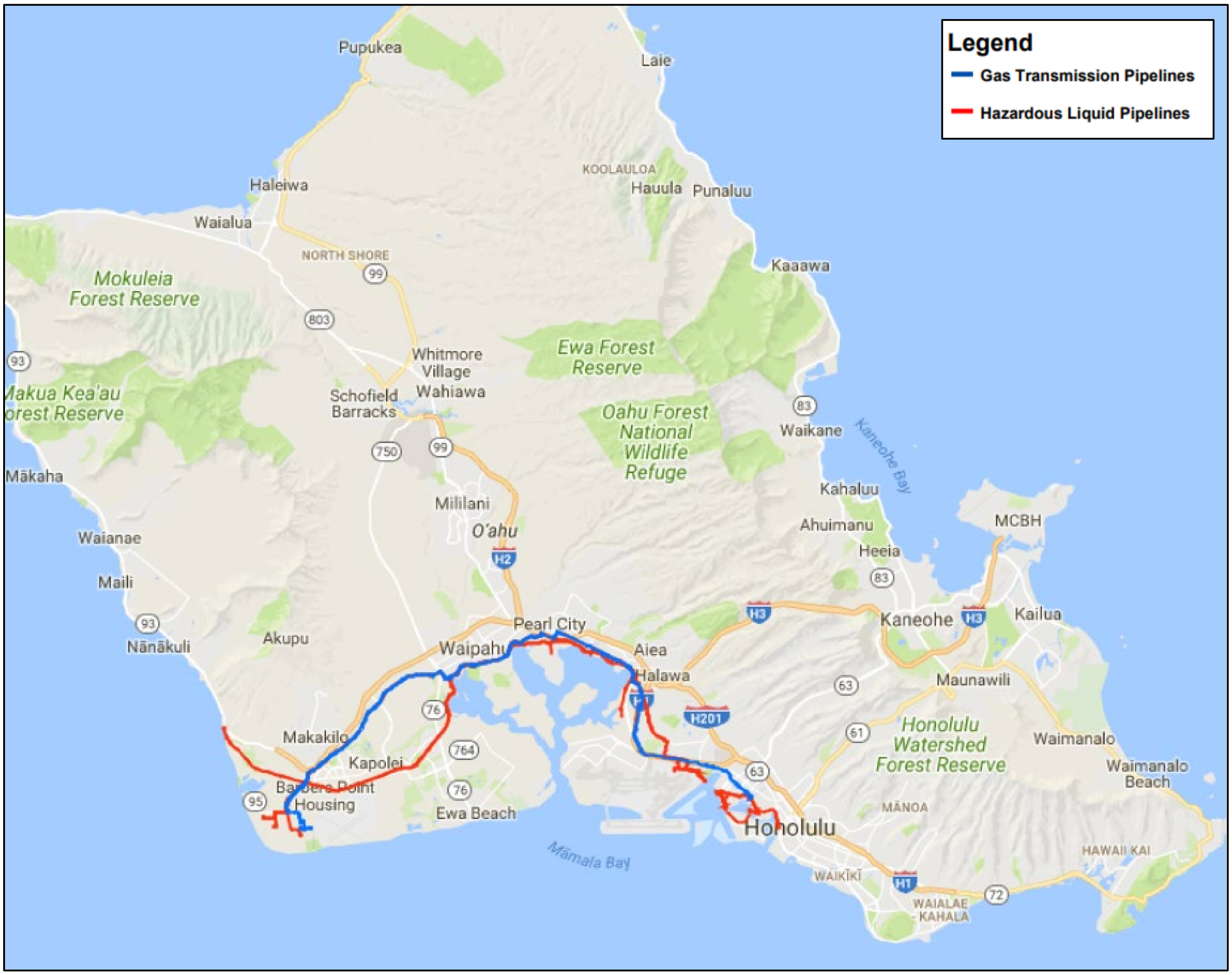
- Weather conditions, which affect how the hazard occurs and develops (such as wind speed and direction)
- Micro-meteorological effects of buildings and terrain, which alters the dispersion of hazardous substances in compliance with applicable codes (such as building or fire codes)
- Mechanical failures (such as fire protection and containment features), which can substantially increase the damage to the facility itself and to surrounding buildings
- Land use, population, and building density, which are factors contributing to the extent of exposure and impacts incurred

Figure 4.7-1. Petroleum and Gas Transmission Pipelines in the County of Hawaiʻi



Source: (U.S. Department of Transportation 2022)

Figure 4.7-2. Petroleum and Gas Transmission Pipelines in the City and County of Honolulu



Source: (U.S. Department of Transportation 2022)

The severity of a hazardous material incident is dependent not only on the circumstances described above but also with the type of substance released, distance from the release, and the related response time for emergency response teams to stabilize and contain the release. Generally, areas closest to a release are at the greatest risk due to their exposure to higher concentrations of the substance and the limited warning time before being impacted. However, depending on the substance/material, a release can rapidly travel great distances or remain present in the environment for long periods of time (e.g., centuries to millennia), allowing for greater dispersal and increasing the spatial extent of impact.

Warning Time

Warning time for a hazardous materials incident can be sudden without any warning (such as an explosion), or may develop slowly (such as a leaking container). Facilities that store extremely hazardous substances are required to notify local officials when an incident occurs. Local emergency responders and emergency management officials determine the need to evacuate the public or whether to advise people to shelter-in-place. Similar to on-site hazardous substances incidents, the amount of warning time for incidents associated with hazardous substances in-transit varies based on the nature and scope of the incident. If an explosion or hazardous materials release does not occur immediately following an accident, there may be time for warning adjacent neighborhoods and enough time to facilitate appropriate protective actions.

PREVIOUS OCCURRENCES AND LOSSES

The 2018 SHMP discussed hazardous material incidents that occurred in the State of Hawaiʻi through 2017. For this 2023 SHMP Update, hazardous material incidents (in-transit and fixed site) were summarized between January 1, 2018, through December 31, 2023. For events prior to 2018, please refer to Appendix E (Hazard Profile Supplement). This section is divided into the different forms of hazardous substance releases (fixed-site and in-transit).

Disaster and Emergency Declarations

No federal, state, or U.S. Department of Agriculture disaster declarations or proclamations for hazardous material-related incidents have been issued relevant to Hawaiʻi or any of its counties.

Fixed-Site Hazardous Materials

The release of hazardous materials has occurred frequently throughout the state. Releases are reported to the Hawaiʻi DOH HEER Office. Table 4.7-2 shows the number of releases reported to the HEER Office in 2018 through 2022. In the five-year period between 2018 and 2022, there have been 2,193 instances of fixed-site hazardous material releases, equating to over one incident per day across the state over a five-year period.

Table 4.7-2. Hazardous Materials Releases Reported to the HEER Office by County, 2018 to 2022

Year	County of Kauaʻi	City and County of Honolulu	County of Maui	County of Hawaiʻi	Total
2018	25	353	48	42	**468**
2019	26	318	60	42	**446**
2020	18	249	35	34	**336**
2021	22	324	40	50	**436**
2022	18	354	75	60	**507**
Total	**109**	**1,598**	**258**	**228**	**2,193**

Source: (Hawaiʻi State Department of Health 2022)

In-Transit Hazardous Materials

In-transit hazardous materials releases occur frequently. Most incidents are minor, but others cause significant impacts such as injury, evacuation, environmental damage, and the need for clean-up. Regulations in 49 CFR 171.15 and 171.16 govern situations where hazardous materials are released and the resulting required notifications and reporting. Unless they are properly reported, it is difficult to identify and track past hazardous materials releases that occur in-transit. Between 2018 and 2022, there were eight notable pipeline incidents recorded by government agencies and the news media. There were no large-scale in-transit highway, waterway, or aviation hazardous materials incidents during that timeframe. Further information on these incidents is listed in Table 4.7-3.

Table 4.7-3. In-Transit Hazardous Material Incidents from 2018 to 2022

Date of Incident	Event Type	Counties Affected	Impacts
January 9, 2018	Corrosion (pipeline)	Honolulu	74 barrels of refined petroleum spilled; $460,500 in damages
July 8, 2019	Corrosion (pipeline)	Honolulu	$82,602 in damages
August 11, 2019	Corrosion (pipeline)	Honolulu	1 barrel hazardous liquid spilled; $20,084 in damages
March 17 and June 2, 2020	Oil Release (pipeline)	Honolulu	About 7,700 gallons of fuel collected from the soil and water
January 26, 2021	Equipment Failure	Honolulu	12 barrels hazardous liquid spilled; $27,420 in damages
May 6–7, 2021	Operator Error (pipeline)	Honolulu	21,000 gallons of jet fuel spilled into a fire suppression line and additional jet fuel spilled into the environment
November 20–21, 2021	Pipeline Rupture	Honolulu	21,000 gallons of jet fuel released from fire suppression line; contaminated public water supply
November 29, 2022	Routine Maintenance Operation (pipeline)	Honolulu	1,300 gallons of Aqueous Film Forming Foam (AFFF) concentrate was released; $1.5 million in damages to date (see Figure 4.7-3)

Source: (US DOT Pipeline and Hazardous Materials Safety Administration 2022, U.S. Environmental Protection Agency 2022, Jedra 2022, McCullough 2022)

Figure 4.7-3. Naval Employees Relocate Soil Contaminated by Aqueous Film Forming Foam (AFFF) Concentrate in 2022

Credit: Spc. Matthew Mackintosh

Probability of Future Hazard Events

Overall Probability

Since there have been no federal declarations for hazardous material incidents in the State of Hawaiʻi, all events reported earlier in this section that occurred between 2018 and 2022 were used to calculate the probability of future occurrences. Based on the extrapolation of data available on the occurrence of previous events, the State of Hawaiʻi experiences over 300 hazardous material incidents each year. Therefore, there is a 100 percent chance of a hazardous material incident occurring in any given year in the state. However, as was the case for historical events in the state, the magnitude of the incidents expected to occur will vary widely from very minor releases to the potential for major events in which thousands of gallons of hazardous materials may be released and large populations of people are affected.

Climate Change Impacts

As discussed in Section 4.2 (Climate Change and Sea Level Rise), Section 4.6 (Flood), and Section 4.15 (Wildfire), it is highly likely that changing future conditions will exacerbate current conditions and increase future event-based flood and wildfire risk. Sites that store hazardous materials that are at risk from current flooding and wildfires will become more vulnerable as climate change accelerates these hazards. Flooding or wildfire could cause releases of hazardous materials if they are not properly stored or contained. The release of these hazardous materials may expose the nearby population and harm water and air quality and the overall environmental and economic health of the area.

In terms of sea level rise, septic tanks, cesspools, and other OSDS as well as other hazard materials and hazardous waste storage and disposal sites are located along the coast. The projected rise in sea level will eventually result in the failure of the OSDS. Unable to operate properly, they will contribute to the degradation of nearshore water quality. Additionally, a release from OSDS could change disease risk for coral reefs and negatively impact nearby coral and coastal resources. Refer to Section 4.2 (Climate Change and Sea Level Rise) regarding the sea level rise projections for the State of Hawaiʻi (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017).

A recent study indicates that tidally driven groundwater inundation of wastewater infrastructure is already occurring in urban Honolulu. The study shows that higher ocean water levels are leading to wastewater entering storm drains and the ocean (McKenzie, Habel and Henrietta 2021). As sea levels continue to rise, so will these hazardous materials releases.

4.7.2 VULNERABILITY ASSESSMENT

Overall, it is difficult to quantify potential losses due to hazardous material incidents because of the many variables that must be considered, including but not limited to the specific hazardous substance, quantity, location, time of day, meteorological conditions, surrounding environment and emergency response and clean-up capabilities. Potential impacts may be local, regional, or statewide depending on the magnitude of the event and level of service disruptions. A qualitative assessment is discussed below.

Assessment of State Vulnerability and Potential Losses

This section discusses statewide vulnerability of exposed state assets (state buildings and roads) community lifelines, and critical facilities to hazardous material incidents.

State Assets

Potential losses to state buildings caused by a hazardous materials release is difficult to monetize. The degree of damages to the asset depends on the scale of the incident. Generally speaking, all 6,095 state buildings are potentially vulnerable to a hazardous materials release. State assets proximate to Tier II facilities or NPL sites or transportation corridors that permit the transport of hazardous materials have an increased risk of exposure. Depending upon the incident, state employees may need to evacuate the building if exposure may impact human health. This may result in loss of productivity that can be measured by days and dollar equivalency. In terms of building-related and property damage, damage may include but is not limited to damage to heating, ventilation and air conditioning (HVAC) systems due to the corrosive effects of some chemicals and/or contaminated soil, groundwater, and nearby waterbodies.

All state roads that permit the transport of hazardous materials are potentially at risk of an incident. Transportation carriers must have response plans in place to address accidents; otherwise, the local emergency response team will step in to secure and restore the area. Quick response minimizes the volume and concentration of hazardous materials that disperse through air, water, and soil. Hazardous material releases may lead to road closures until response and clean-up efforts are completed. This may impact access to communities, commuting to work, and impact the ability to deliver goods and services efficiently.

Community Lifelines and Critical Facilities

Similar to state assets, potential losses to community lifelines and critical facilities caused by a hazardous materials release are difficult to monetize. The degree of damages to the asset depends on the scale of the incident. Critical facilities need to remain in operation before, during, and after disaster events. Loss of use will impact the services they provide to the state, which may have public safety and economic implications. Ports and harbors are critical points of entry that need to remain open and operational to maintain the vital just-in-time shipping logistics required to sustain each island. In the event of a large-scale hazardous materials release resulting in port closures, there will be cascading impacts statewide.

Assessment of Local Vulnerability and Potential Losses

This section provides a summary of vulnerability and potential losses to population, general building stock, and environmental resources and cultural assets. Each county's vulnerability and potential loss will vary greatly depending not only on the type and intensity of the release. The local HMPs were reviewed, and their discussion of hazardous material incidents is summarized below:

- **County of Kaua'i**—In the 2021 Kaua'i County Multi-Hazard Mitigation and Resilience Plan, hazardous materials are briefly discussed in the individual hazards section (Kaua'i Emergency Management Agency 2021). The County of Kaua'i has 77 Tier II facilities.

- **City and County of Honolulu**—The 2020 City and County of Honolulu Multi-Hazard Pre-Disaster Mitigation Plan addresses hazardous materials as a stand-alone hazard (City and County of Honolulu 2020). The City and County of Honolulu has the greatest number of Tier II facilities compared to the other counties (406 facilities). The three NPL sites in the State of Hawaiʻi are located in the City and County of Honolulu. In addition, the oil refineries and pipelines are on the island.
- **County of Maui**—In the 2020 Maui County HMP, the hazardous materials hazard was addressed with a qualitative analysis as a stand-alone hazard in the plan. According to the plan, Maui County has 12 EPA-designated Toxic Release Inventory (TRI) facilities that are considered critical infrastructure operations (Maui Emergency Management Agency 2020). Maui County has 139 Tier II facilities.
- **County of Hawaiʻi**—The 2020 Hawaiʻi County Multi-Hazard Mitigation Plan discusses hazardous materials in the individual hazard sections. In addition, there are 215 Tier II facilities on the County of Hawaiʻi.

Socially Vulnerable and Total Populations

All counties in the State of Hawaiʻi have Tier II facilities. For the purposes of this assessment, the entire population is exposed and could potentially be impacted by a hazardous materials release—a fixed-site hazardous material release, in-transit hazardous material release, or both. When hazardous substances are released in the air, water, or on land they may contaminate the environment and pose greater danger to human health. The general population may be exposed to a hazardous substances release through inhalation, ingestion, or dermal exposure. Exposure may be either acute or chronic, depending upon the nature of the substance and extent of release and concentration. The populations considered most vulnerable include the elderly (persons over the age of 65), the young, pregnant women and people who are ill or immunocompromised. Vulnerable communities nearest to hazardous materials sites are often composed of lower housing values, incomes, and education levels than the national average. These vulnerable communities have the least time to react in the event of a catastrophic hazardous material release (Orum, et al. 2014). Cascading events from a disaster are more likely to amplify and compound vulnerabilities.

Populations exposed to environmental contamination from hazardous materials may experience chronic stress for various reasons (e.g., health concerns, uncertainty, and community conflict). This can be compounded when socially vulnerable populations do not have the resources to move to another location or seek medical help. Some may feel exploited, dismissed, powerless, unheard, or unsupported (Agency for Toxic Substances and Disease Registry 2021).

Populations living and/or working near facilities that produce, store, or transport hazardous substances are at higher risk to exposure. In particular, populations downstream, downwind, and downhill of a released substance are particularly vulnerable. Depending on the type of release and environmental conditions, people may be evacuated as a precaution or instructed to shelter-in-place. Section 4.16 (Windstorm) discusses the unique terrain in the state and how this impacts wind effects and speeds in each county, which can plan a role in the dispersion of airborne chemical releases.

Populations living and/or working near major transportation routes (such as Interstates H1, H2, H3, and H201) are more vulnerable to a hazardous materials release because of the potential for chemicals to be transported on these major thoroughfares. Hazardous substances can also be transported via pipeline. There are petroleum and gas transmission lines on the City and County of Honolulu, and the County of Hawaiʻi (Figure 4.7-1 and Figure 4.7-2). The closure of waterways, ports, harbors, airports, highways, or refineries as a result of a hazardous materials release has the potential to impact the ability to deliver goods and services efficiently and could have cascading economic impacts to other islands.

Overall, the entire population of the State of Hawai'i is exposed and vulnerable to hazardous material releases.

General Building Stock

Hazardous material releases can damage and destroy public, commercial, and private property. Losses include both direct and indirect costs. Direct costs can be defined as:

- The cost of materials
- Property damage
- Response cost
- Remediation/clean-up cost for a specific release

All other costs and losses from hazardous material releases are indirect. Indirect costs include:

- Loss of productivity as a result of damage to land, facilities, or interruption of services
- Loss of access to recreation lands and facilities
- Cost of lost human productivity due to injury and death
- Damages to ecosystems
- The cost of litigation as a consequence of the release

Damages to transportation infrastructure and their closure is not uncommon following a hazardous materials release. Similar to the fixed-site hazardous materials release, the greatest risk to population and the built environment would be from an explosion from hazardous materials in transport. Proximity, intensity and the structural integrity of the building itself are all factors in the subsequent vulnerability and expected damage.

Environmental Resources

A hazardous substance release, whether fixed-site or in-transit, can negatively impact the natural environment. Depending on the nature and amount of the substance, the release may contaminate the air, water, or soil, potentially causing concern for direct human and animal exposure, recreational usage, crop irrigation, and fish and wildlife consumption.

Water contamination, whether surface water, groundwater, or marine, is an immediate concern from a hazardous materials release potentially impacting potable water supplies. Wildlife and recreational activities may also be impacted. Hazardous material releases could also significantly impact soils, including agricultural lands. Depending on the characteristic of the hazardous material and/or the volume of product involved, the affected area can be as small as several square feet or as large as many square miles that require soil remediation. Such environmental damage can linger for decades and result in extensive remediation costs.

Coral reef ecosystems are fragile and extremely vulnerable to environmental stresses, including runoff and oil spills. Runoff from land-based pollution sources may include hazardous materials that carry sediment, high levels of nutrients from agricultural areas, sewage outflows, or pollutants such as petroleum products and pesticides. The degree of damage will depend upon the coral species, life stage, and exposure. Impacts can result in bleaching, which can damage or kill coral depending upon the severity and duration of the environmental stress (National Oceanic and Atmospheric Association 2022, National Oceanic and Atmospheric Association 2022).

Cultural Assets

Loss of and harm to native species and ecosystems as a result of a hazardous materials release will adversely impact the Hawaiian cultural traditions and practices, which are closely tied to the natural environment. Hawaiian fishponds may be impacted by a hazardous materials release. Depending on the material, the release may kill the fish species, or the bioaccumulation of pollutants can affect animals high on the food chain long after a release. Additionally, site remediation efforts following a hazardous material release can result in adverse impacts to archeological resources and sensitive cultural areas in the attempt to remove and/or excavate contaminated sediments from an affected area.

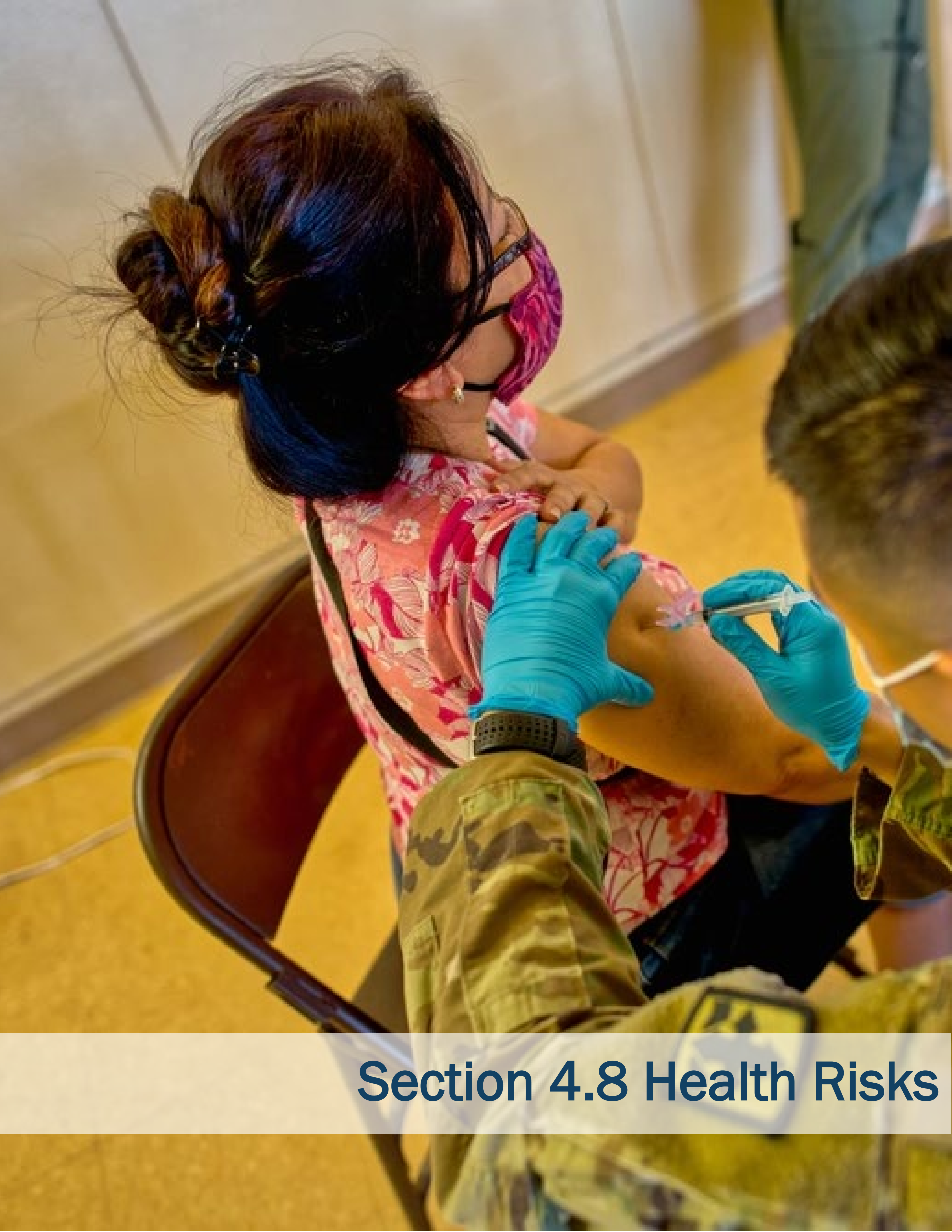
Future Changes that May Impact State Vulnerability

Understanding future changes that impact vulnerability in the state can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The state considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

As development continues and populations increase, the risk for a hazardous material release and the potential impacts to the population, infrastructure, and environmental and cultural resources will increase as well. The number and types of hazardous chemicals stored in and transported through the state will likely continue to increase. As the population grows, the number of people vulnerable to the impacts of hazardous materials spills and transportation incidents will increase. Population and business growth along major transportation corridors increases the vulnerability to transportation-related hazardous material spills. Growth increasing commercial and residential density near fixed-site hazardous materials facilities will also increase vulnerability.

Section 4.8 Health Risks



Health Risks

Hawaiʻi is vulnerable to a wide range of health risks, all of which can be exacerbated by natural and human-caused hazards the State faces as well as by the high flow of international and domestic travelers. The islands have limited healthcare infrastructure, which means health risks are a serious concern.

CHANGES SINCE 2018

+1 Declared Disasters

+3 Health Risk Events

COUNTIES MOST VULNERABLE

Kauaʻi Honolulu Maui Hawaiʻi

SOCIALLY VULNERABLE POPULATION

22.3% Of Total Population

316,257 Persons

HAZARD RANKING

Low Medium High

COMMUNITY LIFELINES

1,369

Total

CLIMATE PROJECTIONS

Over half of known infectious diseases can be aggravated by climate change

More flooding will spread infectious agents in water on a wider scale

Changes in temperature and precipitation can influence seasonality, distribution, and prevalence of vector-borne diseases

Health risk impacts on these physical state assets are unknown at this time.

Environmental Resources

State Buildings

Miles of State Road

Hawaiian Home Lands

Cultural Resources

CONTENTS

TABLES

FIGURES

[1] *Section Cover Photo: Vaccination clinic on Kauaʻi. Photo by 1st Lt. Anyah Peatross*

SECTION 4. RISK ASSESSMENT

4.8 HEALTH RISKS

2023 SHMP Update Changes

- Information has been added about the COVID-19 pandemic.
- Health risk events that occurred in the State of Hawaiʻi from January 1, 2018 through December 31, 2022, were researched for this 2023 SHMP Update.
- New and updated figures from federal and state agencies are incorporated.
- This section now includes a discussion of how health risks impact socially vulnerable populations and community lifelines.

4.8.1 HAZARD PROFILE

The state is vulnerable to natural hazards. Health-related impacts have occurred with natural hazards, especially where water quality is compromised. Climate-related extreme events have resulted in gastrointestinal illness, respiratory problems (especially from wildfires and volcanic gas emissions), and vector-borne outbreaks, such as dengue fever. It is important to consider potential health-related disasters and to factor these considerations in disaster risk reduction efforts and hazard mitigation planning. These and other risks to human health that occur as a result of natural hazard events are discussed throughout Section 4 (Risk Assessment). This section focuses on the COVID-19 pandemic, infectious disease, pandemic flu, and bioterrorism hazards that may impact the state's resident and visitor populations. Volcanic emissions and volcanic ash, which are hazardous to human health, are discussed in Section 4.14 (Volcanic Hazards); human health impacts related to contaminated flood water are discussed in Section 4.6 (Flood).

Hazard Description

The following provides a brief description of the health risks of concern in the State of Hawaiʻi. This is not a comprehensive assessment of all health risks that may impact Hawaii's residents and visitors; rather it is a brief overview of risks and vulnerability in the state.

Coronavirus Disease (COVID-19)

COVID-19 is an infectious disease caused by the SARS-CoV-2 virus. The virus can spread in small liquid particles from the mouth or nose of infected persons when they cough, sneeze, speak, sing, or breathe. Most people infected with the virus experience mild to moderate respiratory illness and recover without requiring special treatment. However, some become seriously ill and require medical attention. Older people and those with underlying medical conditions such as cardiovascular disease, diabetes, chronic respiratory disease, or cancer are more likely to develop serious illness. Anyone at any age can get sick with COVID-19 and become seriously ill or die (World Health Organization 2022).

Vector-Borne Disease

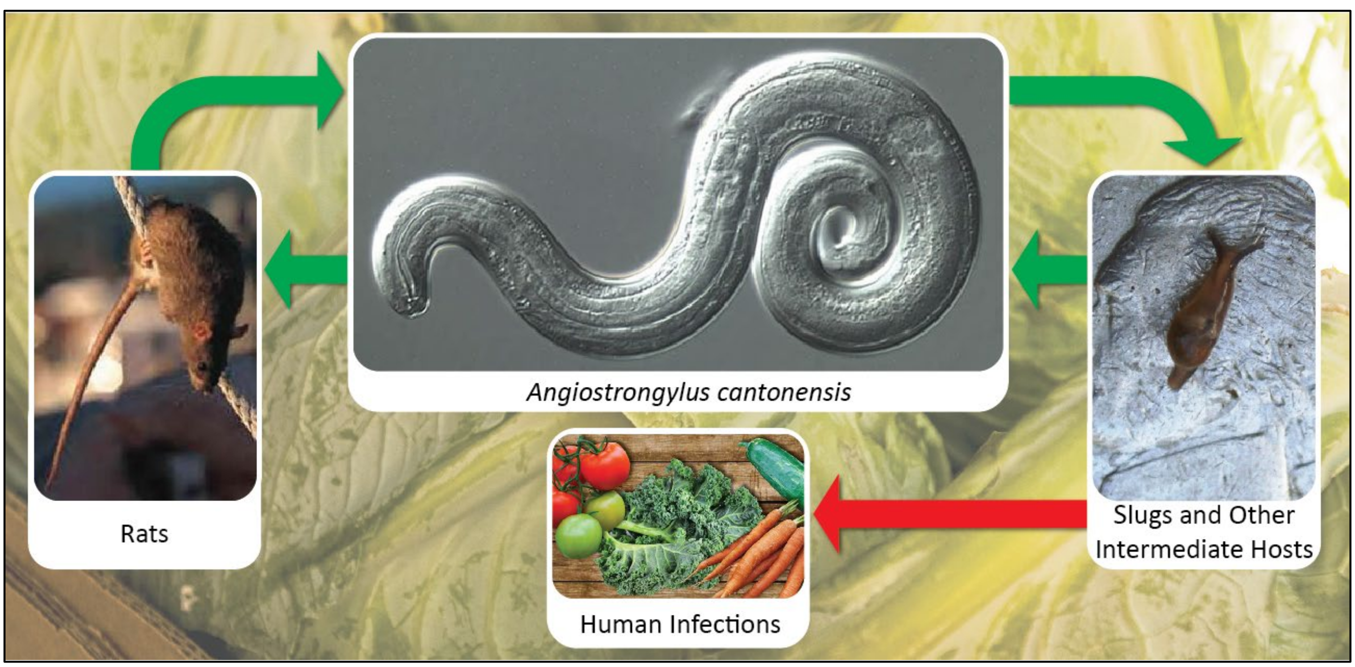
Vector-borne diseases account for more than 17 percent of all infectious diseases worldwide. Vectors are living organisms that can transmit infectious diseases between humans or from animals to humans (World Health Organization 2020). The most common disease vectors in Hawaiʻi are mosquitoes (

Figure 4.8-1) and parasites (Figure 4.8-2). The geographic distribution of these vectors is expected to expand with climate change, potentially increasing the risk of these illnesses in Hawaiʻi.

Figure 4.8-1 Aedes albopictus (left) and Aedes aegypti (right) mosquitoes are common vectors for disease and illness in Hawaiʻi

Source: (Centers for Disease Control and Prevention 2022)

Figure 4.8-2. Rat Lungworm Host and Infection Cycle



Source: (State of Hawaiʻi, Department of Health 2022)

Dengue Fever

Dengue fever is a viral illness spread by *Aedes* mosquitoes. The *Aedes aegypti* or *Aedes albopictus* mosquito are the primary transmitters of the virus. The last reported dengue outbreak on Hawaii Island was from 2015–2016 (State of Hawaiʻi, Department of Health 2022). Symptoms appear 4 to 7 days after being bitten by a mosquito that is infected with the virus and include high fever, rash on the arms and legs, body aches, and headache. Dengue fever is not transmitted directly from one person to another; however, mosquitoes can transmit the disease by biting an infected individual and becoming a carrier of the virus, capable of infecting other people.

Chikungunya

Chikungunya is a viral illness spread by being bitten by mosquitoes. Symptoms include fever, severe joint pain, headache, muscle pain, joint swelling, nausea, vomiting, redness around the eyes, and rash. Individuals who have been infected generally recover within 7–10 days. Chikungunya cannot be passed from one person to another. Though there are no vaccines or specific treatment procedures, death from chikungunya is not common (State of Hawaiʻi, Department of Health 2022).

Zika

Zika is a viral illness that can be spread to people through mosquito bites. It was first discovered in a monkey in the Zika forest of Uganda in 1947. Before 2015, outbreaks were reported in areas of Africa, Southeast Asia, and the Pacific Islands. In 2015, outbreaks of Zika were reported in Brazil and other South American countries. To date, there have been no cases of locally acquired Zika infections in Hawaiʻi (State of Hawaiʻi, Department of Health 2022).

People are infected with Zika virus primarily through the bite of an infected *Aedes aegypti* or *Aedes albopictus* mosquito, which are the same mosquitoes that spread dengue fever and chikungunya. The mosquito becomes infected when it bites a person who is already infected with the Zika virus. It takes a week or more for the Zika virus to replicate in the mosquito; then, the mosquito can transmit the virus to a new person (State of Hawaiʻi, Department of Health 2022).

Rat Lungworm

Rat lungworm is a disease caused by a parasitic nematode (roundworm parasite) called *Angiostrongylus cantonensis* and is a disease that can affect the brain and spinal cord (State of Hawaiʻi, Department of Health 2022). The adult form of *A. cantonensis* is only found in rodents. However, infected rodents can pass larvae of the worm in their feces. Snails, slugs, and certain other animals (including freshwater shrimp, land crabs, and frogs) can become infected by ingesting these larvae; these are considered intermediate hosts. Humans can become infected with rat lungworm if they eat (intentionally or otherwise) a raw or undercooked infected intermediate host, thereby ingesting the parasite. Sometimes people can become infected by eating raw produce that contain small infected snails or slugs. Rat lungworm is not spread person-to-person.

Rat lungworm can cause a rare type of meningitis (eosinophilic meningitis). While some infected people may not have any symptoms or only have mild symptoms, others infected may develop symptoms that are much more severe. There is no specific treatment for the disease, and symptoms usually last between 2 to 8 weeks (State of Hawaiʻi, Department of Health 2022).

Water-Borne Disease

Water-borne diseases are conditions caused by pathogenic micro-organisms that are transmitted in water. Disease can be spread from swimming, washing, drinking water, or eating food exposed to infected water. Increased flooding expected from climate change is expected to increase exposures to these micro-organisms, resulting in more infections in Hawaiʻi.

Leptospirosis

Leptospirosis is a bacterial disease that affects humans and animals. It is caused by bacteria of the genus *Leptospira*. Humans can get leptospirosis through direct contact with urine from infected animals or through water, soil, or food contaminated with their urine. In humans, leptospirosis causes a wide range of symptoms, and some infected persons may have no symptoms at all. Symptoms of leptospirosis include high fever, severe headache, chills, muscle aches, and vomiting, and may include jaundice (yellow skin and eyes), red eyes, abdominal pain, diarrhea, or a rash. If the disease is not treated, patients may develop kidney damage, meningitis (inflammation of the membrane around the brain and spinal cord), liver failure, and respiratory distress. In rare cases, death occurs. Many of these symptoms can be mistaken for other diseases. Leptospirosis is confirmed by laboratory testing of a blood or urine sample.

Leptospirosis occurs worldwide but is most common in temperate or tropical climates. It is an occupational hazard for many people who work outdoors or with animals, for example, farmers, sewer workers, veterinarians, fish workers, dairy farmers, or military personnel. It is a recreational hazard for campers or those who participate in outdoor sports in contaminated areas and has been associated with swimming, wading, playing in contaminated streams and waterfalls and navigating flood waters. The incidence is also increasing among children who live in urban areas.

Legionnaires' Disease

Legionnaires' illness is caused by *Legionella*, a type of bacterium found naturally in freshwater environments. *Legionella* becomes a health concern when it grows and spreads in human-made building water systems not properly maintained (Centers for Disease Control and Prevention 2021). Legionnaires' disease is a very serious type of pneumonia caused by inhalation of small droplets of water containing the bacteria. Early symptoms of Legionnaire's disease include muscle aches, headaches, loss of appetite, tiredness, and cough, often followed by chills, diarrhea, and high fever. Symptoms of Legionnaire's disease can be difficult to distinguish from other cases of pneumonia and typically begin to occur 5 to 6 days after exposure to *Legionella* bacteria; however, the incubation period can range from two days to almost two weeks (State of Hawaiʻi, Department of Health 2022).

Outbreaks of Legionnaires' disease are often associated with large or complex water systems, like those found in hospitals, hotels, and cruise ships. The disease is typically treated with antibiotics that kill the bacteria in the body. Most people healthy people exposed to *Legionella* do not get sick. Those with increased risk of getting sick are people over 50 years of age, smokers, and people with compromised immune systems, cancer, lung disease, or other underlying illnesses (Centers for Disease Control and Prevention 2021).

Pandemic Flu

There are numerous types of pandemic flu, and the strains of the virus continue to mutate and change. Novel influenza represents the emergence of new subtypes of the influenza virus that have not previously been identified and represent a class of viruses against which there is little to no pre-existing immunity or vaccine. Each county has been required to develop procedures for dealing with this type of threat. While many of the recommendations include social distancing, it is important to plan for the eventuality of a pandemic to determine how to maintain businesses and services to prevent economic collapse in addition to the health threats.

H5N1 or Avian Flu

Avian influenza is an infection caused by avian influenza (bird flu) viruses. These influenza viruses occur naturally among birds. Wild birds worldwide carry the viruses in their intestines but usually do not get sick from them. However, avian influenza is very contagious among birds and can make some domesticated birds, including chickens, ducks, and turkeys, very sick and kill them.

Infected birds shed influenza virus in their saliva, nasal secretions, and feces. Susceptible birds become infected when they have contact with contaminated secretions/excretions or with surfaces that are contaminated with secretions/excretions from infected birds. Domesticated birds may become infected with avian influenza virus through direct contact with infected waterfowl or other infected poultry or through contact with surfaces (such as dirt or cages) or materials (such as water or feed) that have been contaminated with the virus.

Scientists are concerned that H5N1 virus one day could be able to spread easily from one person to another. Because these viruses do not commonly infect humans, there is little or no immune protection against them in the human population. If H5N1 virus were to gain the capacity to spread easily from person-to-person, an influenza pandemic could begin.

H1N1 or Swine Flu

During the period from 2007 to 2010, there were incidents of swine flu (H1N1) outbreaks in the State of Hawaiʻi. Of particular concern is the 2009 outbreak of H1N1 pandemic that resulted in several deaths. Similar to other outbreaks, the virus spread with international travelers. This is particularly concerning for the state since it is among the most remote places on the planet, and it will be difficult to sustain livelihoods should the state lose connection with the United States mainland or international travel due to quarantines or travel restrictions.

Bioterrorism

The Center for Disease Control (CDC) defines a bioterrorism attack as the deliberate release of viruses, bacteria, or other germs (agents) used to cause illness or death in people, animals, or plants. These agents are typically found in nature, but it is possible that they could be changed to increase their ability to cause disease, make them resistant to current medicines, or increase their ability to be spread into the environment. Biological agents can be spread through air, water, or food. Terrorists may use biological agents because they can be extremely difficult to detect and may not cause illness for several hours to several days. Some bioterrorism agents, such as the smallpox virus, can be spread from person-to-person and some, such as anthrax, cannot.

Location

The state's central location between the continental United States and Asia, with hundreds of thousands of visitors each month, leads to considerable exposure to and potential for the introduction of new or re-emerging health risks. Health events can cover a wide geographic area and can affect large populations, including any of the Hawaiian Islands. Size and extent of an infected population depends on how easily the illness is spread, mode of transmission, and amount of contact between infected and uninfected individuals. Locations with higher density populations are more susceptible to outbreaks, as disease can be transmitted easier between people due to their proximity to infected individuals. Additionally, facilities that group vulnerable populations, such as daycare centers, schools, senior centers and medical facilities, may also contribute to disease transmission.

Extent

The U.S. Centers for Disease Control and Prevention have defined levels of disease as follows (Centers for Disease Control and Prevention n.d.):

- *Sporadic* refers to a disease that occurs infrequently and irregularly.
- *Endemic* refers to the amount of a particular disease that is usually present in a community. This level is not necessarily the desired level but rather is the observed level.
- *Hyperendemic* refers to persistent, high levels of disease occurrence.
- *Epidemic* refers to an increase, often sudden, in the number of cases of a disease above what is normally expected in that population in that area.
- *Outbreak* carries the same definition of epidemic but is often used for a more limited geographic area.
- *Cluster* refers to an aggregation of cases grouped in place and time that are suspected to be greater than the number expected, even though the expected number may not be known.
- *Pandemic* refers to an epidemic that has spread over several countries or continents, usually affecting a large number of people.

Severity of a disease depends on a number of factors. These include the size of the vector populations (the population size and distribution of insects or animals capable of transmitting a disease, e.g., mosquito-borne illnesses), aggressiveness of the disease, ease of transmission, and factors associated with the impacted community (e.g., access to medical care, demographic data, and population density). High-risk populations considered more vulnerable to various health hazards are described in the vulnerability assessment.

The magnitude of an infectious disease outbreak is also related to the ability of the public health and medical communities to stop the spread of the disease. Most disease outbreaks that cause catastrophic numbers of deaths are infectious in nature, meaning that they are spread from person-to-person. The public health and health care providers in Hawaiʻi routinely utilize known and established methods to reduce morbidity and mortality from infectious disease. However, the capacity of the health care system is limited and varies from county to county.

The severity of the impact of influenza depends on the nature of the outbreak, whether it is pandemic flu or seasonal flu. Pandemic flu should not be confused with seasonal flu. Seasonal flu is a less severe concern because of its regularity of occurrence and predictability. Table 4.8-1 lists key differences between pandemic and seasonal flus.

Table 4.8-1. Seasonal Flu Versus Pandemic Flu

Seasonal Flu	Pandemic Flu
Influenza (flu) is a contagious respiratory illness caused by flu A and B viruses that infect the human respiratory tract. Annual flu epidemics occur among people worldwide.	A flu pandemic is a global outbreak of a new flu A virus in people that is very different from current and recently circulating seasonal flu A viruses.
Epidemics of seasonal flu happen every year. Fall and winter are the time for flu in the United States.	Flu pandemics happen rarely. Four flu pandemics have happened in the past 100 years, but experts agree another one is inevitable.
Flu viruses are thought to spread mainly from person-to-person through droplets made when someone with flu coughs, sneezes, or talks near a person (within 6 feet).	Pandemic flu viruses would spread in the same way as seasonal flu, but a pandemic virus will likely infect more people because few people have immunity to the pandemic flu virus.
Seasonal flu vaccines are made each year to vaccinate people against seasonal flu. Everyone 6 months and older should get a flu vaccine every year. For most people, only one dose of vaccine is needed.	Although the U.S. government maintains a limited stockpile of some pre-pandemic flu vaccines, vaccines may not be widely available in the early stages of a pandemic. Two doses of pandemic flu vaccine will likely be needed.
Prescription medications called antiviral drugs can treat seasonal flu. During a severe flu season, there can be spot shortages of these drugs.	Flu antiviral medications may be used to treat pandemic flu if the virus is susceptible to these drugs. While a limited amount of flu antiviral drugs are stockpiled for use during a pandemic, supplies may not be enough to meet demand during a pandemic.
Young children, people 65 years and older, pregnant women, and people with certain long-term medical conditions are more likely to have serious flu complications.	Because this is a new virus not previously circulating in humans, it is not possible to predict who would be most at risk of severe complications in a future pandemic. In some past pandemics, healthy young adults were at high risk for developing severe flu complications.

Source: (Centers for Disease Control and Prevention 2018)

Health-related events, such as pandemics, are inevitable and arrive with very little warning. Identification, containment, and treatment of pandemic outbreaks and even cases of bioterrorism are further complicated by the highly transient nature of the tens of thousands of daily visitors, the state's isolation, and the associated delay in importing the necessary medical supplies, medicines, and resources (County of Kauaʻi 2015).

As experienced at the start of the COVID-19 pandemic, air travel increases the speed of spread of a new virus and decrease the time available for implementing interventions. Passengers traveling through the state's airports are monitored for disease by airline crews, the federal Transportation Security Administration (TSA) staff, and state health officials. The Centers for Disease Control and Prevention (CDC) staff responds to reports of illnesses on airplanes, cruise, and cargo vessels at international ports of entry. The CDC operates a quarantine station at the Daniel K. Inouye International Airport in Honolulu. The station's jurisdiction includes all ports in Hawaiʻi, Guam, American Samoa, the Freely Associated States and the Commonwealth of the Northern Mariana Islands (Centers for Disease Control and Prevention 2021).

Outbreaks are expected to occur simultaneously throughout much of the United States, potentially limiting the availability of federal and or inter-state assistance in the form of human and material resources that usually occur in response to other disasters. Warning time for a disease outbreak will depend on the origin of the virus, virus incubation time (the duration required before an individual begins to develop symptoms of an illness), and the amount of time needed to identify the virus.

PREVIOUS OCCURRENCES AND LOSSES

According to the Hawaiʻi State Department of Health, 369,914 cases of COVID-19 were reported through December 14, 2022. The state also saw 8,067 cases of influenza in 2018, 240 cases of the mumps in 2018, 32 cases of Leptospirosis in 2019, and 25 cases of Legionellosis in 2022 (see Tables Table 4.8-2 and Table 4.8-3). For this 2023 SHMP Update, notable diseases also include chikungunya, dengue fever, influenza, leptospirosis, legionellosis, mumps, rat lungworm, and Zika.

Table 4.8-2. Significant Health Risk Events in the State of Hawaiʻi, 2018 to 2022

Date(s) of Event	Event Type	Counties Affected	Description
January 2020–December 14, 2022	COVID-19	Kauaʻi, Honolulu, Maui, Hawaiʻi	369,914 cases; 1,748 deaths

Source: (State of Hawaiʻi, Department of Health 2022)

Table 4.8-3. Reported Cases of Notable Diseases in the State of Hawaiʻi

Disease	2018	2019	2020	2021	2022
Chikungunya[a]	2	3	0	0	0
Dengue Fever[a]	18	20	5	0	3
Influenza [a] (lab-confirmed)	8,067	4,673	3,104	28	5177
Legionellosis[a]	23	22	16	15	25
Leptospirosis[a]	22	32	10	13	9
Mumps[a]	240	4	3	0	3
Rat Lungworm	11	11	6	7	1
Zika[a]	7	2	0	0	0

Source: (State of Hawaiʻi, Department of Health 2022)
Note:
a. Statistics are provided to the CDC to monitor national public health

Disaster and Emergency Declarations

The following disaster declarations or emergency proclamations related to public health have been issued for Hawaiʻi:

- **Federal disaster (DR) or emergency (EM) declarations, 1955 – 2022**: 1 event, classified as “biological (COVID)”
- **Hawaiʻi state emergency proclamations, 2018 – 2022**: 38 proclamations and supplementary proclamations related to COVID-19
- **U.S. Department of Health and Human Services public health emergency declarations**, 2018–2022: 2 nationwide events, classified as COVID-19 and Monkeypox
- **USDA agricultural disaster declarations, 2012 – 2022**: none

Table 4.8-2 shows significant health events that have occurred in the state between 2018 and 2022. Records of health risks prior to 2018 as documented in the 2018 SHMP are provided in Appendix E (Hazard Profile Supplement).

Probability of Future Hazard Events

Overall Probability

The best predictor of the probability of future health risks is the state's history of these events. The state can expect thousands of cases of COVID-19 and the flu, and several cases of mosquito-borne illnesses each year, with periodic outbreaks (15 years passed between the last two outbreaks of dengue fever).

The popularity of the State of Hawaiʻi as a tourist destination will also drive future health events. The Daniel K. Inouye International Airport currently serves 2.5 million international passengers annually. The Kahului Airport serves 156,000 each year, and Ellison Onizuka Kona International Airport at Keāhole serves 30,000 each year. Additionally, 67,000 cruise and cargo ship passengers and crew visit the state each year (Centers for Disease Control and Prevention 2021). As the number of people traveling into and out of the state increases, so does the possibility of disease transmission.

Additionally, infrastructure and environmental quality have significant contributions to public health. Deterioration of either man-made or environmental systems can result in adverse impacts to public health, increasing the state's vulnerability to public health emergencies.

Climate Change Impacts

Studies at the University of Hawaiʻi at Mānoa have shown that over half of known infectious diseases can be aggravated by climate change (Mora, et al. 2022).

Changes in temperature and precipitation can influence seasonality, distribution, and prevalence of vector-borne diseases, which are influenced significantly by high and low temperature extremes and precipitation patterns (Rocklöv and Dubrow 2020). A changing climate may also create conditions favorable for invasive mosquitoes in Hawaiʻi. Research into modeling vector-borne diseases and climate change has shown an accelerating invasion potential of the *Aedes aegypti* mosquito (Iwamura, Guzman-Holst and Murray 2020) and subsequent potential spread of related illnesses. In addition, infectious agents and chemical toxins in water will spread on a wider scale as more flooding results from climate change. Floodwaters that remain in small, still pools after flooding has subsided can provide additional habitat for mosquito reproduction. This leads to more mosquitoes that can carry diseases such as dengue fever, chikungunya, and Zika (Kulkarni, Duguay and Ost 2022). More flooding will also expose more people to waterborne infectious diseases such as leptospirosis.

Extreme heat events are increasing in frequency and duration. When extreme heat persists for more than two days, the population is more likely to experience serious health risks or even death (Figure 4.8-3).

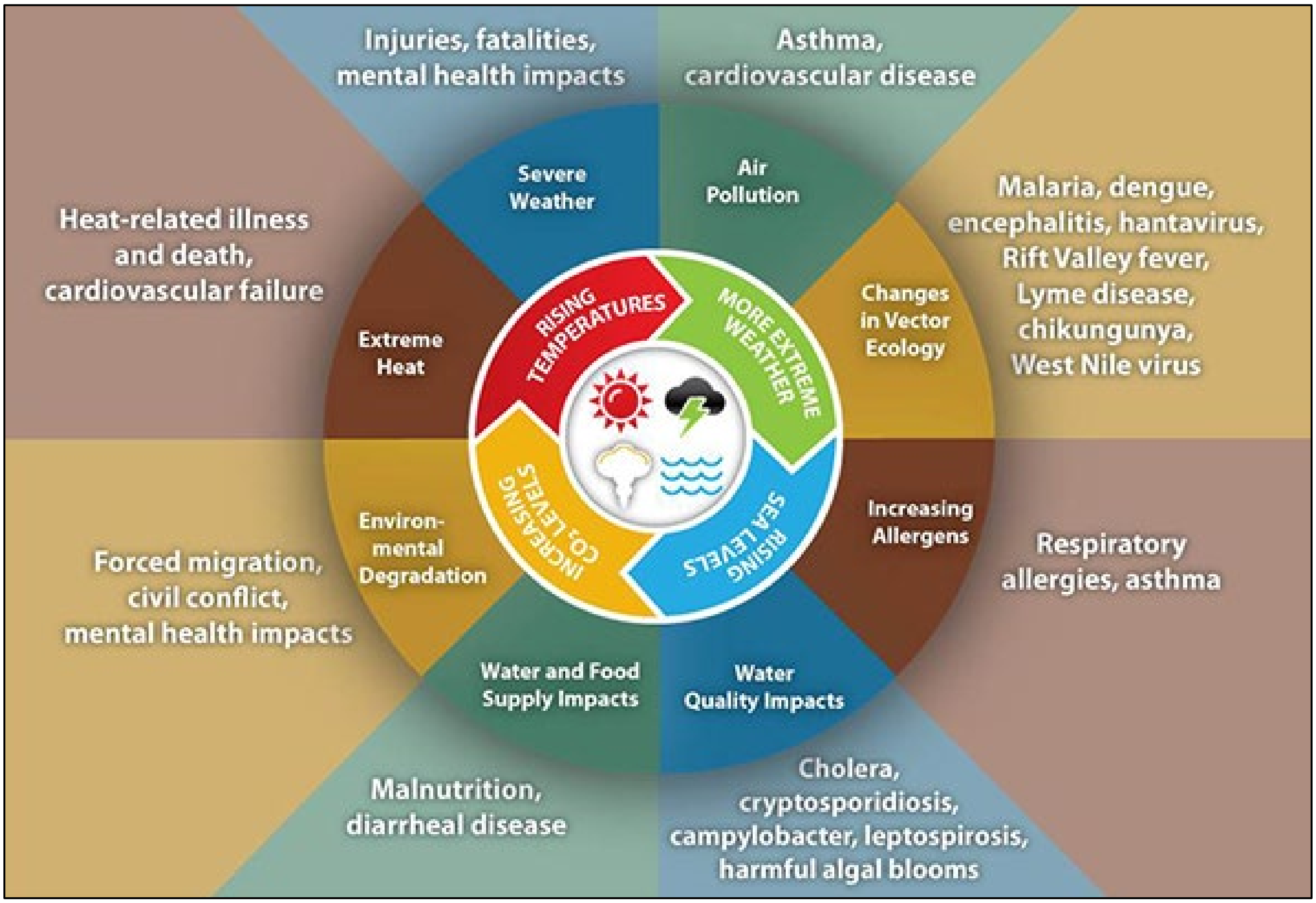
4.8.2 VULNERABILITY ASSESSMENT

No spatial data was available to assess health risk vulnerability. A qualitative assessment was conducted.

Assessment of State Vulnerability and Potential Losses

This section discusses statewide vulnerability of exposed state assets (state buildings and roads) and critical facilities to health risks.

Figure 4.8-3. Climate Change Impacts on Human Health



Source: (Centers for Disease Control and Prevention 2022)

State Assets

State buildings and roads are not exposed or vulnerable to this hazard. While the actual structures will not be impacted, the effect of absenteeism on state workers will impact the delivery of state services. The impacts and potential losses from this hazard are largely economic and are dependent on the type, extent, and duration of the illness.

Procedures for continuity of government operations will need to be implemented during a public health emergency, such as a pandemic. The most recent U.S. Department of Health and Human Services update of the national Pandemic Influenza Plan assumed a disease attack rate between 20 and 30 percent depending on the severity of the outbreak (U.S. Department of Health and Human Services 2017). According to the State of Hawaiʻi Department of Business, Economic Development & Tourism, in 2022 there were 68,800 state government jobs (DBEDT 2022). A 20 to 30 percent absentee rate would mean that a shortage of 13,600 and 20,640 state government employees would impact state facilities and the services they provide.

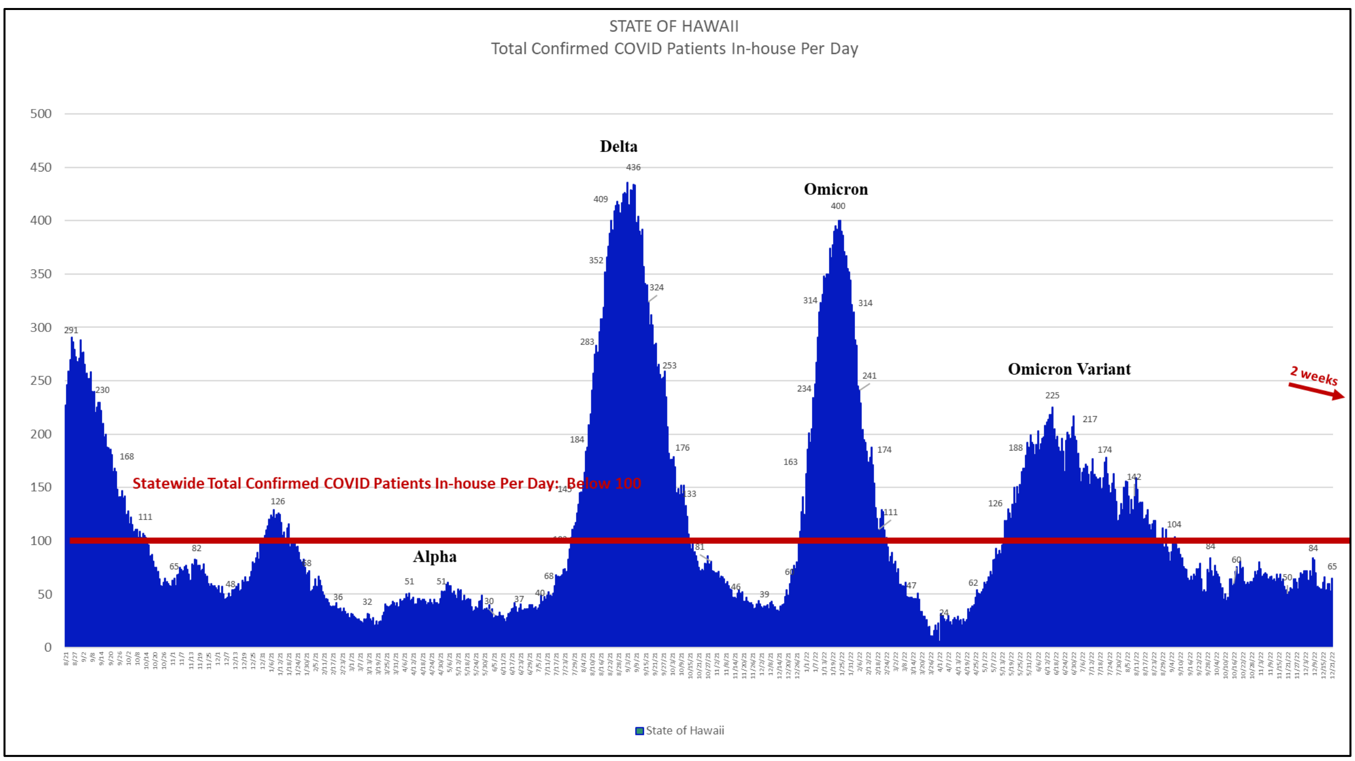
Community Lifelines and Critical Facilities

The impacts and potential losses from this hazard are largely economic and are dependent on the type, extent, and duration of the illness. A pandemic outbreak could result in a temporary closure to ports of entry to the state impacting the state's "just in time" supply management system and the import and export of goods and vital resources.

Similar to state assets, the actual community lifelines and critical facilities themselves will not be impacted; however, the delivery of critical services and the running of critical infrastructure will be due to absenteeism of workers (e.g., dock employees, airport staff and schoolteachers). Healthcare workers in public health and in direct patient contact are essential during a health risk event. According to the State of Hawaiʻi Department of Business, Economic Development & Tourism, in 2022, there were 73,400 healthcare jobs in the state (DBEDT 2022). A 20 to 30 percent absentee rate would mean that a shortage of 14,680 and 22,020 healthcare employees would impact critical health-related facilities and the services they provide.

In addition, an increase in hospitalization and emergency room visits may take place as a result of a health risk, creating a greater demand on these critical facilities, their staff and resources. Figure 4.8-4 shows that during the COVID-19 pandemic, up to 436 confirmed COVID patients were hospitalized each day (Healthcare Assosciation of Hawaiʻi 2022).

Figure 4.8-4. Hawaiʻi COVID Hospitalizations, August 2020–December 2022



Source: (Healthcare Assosciation of Hawaiʻi 2022)

Assessment of Local Vulnerability and Potential Losses

This section provides a summary of statewide exposure and potential losses to population, general building stock, environmental resources, and cultural assets. The local SHMPs were reviewed, and their discussions of health risks are summarized below:

- Kauaʻi County—The 2021 County of Kauaʻi Multi-Hazard Mitigation and Resilience Plan includes an entire appendix containing a qualitative assessment of health-related hazards.
- City and County of Honolulu—The 2020 Multi-Hazard Pre-Disaster Mitigation Plan for the City and County of Honolulu briefly discusses the health impacts of vog but does not address health risks as a separate hazard.
- Maui County—The 2020 County of Maui Hazard Mitigation Plan Update provides a qualitative discussion on health risks.
- Hawaiʻi County—The 2020 County of Hawaiʻi Multi-Hazard Mitigation Plan discusses pandemic outbreaks as a hazard of interest.

Socially Vulnerable and Total Populations

The entire population, residents, and visitors, of the State of Hawaiʻi is exposed and potentially vulnerable to any of the health risks discussed above. Health risks can cover a wide geographic area and can affect large populations. The size and extent of an infected population depends on how easily the illness is spread, mode of transmission, and amount of contact between infected and uninfected individuals. Locations with higher-density populations are more susceptible to outbreaks, as the disease can be transmitted more easily.

Because of concerns about COVID-19, an estimated 41 percent of U.S. adults delayed or avoided medical care, including urgent or emergency care (12 percent) and routine care (32 percent). Avoidance of urgent or emergency care was more prevalent among unpaid caregivers for adults, persons with underlying medical conditions, Black adults, Hispanic adults, young adults, and persons with disabilities (Czeisler, et al. 2020).

Food insecurity can impact those who lose employment during a pandemic, who are not eligible for Supplemental Nutrition Assistance Program benefits due to immigration status, or who may not be able to access food at stores because of supply chain issues or lack of stock. Food banks may be the only option for these families. Since the onset of the COVID-19 pandemic, food insecurity in Hawaiʻi has grown by more than 50 percent, which is the largest percentage increase in the nation (Hawaiʻi Food Bank 2021).

Vulnerable populations, especially the young, pregnant women, the elderly and those who have underlying health conditions or a weaker immune system, are at greater risk for both contracting a disease and suffering fatal or severe consequences. Refer to Section 3 (State Profile), which summarizes demographics exposed to health risks by county.

In addition to the physical impacts of a health risk event, mental health impacts are also prevalent. A survey published in 2021, conducted by the Hawaiʻi State Department of Health, indicated that about half of the respondents began experiencing mental health conditions during the COVID-19 pandemic. Mental health impacts were especially noted among young adults and those with a household income of less than $50,000 (State of Hawaiʻi, Department of Health 2021). Mental stress and anxiety may be experienced by both the population directly impacted or first responders. Associated economic impacts include health care costs and lost productivity at work or in the home.

General Building Stock and Economy

The general building stock is not exposed or vulnerable to the identified health risks of a disease outbreak as a disease affects only persons susceptible to the illness. However, the general building stock may contribute to the transmission of disease during an outbreak as a result of various design conditions (i.e., homes without window screens are more vulnerable to the spread mosquito-borne diseases), while aging infrastructure of the state's building stock could play a significant role in the spread of water-borne illness, such as Legionnaire's disease.

According to the Hawaiʻi Tourism Authority, tourism is the largest single source of private capital into the state's economy. A health risk such as a pandemic would have a significant impact on the economy. As a point of reference, in April 2020, the state's tourism decreased 99.5 percent due to the COVID-19 pandemic (Department of Business, Economic Development & Tourism 2021).

Environmental Resources and Cultural Assets

The type of health risk will determine the effect on the environment.

Air pollution dropped suddenly during the COVID-19 lockdown between March 19 and May 7, 2020. Overall improvement of air and water quality, reduction of noise, and restoration of ecology were all noted during the pandemic (Rume and Didar-Ul Islam 2020, Cheng 2021).

An increased demand for single-use plastic products during the pandemic led to more than 8 million tons of pandemic-associated plastic waste generated globally, with more than 25,000 tons entering the global ocean. Most of the plastic is from medical waste generated by hospitals (Peng, et al. 2021). Powerful disinfectants end up in water supplies. Microplastics from degrading personal protective equipment (e.g., masks, gloves) can contribute to high concentrations found in fish, water, sediments, soils, and the air (Hartman 2021).

A bioterrorism attack may not only impact the general population but animals and plants as well because agents can spread through the air, water or in food. Livestock and poultry populations may become infected due to a health risk impacting the local economy and available food sources. Bacteria, pathogens, and other pollutants introduced into the local hydrology of the state's water cycle can also have long-term impacts on water resources, further contributing to adverse public health impacts.

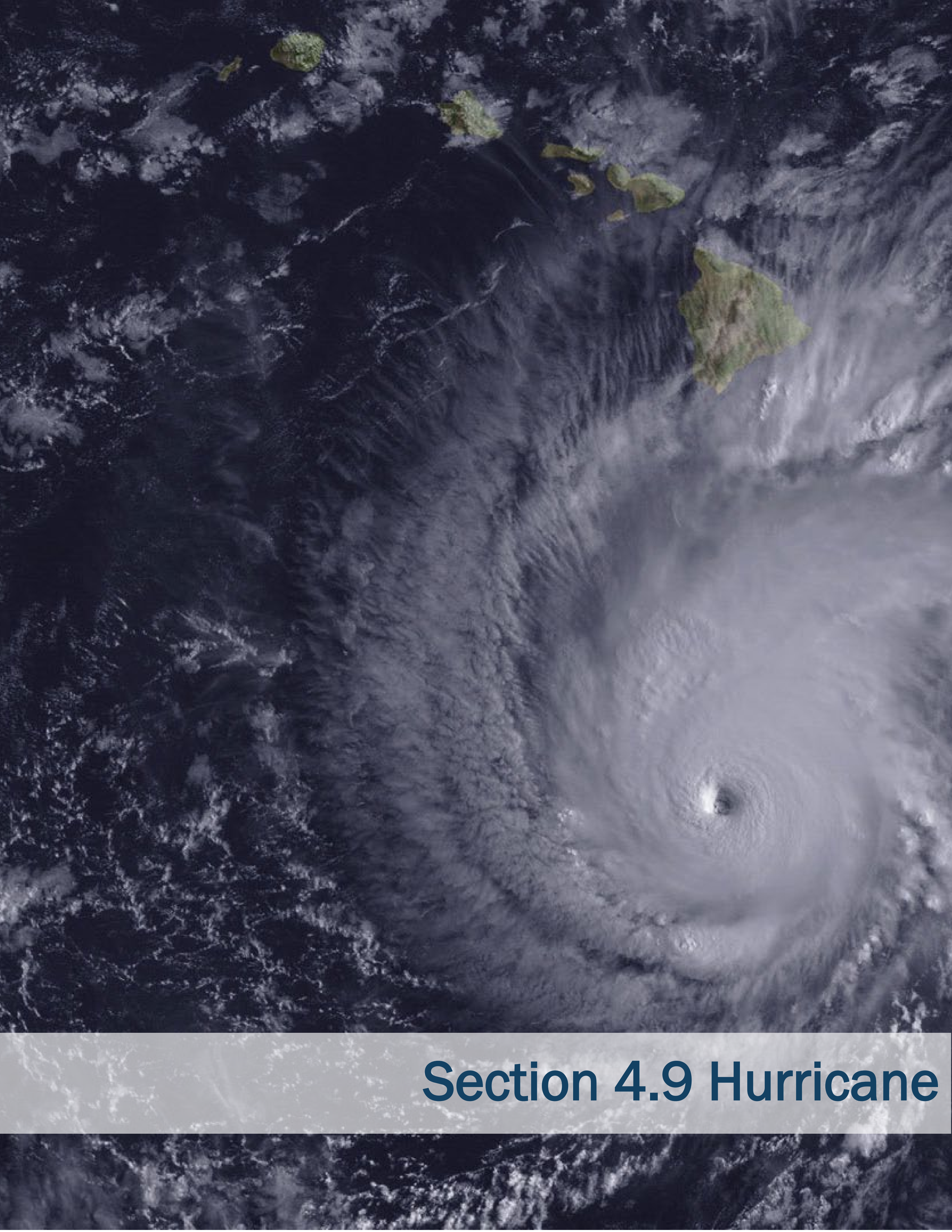
Future Changes that May Impact State Vulnerability

Understanding future changes that impact vulnerability in the state can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The state considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

As the population characteristics of the state change, there will be more people in age categories that are more susceptible to infectious diseases (elderly and young populations). The ability to withstand impacts will depend on preparedness of the state as well as local communities.

In addition, the continued robust international tourism industry in Hawaiʻi makes it more vulnerable to health risks. Air travel could increase the speed of spread of a new virus and decrease the time available for implementing interventions. Economically, another pandemic or a disease outbreak would likely have a significant impact on tourism as people decrease their travel. Scares of infectious disease and pandemic flu could collapse the tourism economy again.



Section 4.9 Hurricane

Hurricane

Hurricane season generally runs from the beginning of June to the end of November, but storms can form before and after the season. Hurricanes and tropical storms threaten the State with excessive rain, storm surge, and strong winds. Statistics below represent the Category 4 SLOSH (Sea, Lake and Overland Surges from Hurricanes) inundation area.

CHANGES SINCE 2018

+4 Declared Disasters

+7 Hurricane Events

COUNTIES MOST VULNERABLE

Kauaʻi Honolulu Maui Hawaiʻi

SOCIALLY VULNERABLE POPULATION

2.14% Of Total Population

30,320 Persons

HAZARD RANKING

Low Medium High

COMMUNITY LIFELINES

217 Total

Food, Water, Shelter — Greatest

CLIMATE PROJECTIONS

Hurricanes and tropical storms are projected to grow in average size and strength due to climate change and rise in sea level

El Niño events will be more frequent, increasing tropical cyclone activity

The northeast trade winds may shift large-scale pressure and wind patterns that impact the State of Hawaiʻi

654 State Buildings

78 Miles of State Road

SQUARE MILES

33 Environmental Resources

2.5 Hawaiian Home Lands

22 Cultural Resources

CONTENTS

TABLES

FIGURES

[1] *Section Cover Photo: Hurricane Lane. Photo courtesy of NOAA*

SECTION 4. RISK ASSESSMENT

4.9 HURRICANE

2023 SHMP Update Changes

- Hurricane and tropical storm events that occurred in the State of Hawaiʻi from January 1, 2018, through December 31, 2022, were researched for the 2023 SHMP Update.
- New and updated figures from federal and state agencies were incorporated.
- This section now includes a discussion of how hurricanes impact socially vulnerable populations and community lifelines.
- In Environmental Resources, reefs (both artificial and coral) were analyzed in their own category.
- Six types of cultural resources (archaeology, burial sensitivity area, historic building, historic district, historic object, and historic structure) were added to the vulnerability assessment.

4.9.1 HAZARD PROFILE

Hurricanes and tropical storms can bring excessive amounts of rain, strong and damaging winds, storm surge, high waves, erosion along shorelines, and tidal and coastal flooding. While the occurrence of such storms is low in the state, when they do occur, they can have dramatic, damaging, and potentially deadly effects. For the 2023 SHMP Update, this profile and associated vulnerability assessment will focus on hurricane-force winds and storm surge and include events identified as hurricanes and tropical storms. Other hazards associated with tropical cyclone events are generally addressed in other hazard sections. Please refer to Section 4.6 (Flood) and Section 4.16 (Windstorm) for high winds.

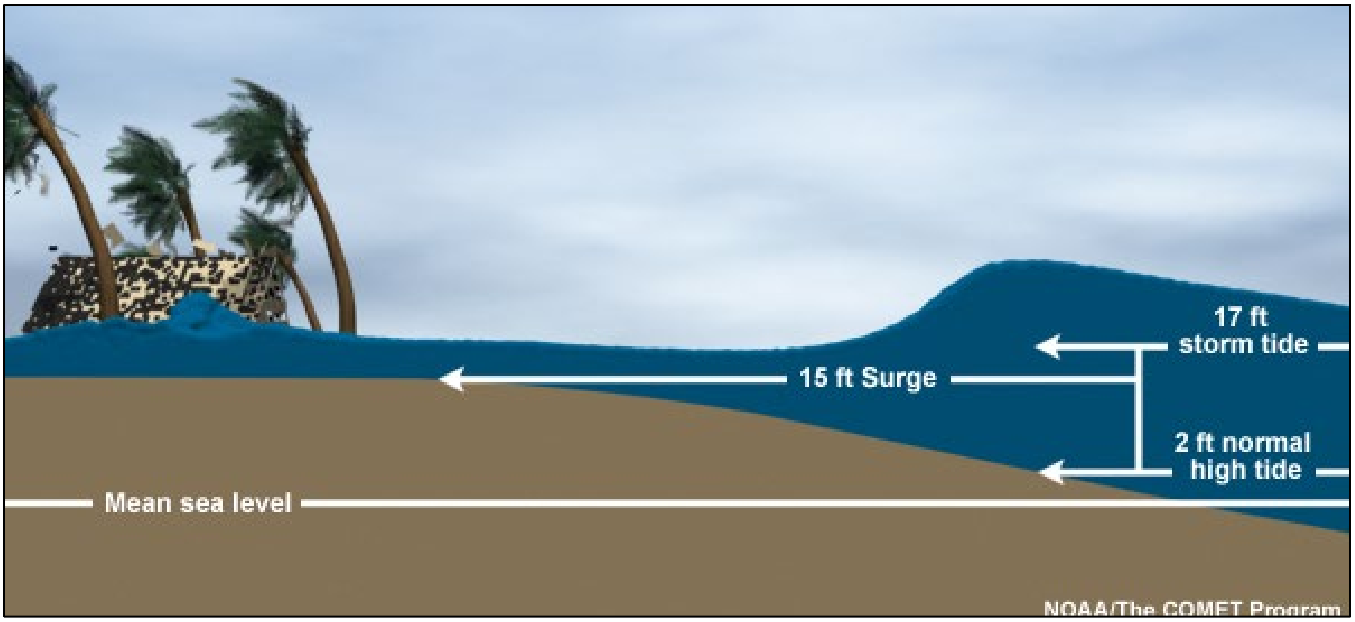
HAZARD DESCRIPTION

A tropical cyclone is a rotating, organized system of clouds and thunderstorms that originates over tropical or subtropical waters and has a closed low-level circulation. Tropical depressions, tropical storms, and hurricanes are all types of tropical cyclones that are distinguished by their sustained wind speeds. These storms rotate counterclockwise in the northern hemisphere around the center and are accompanied by heavy rain and strong winds (NOAA 2022). The weather associated with tropical cyclones typically lasts between 12 and 18 hours, with a slow-moving storm lasting around 24 hours. The State of Hawaiʻi is located in the Central Pacific basin, where hurricane season runs from June 1 to November 30.

Storm Surge

Storm surge is an abnormal rise of water generated by a storm, over and above the predicted astronomical tides (see Figure 4.9-1). Storm surge occurs when water is pushed toward the shoreline by the force of winds from the storm. Friction between the water and the moving air creates drag that, depending upon the distance of water (fetch) and velocity of the wind, can pile water up to depths greater than 20 feet from the shoreline inland. The rise in water level can cause extreme flooding in coastal areas, especially when storm surge coincides with normal high tide (National Hurricane Center 2022).

Figure 4.9-1. Storm Surge



Source: (National Hurricane Center 2022)

All types of tropical cyclones generate large swells, causing varying degrees of damage. This is characteristic of hurricanes that pass close but do not directly impact the State of Hawaiʻi. For example, communities on the Waiʻanae Coast in the City and County of Honolulu suffered severe damage from Hurricanes Iwa and Iniki, yet neither of these storms hit the Island of Oʻahu.

According to the National Hurricane Center, there are many factors that contribute to the amount of surge a given storm produces at a given location:

- **Central Pressure:** Lower pressure of the storm will produce a higher surge; however, the central pressure of the storm is a minimal contribution compared to the other factors.
- **Storm Intensity:** Stronger winds will produce higher surge.
- **Storm Forward Speed:** On the open coast, a faster storm will produce a higher surge. However, a higher surge is produced in bays, sounds, and other enclosed bodies of water with a slower storm.
- **Angle of Approach to Coast:** The angle at which a storm approaches a coastline can affect how much surge is generated. A storm that moves onshore perpendicular to the coast is more likely to produce a higher storm surge than a storm that moves parallel to the coast or moves inland at an oblique angle.

- **Shape of the Coastline:** Storm surge will be higher when a hurricane makes landfall on a coastline that is curved inward, as opposed to a coastline that is curved outward.
- **Size:** A larger storm will produce a higher surge. The winds of a larger storm push on a larger area of the ocean. The strong winds of a larger storm tend to affect a larger area than a smaller storm.
- **Width and Slope of the Ocean Bottom:** Higher storm surge occurs with wide, gently sloping continental shelves, while lower storm surge occurs with narrow, steeply sloping shelves.
- **Local Features:** Storm surge highly depends on local features and barriers that will affect the flow of water. In the state, this includes inlets, bays, and rivers (National Hurricane Center 2022).

Heavy Rain

Hurricanes and other tropical cyclones often produce widespread, torrential rains in excess of 6 inches, which may result in deadly and destructive flooding (see Figure 4.9-2 and Figure 4.9-3). Rainfall amounts are not directly related to the strength of the storm but rather to the speed and size. Slower moving, larger storms produce more rainfall. Additionally, mountainous terrain enhances rainfall from a hurricane (National Hurricane Center 2022).

Figure 4.9-2. Flooding in Hilo from Hurricane Lane, 2018

Source: Hawaiʻi Emergency Management Agency

Figure 4.9-3. Road Washout in Maui from Hurricane Lane Flooding

Source: Hawaiʻi Emergency Management Agency

Strong Winds

The strongest winds are typically found on the right side of the center of the hurricane. Wind speeds decrease with increased distance away from the center of the storm. Atlantic and Central Pacific hurricanes are classified into five categories according to the Saffir-Simpson Hurricane Wind Scale, which estimates potential property damage according to the hurricane's sustained wind speed. Refer to the Extent subsection of this profile for details regarding the Saffir-Simpson Scale (National Hurricane Center 2022).

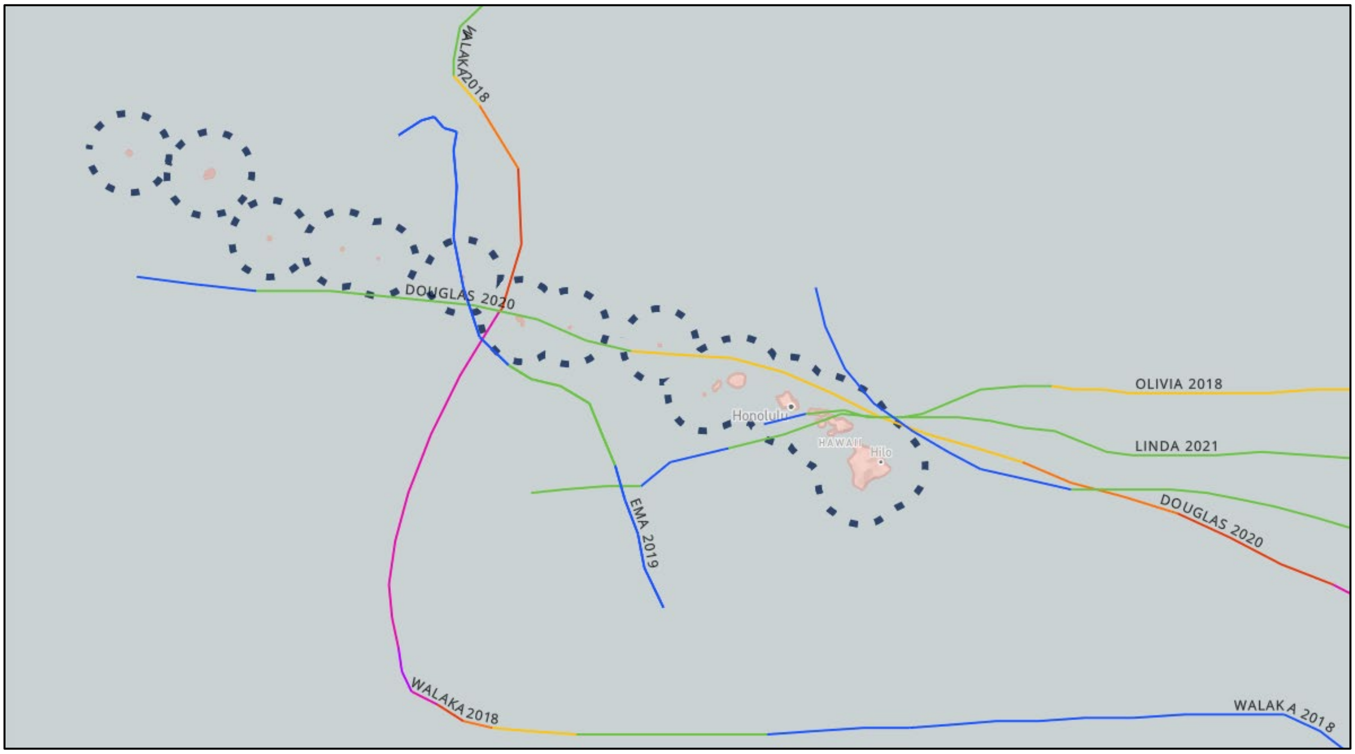
Microbursts and mini swirls are small, localized wind bursts that can reach speeds of greater than 200 mph. During Hurricane Iniki, damage patterns and debris indicated that there were more than 26 microbursts (sudden intense downdrafts) and two mini swirls (a violent whirlwind, not tornado) that occurred in the County of Kauaʻi (State of Hawai'i 2018).

Location

The entire State of Hawaiʻi and its communities are vulnerable to the damaging impacts of hurricanes. Historically, it has been relatively rare for a hurricane to intersect the state; however, large swells and high winds from near misses are quite common. Each county in the state has been affected by hurricanes and are at risk to damages from these storms (NOAA 2022). The coastal areas of the State of Hawaiʻi are more susceptible to damage caused by a combination of high winds and tidal surge. Inland areas, especially those in the 1% and 0.2% annual chance flood areas depicted on the FEMA DFIRMs, are also at risk to flooding because of heavy rains associated with the storms. Refer to Section 4.6 (Flood) for details regarding inland flooding.

NOAA's Historical Hurricane Tracks tool is a public interactive mapping application that displays Atlantic Basin and East-Central Pacific Basin tropical cyclone data. This interactive tool catalogs tropical cyclones that have occurred from 1842 to 2022 (latest date available from data source). Figure 4.9-4 displays tropical cyclone tracks within 60 nautical miles of the State of Hawaiʻi. The figure shows tropical cyclone events that occurred between 2018 and 2022.

Figure 4.9-4. Historical Tropical Storm and Hurricane Tracks, 2018 to 2022



Source: (NOAA 2022)

EXTENT

Once a tropical cyclone has been characterized as a hurricane, its intensity is measured by the Saffir-Simpson Hurricane Scale. The Saffir-Simpson Hurricane Wind Scale is a 1 to 5 rating based on a hurricane's sustained wind speed. This scale estimates potential property damage (refer to Table 4.9-1). Hurricanes reaching Category 3 and higher are considered major hurricanes because of their potential for significant loss of life and damage. Category 1 and 2 storms are still dangerous and require preventive measures (State of Hawai'i 2018).

As stated earlier, storm surge inundation from hurricanes can be devastating to areas along the coastline. Table 4.9-2 summarizes the area of coastline that may be potentially inundated by storm surge from hurricane Categories 1 through 4. The City and County of Honolulu have the greatest number of square miles that may be inundated by storm surge.

Table 4.9-1. Saffir-Simpson Hurricane Scale

Category	Wind Speed (mph)	Storm Surge (feet)	Expected Damage
1	74 to 95	4 to 5	Damaging winds are expected. Some damage to buildings could occur, primarily to unanchored structures (such as school portables). Some damage is likely to poorly constructed signs. Loose outdoor items will become projectiles, causing additional damage. Persons struck by windborne debris risk injury and possible death. Numerous large branches of healthy trees will snap. Some trees will be uprooted, especially where the ground is saturated. Many areas will experience power outages with some downed power poles. Hurricane Iwa (passing just northwest of Kauaʻi in 1982) and Hurricane Norman (2018, passing just northeast of the Hawaiian Islands) are examples of Category 1 hurricanes that directly impacted the State of Hawaiʻi.
2	96 to 110	6 to 8	Very strong winds will produce widespread damage. Some roofing, door, and window damage of buildings will occur. Considerable damage to unanchored structures and poorly constructed signs is likely. A number of glass windows in high-rise buildings will be dislodged and become airborne. Loose outdoor items will become projectiles, causing additional damage. Persons struck by windborne debris risk injury and possible death. Numerous large branches will break. Many trees will be uprooted or snapped. Extensive damage to power lines and poles will likely result in widespread power outages that could last a few to several days. There is no record of a Category 2 hurricane directly impacting Hawaiʻi. Elsewhere in the United States, Hurricane Erin (1995, 100 mph at landfall in northwest Florida) and Hurricane Isabel (2003, 105 mph at landfall in North Carolina) are examples of Category 2 hurricanes at landfall.
3 (major)	111 to 129	9 to 12	Dangerous winds will cause extensive damage. Some structural damage to houses and buildings will occur with a minor amount of wall failures. Unanchored structures and poorly constructed signs are destroyed. Many windows in high-rise buildings will be dislodged and become airborne. Persons struck by windborne debris risk injury and possible death. Many trees will be snapped or uprooted and block numerous roads. Near total power loss is expected with outages that could last from several days to weeks. There is no record of a Category 3 hurricane directly impacting Hawaiʻi. Elsewhere in the United States, Hurricane Rita (2005, 115 mph landfall in east Texas/Louisiana) and Hurricane Darby (2016, Category 3 storm that weakened to a tropical depression shortly after making landfall in Hawaiʻi) are examples of Category 3 hurricanes at landfall.
4 (major)	130 to 156	13 to 18	Extremely dangerous winds causing devastating damage are expected. Some wall failures with some complete roof structure failures on houses will occur. All signs are blown down. Complete destruction of unanchored structures. Extensive damage to doors and windows is likely. Numerous windows in high-rise buildings will be dislodged and become airborne. Windborne debris will cause extensive damage, and persons struck by the wind-blown debris will be injured or killed. Most trees will be snapped or uprooted. Fallen trees could cut off residential areas for days to weeks. Electricity will be unavailable for weeks after the hurricane passes. Hurricane Iniki, which made landfall on Kauaʻi in 1992, is an example of a Category 4 hurricane at landfall in Hawaiʻi.
5 (major)	157 or more	greater than 18	Catastrophic damage is expected. Complete roof failure on many residences and industrial buildings will occur. Some complete building failures with small buildings blown over or away are likely. All signs blown down. Complete destruction of unanchored structures. Severe and extensive window and door damage will occur. Nearly all windows in high-rise buildings will be dislodged and become airborne. Severe injury or death is likely for persons struck by wind-blown debris. Nearly all trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. There is no record of a Category 5 hurricane directly impacting the State of Hawaiʻi. Elsewhere in the United States, Hurricane Andrew (1992, 165 mph at landfall in Southeast Florida) and Hurricane Michael (2018, 160 mph landfall in northwest Florida) are examples of Category 5 hurricanes at landfall.

Source: (National Hurricane Center 2022)

Table 4.9-2. Storm Surge Inundation Area by County

County	Area (in square miles)								
	Total County Area	Category 1 Hurricane	Cat 1 as % of Total Area	Category 2 Hurricane	Cat 2 as % of Total Area	Category 3 Hurricane	Cat 3 as % of Total Area	Category 4 Hurricane	Cat 4 as % of Total Area
County of Kauaʻi	624.2914	4.5	0.72%	5.8	0.93%	10.1	1.62%	12.2	1.95%
City and County of Honolulu	598.5707	10.9	1.82%	22.3	3.73%	31.8	5.31%	38.2	6.38%
County of Maui	1,176.28	5.8	0.49%	7.9	0.67%	9.8	0.83%	11.4	0.97%
County of Hawaiʻi	4,039.64	1.9	0.05%	2.5	0.06%	3.7	0.09%	5.3	0.13%
Total	**6,438.78**	**23.1**	**0.36%**	**38.5**	**0.60%**	**55.4**	**0.86%**	**67.1**	**1.04%**

Source: Federal Emergency Management Agency; National Weather Service; National Oceanic and Atmospheric Administration

Warning Time

Tropical cyclones are a unique weather phenomenon because they can be closely monitored and tracked. As a result, accurate warnings up to days in advance of the event are possible with the track modeling offering possible storm movement up to a week prior. Track forecasts have improved partly due to an increase in the number of satellites outfitted with more sophisticated weather-monitoring devices. Additionally, supercomputing has increased, and computer models used for forecasting keep improving. Intensity forecasts, by contrast, show little improvement over the last 20 years (Freedman 2011). Lack of improvement in intensity forecasts presents a problem for the State of Hawaiʻi because most hurricane-related damages come from destructive winds.

The Central Pacific Hurricane Center issues tropical cyclone advisory packages whenever a tropical cyclone is active in the Central North Pacific Basin. If a tropical cyclone is active in the Eastern North Pacific, the National Hurricane Center issues the package. The following provides definitions, as defined by the Central Pacific Hurricane Center, for the tropical cyclone advisory packages.

- **Tropical Cyclone Public Advisory.** The Tropical Cyclone Public Advisory gives the cyclone position in terms of latitude and longitude coordinates and distance from a selected land point or island, as well as the current motion. The advisory includes the maximum sustained winds in miles per hour and the estimated or measured minimum central pressure in millibars and inches. The advisory may also include information on potential storm tides, rainfall, or tornadoes associated with the cyclone as well as any pertinent weather observations.
- **Public advisories are issued for all Central Pacific tropical cyclones.** Public advisories are normally issued every six hours. They may be issued every two or three hours when coastal watches or warnings are in effect. Special public advisories may be issued at any time due to significant changes in warnings or in the cyclone.
- **Tropical Cyclone Forecast/Advisory.** The Tropical Cyclone Forecast/Advisory contains a list of all current watches and warnings on a tropical or subtropical cyclone as well as the current latitude and longitude coordinates, intensity, and system motion. The advisory contains forecasts of the cyclone positions, intensities, and wind fields for 12, 24, 36, 48, and 72 hours from the current synoptic time. The advisory may also include information on any pertinent storm tides associated with the cyclone. All wind speeds in

the forecast advisory are given in knots (nautical miles per hour). They are issued on all Central Pacific tropical cyclones. Special Forecast/Advisories may be issued at any time due to significant changes in warnings or in the cyclone.

- **Tropical Cyclone Discussion.** The Tropical Cyclone Discussion explains the reasoning for the analysis and forecast of a tropical or subtropical cyclone. It includes a table of the forecast track and intensity. They are issued on all Central Pacific tropical cyclones every six hours. Special Forecast/Advisories may be issued at any time due to significant changes in warnings or in the cyclone.
- **Tropical Cyclone Surface Wind Speed Probabilities.** The Tropical Cyclone Surface Wind Speed Probabilities text product provides probabilities, in percent, of sustained wind speeds equal to or exceeding 34-, 50-, and 64-knot wind speed thresholds. These wind speed probabilities are based on the track, intensity, and wind structure forecasts and uncertainties from the Central Pacific Hurricane Center. These wind speed probabilities are computed for coastal and inland cities as well as offshore locations (e.g., buoys) (National Hurricane Center 2022).

Previous Occurrences and Losses

Disaster and Emergency Declarations

Many sources provided information regarding previous occurrences and losses associated with hurricane-related events throughout the State of Hawaiʻi. The 2018 SHMP discussed specific hurricane-related events that occurred in the state through 2017. For the 2023 SHMP Update, previous events for all hazards assessed were summarized between January 1, 2018, and December 31, 2022. Hurricane events that have affected the state and were declared a FEMA disaster between 2018 and 2022 are identified in Table 4.9-3. For details regarding all declared disasters, refer to Section 4.1 (Overview). Refer to Appendix D (Map Atlas) which illustrates the number of tropical cyclone and hurricane FEMA-declared disasters by county.

- Federal disaster (DR) or emergency (EM) declarations, 1955 – 2022: 7 events, classified as hurricane or typhoon
- USDA agricultural disaster declarations, 2012 – 2022: none
- Hawaiʻi state emergency proclamations, 2018 – 2022: 3 hurricane events

Table 4.9-3. Hurricane-Related Federal Declarations (2018 to 2022)

Event Type	Date Declared	Federal Declaration	Counties Affected
Hurricane Lane	August 22, 2018	EM-3399-HI	Hawaiʻi, Honolulu, Kaua'i, Maui
Tropical Storm Olivia	September 12, 2018	EM-3404-HI	Hawaiʻi, Honolulu, Kaua'i, Maui
Hurricane Lane	September 27, 2018	DR-4395-HI	Hawai'i, Kaua'i, Maui
Hurricane Douglas	July 25, 2020	EM-3529-HI	Hawaiʻi, Honolulu, Kaua'i, Maui

Source: FEMA 2022

Event History

While hurricanes are relatively rare in the State of Hawai‘i, records have shown that the storms can bring very heavy rainfall and strong, damaging winds that lead to storm surge and extremely high waves. The first officially recognized hurricane in the State of Hawai‘i was Hurricane Hiki in August 1950. Since 1950, five tropical cyclones have caused serious damage in the state. Hurricane Nina (1957) produced record winds in the City and County of Honolulu. Hurricane Dot (1959) caused damage to the County of Kaua‘i. Hurricane Estelle (1986) produced very high surf on the Islands of Hawai‘i (County of Hawai‘i) and Maui (County of Maui), and floods on the Island of O‘ahu (City and County of Honolulu). The County of Kaua‘i also received the brunt of Hurricane Iwa, which struck on November 23, 1982, and produced an estimated $234 million in damage (Storm Evolution and Energetics Research 2018). Hurricane Iniki was a Category 4 hurricane that hit the County of Kaua‘i in September 1992, causing almost $2 billion in damages. In 2015, an El Niño year, the Central Pacific saw 15 named storms (eight hurricanes and five major hurricanes), making 2015 the most active season since 1970 (NOAA 2016).

Many sources provided hurricane and tropical storm information regarding previous occurrences and losses throughout the State of Hawai‘i. The 2018 SHMP discussed specific hurricane and tropical storm events that occurred in the State of Hawai‘i through 2017. For this 2023 SHMP Update, hurricane and tropical storm events were summarized between January 1, 2018 and December 31, 2022. Table 4.9-4 includes details of major hurricane and tropical storm events that occurred in the state between 2018 and 2022. Major events include those that resulted in losses or fatalities, as reported by NOAA National Centers for Environmental Information (NCEI), events that resulted in the activation of the state and/or County Emergency Operations Center (EOC), and/or events that led to a FEMA disaster declaration. For events prior to 2018, please refer to Appendix E (Hazard Profile Supplement).

Table 4.9-4. Tropical Storm and Hurricane Events in the State of Hawai‘i, 2018 to 2022

Date(s) of Event	Event Type	Counties Affected	Description
August 22, 2018 – August 26, 2018	Hurricane Lane	Hawai‘i, Honolulu, Kaua‘i, Maui	With Hurricane Lane just west of the Big Island of Hawai‘i, and south of Maui County and O‘ahu, torrential rain fell over parts of the state, especially the Big Island. Flash flooding was the most serious weather problem, with parts of the Big Island seeing total rainfall of 40 to 50 inches. Strong winds also downed trees and power lines, leading to power outages on most isles. Parts of the Big Island got more than 4 feet of rain, triggering widespread flooding and washing out roads. At least 39 people were rescued from flood waters. The torrential rains overwhelmed three sewage pump stations, sending more than 9 million gallons of untreated sewage into Hilo Bay. On Maui, three wind-whipped wildfires quickly spread, forcing more than 300 people to evacuate and destroying more than 20 homes. More than 16 inches of rain fell on the island, which made three homes inaccessible after storm water and debris washed out a road. 45 utility poles and to be replaced due to the hurricane. Areas previously affected on Kaua’i by April’s historic floods were flooded again. One individual died from drowning.
September 01, 2018 – September 14, 2018	Hurricane Olivia	Hawai‘i, Honolulu, Kaua‘i, Maui	Hurricane Olivia was the first tropical cyclone to make landfall on Maui and Lanai in recorded history. Olivia originated from a broad area of low pressure that formed several hundred miles southwest of Mexico on August 30.

Date(s) of Event	Event Type	Counties Affected	Description
			Olivia weakened into a tropical storm on September 11, before making brief landfalls in northwest Maui and Lānaʻi on the next day. Olivia was downgraded to a tropical depression on September 13. Maui reported over 8 inches of rain and many flooded areas. Several homes had to be evacuated along the Honoapiilani Highway. Several trees were knocked down on both Maui and Honolulu. Wind gusts up to 55 miles per hour were reported in Lānaʻi, while Honolulu saw wind gusts of 40 miles per hour.
July 30, 2019 – August 04, 2019	Hurricane Erick	Hawaiʻi, Kauaʻi, Maui	Hurricane Erick was the first tropical cyclone of the season in the Central Pacific, moving into the basin from the east on July 30. Erick rapidly intensified to a major Category 4 hurricane later that day, then steadily weakened as it passed far south of the main Hawaiian Islands. Erick did not make a direct impact on the Hawaiian Islands; however, the then tropical storm did cause swells and high surf along the eastern and southern shores on the islands of Hawaiʻi and Maui. Erick also contributed heavy rains on Hawaiʻi and Kauaʻi Counties.
July 28, 2019 – August 07, 2019	Tropical Storm Flossie	Hawaiʻi, Maui	Tropical Storm Flossie entered the basin on August 3 and approached Hawaiʻi from the east, eventually dissipating before reaching the islands. Flossie did not make a direct impact on the Hawaiian Islands; however, the tropical storm did cause swells and high surf along the eastern and southern shores on the islands of Hawaiʻi and Maui.
October 11, 2019 – October 16, 2019	Tropical Storm Ema	Papahānaumokuākea Marine National Monument	Tropical Storm Ema, the second cyclone to be named from the Central Pacific list of names, developed southwest of the main Hawaiian Islands on October 12. Ema dissipated over the southern portion of the Papahānaumokuākea Marine National Monument shortly before crossing between French Frigate Shoals and Maro Reef.
July 20, 2020 – July 30, 2020	Hurricane Douglas	Hawaiʻi, Honolulu, Kauaʻi, Maui	Hurricane Douglas was a strong tropical cyclone that became the closest passing Pacific hurricane to the island of Oʻahu on record, surpassing the previous record held by Hurricane Dot in 1959. The eighth tropical cyclone, fourth named storm, first hurricane, and first major hurricane of the ongoing 2020 Pacific hurricane season, Douglas originated from a tropical wave, which entered the basin in mid-July. The southern eyewall of Douglas tracked just north of Maui, Oʻahu, and Kauaʻi, sparing those islands from seeing the worst of the hurricane's strong winds and heavy rainfall. Heavy rain and strong winds were apparent on Maui and Molokaʻi, but no major damage came to any of the Hawaiian Islands. Some trees fell across highways and Kamehameha Highway in Oʻahu was closed because of debris on the road. Most areas of Hawaiʻi County, Maui County, and Kauaʻi County picked up 1 to 3 inches of rain from Douglas. Isolated wind gusts above 55 mph were clocked in a few areas, but, for the most part, gusts remained from 30 to 50 mph.
August 09, 2021 – August 24, 2021	Hurricane Linda	Hawaiʻi, Honolulu, Kauaʻi, Maui	Hurricane Linda rapidly developed into a Category 4 hurricane off the southern coast of Mexico. As the storm approached the State of Hawaiʻi, it was a tropical storm, dropping to a tropical depression just a few days prior to making landfall. The post-tropical storm brought heavy rains and 20–30 mile per hour winds to the state.

Sources: NOAA 2023; NOAA 2022; Hawai'I News Now 2018; The Weather Channel 2018; Hawai'I News Now 2019; CDC 2021; NWS 2019
Note:
Hurricane documentation for the State of Hawaiʻi is extensive, and not all sources have been identified or researched. Additionally, loss and impact information for many events could vary depending on the source. Therefore, the table may not include all events that have occurred in the state.

PROBABILITY OF FUTURE HAZARD EVENTS

Overall Probability

A myth in the State of Hawaiʻi is that the islands that constitute the County of Maui (the Islands of Molokaʻi, Lānaʻi, Kahoʻolawe, and Maui) and the City and County of Honolulu (the Island of Oʻahu) are less vulnerable to a direct hit by a hurricane than the Counties of Kauaʻi and Hawaiʻi. This myth has developed because, until 1950, tropical storms hitting the Hawaiian Islands were not classified as hurricanes. It was not until the advent of weather satellites that the nature of storms in this part of the world was understood to be hurricanes (State of Hawai'i 2018). Since 1950, 30 tropical cyclones have passed within 200 nautical miles of the State of Hawaiʻi. All islands have been in the direct path of a tropical cyclone at least once (NOAA 2022).

In evaluating the potential for hazard events of a given magnitude, a return period is often used. This should be regarded as the inverse of the annual frequency of occurrence and not as a recurrence interval. For example, a return period of 1 in 250 years does not correspond to an event that will occur exactly every 250 years but to an event that has a 0.4% chance of occurring in any given year (World Meteorological Organization 2015). Utilizing the FEMA Hazus wind model, the peak gust wind speeds for a statewide 100-year mean return period (MRP) event ranges from 88 to 151 mph (Category 1 to 4 wind speeds); and the peak gust wind speeds for a statewide 500-year MRP event ranges from 105 to 173 mph (Category 2 to 5 wind speeds). Every hurricane will be unique and wind speeds will vary based on the storm track and present conditions.

Hurricane Hazard Scenarios

- **Wind** – To assess the state's vulnerability to the hurricane wind hazard, a statewide 500-year Mean Return Period (MRP) hurricane scenario was run in FEMA's Hazus wind model to estimate potential losses.
- **Storm Surge** – To assess the state's vulnerability to storm surge, the Category 4 SLOSH data was used to estimate exposure. The hazard area is called the Category 4 SLOSH Inundation Area.

The two datasets referenced above are not directly connected and should be used to evaluate vulnerability separately.

For the 2023 SHMP Update, the most up-to-date information was collected to calculate the probability of future occurrence of hurricane events, of all magnitudes, in the State of Hawaiʻi. Information from the 2018 SHMP, FEMA, NOAA-NCEI, and the National Hurricane Center were used to identify the number of hurricane events that occurred between 1950 and 2022 (NOAA 2022). Using these resources ensures the most accurate probability estimates possible. Based on historical statistics, the State of Hawaiʻi has a 68.5% chance of a hurricane of any magnitude (tropical storm, tropical depression, and Category 1 through 4 hurricanes) occurring within 60 nautical miles in any given year. Based on the historical record, the State of Hawaiʻi has experienced six FEMA declarations associated with hurricanes since 1954. Using these historic statistics, the state may expect to experience a hurricane event that leads to a FEMA declaration once every 11 years.

Climate Change Impacts

Hurricanes and tropical storms are projected to grow in average size and strength due to climate change and rise in sea level. Waves generated by these systems are anticipated to cause statewide coastal erosion and flooding, which will be worsened by sea level rise. More frequent El Niño events are also projected, increasing tropical cyclone activity and corresponding waves, flooding, and erosion for the state (Cai, et al. 2014). In addition, changes detected in the prevailing wind over the Hawaiian Islands, the northeast trade wind, may shift large-scale pressure and wind patterns that impact the State of Hawaiʻi (Garza, et al. 2012). The shift in trade winds may shift the track of future storm events such as tropical cyclones. For details regarding climate change as a distinct hazard and its unique impacts to the State of Hawaiʻi, refer to Section 4.2 (Climate Change and Sea Level Rise).

4.9.2 VULNERABILITY ASSESSMENT

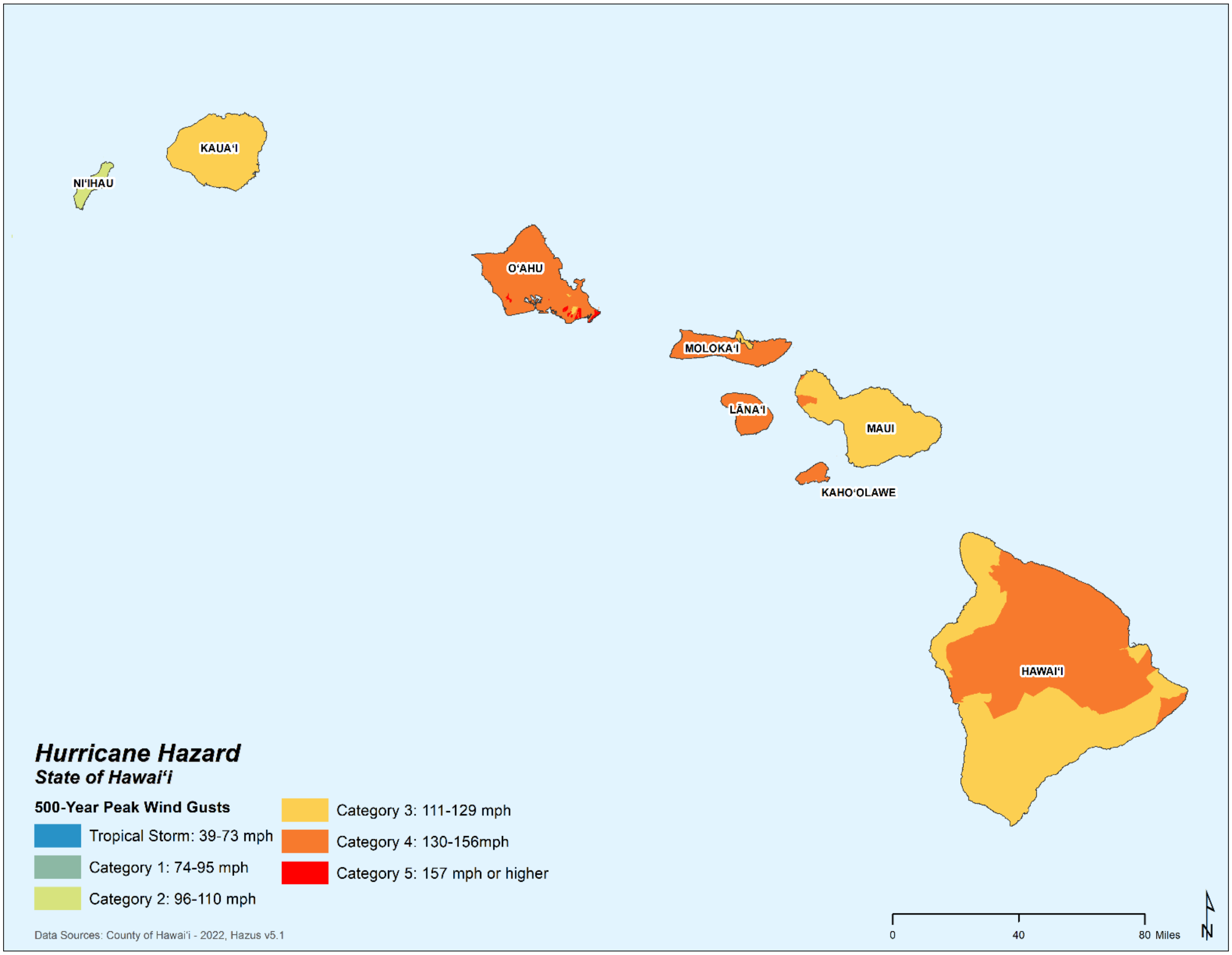
According to the *2015 Hawaiʻi Catastrophic Hurricane Plan/FEMA Region IX Hawaiʻi Catastrophic Annex*, a hurricane of any size and duration may pose a threat to the infrastructure, environment, and economy and impact the daily lives of residents (FEMA 2015). This is because of the state's geographic location and isolation, which requires high dependence on maritime cargo to maintain and sustain its economic vitality. In addition, the state is densely populated along its coastal shores. Thus, the state's population, property and economy are highly vulnerable to storm surge and high winds, which are the main threats of a hurricane. For the 2023 SHMP Update, two analyses were conducted to assess hurricane vulnerability:

1. For the wind component of the hurricane hazard, a statewide 500-year Mean Return Period (MRP) hurricane scenario (see Figure 4.9-5) was run in FEMA's Hazus wind model to estimate potential losses. This scenario was created for the *2015 Hawaiʻi Catastrophic Hurricane Plan/FEMA Region IX Hawaiʻi Catastrophic Annex*, with a specific storm track and wind speeds. Results are reported below. Four Category 4 county-specific hurricane scenarios were also run in Hazus, and general building stock losses and sheltering estimates are included in Appendix F (State Profile and Risk Assessment Supplement). Appendix D (Map Atlas) displays maps of the storm track and wind speeds associated with the four county-specific hurricane scenarios.

2. The NOAA National Hurricane Center provided the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) Model data for the State of Hawaiʻi. The storm surge inundation areas were created by multiple analysis runs for hurricanes approaching the State of Hawaiʻi from different directions and retaining the highest inundation value at a given location (the maximum of maximums) for each hurricane Category 1 through 4. The SLOSH data is a non-regulatory product, meaning it is not used to determine flood insurance rates. The data promotes storm surge risk awareness. This data was overlaid with the state assets to determine exposure to storm surge.

The two datasets referenced above are not directly connected. The wind data was used to determine general building stock losses, displaced households and shelter needs in the state resulting from a Category 4 hurricane. The storm surge data was used to determine exposure of state assets, critical facilities, population, general building stock, and environmental resources and culture assets to the hazard.

Figure 4.9-5. 500-year Mean Return Period Hurricane Statewide Scenario



Assessment of State Vulnerability and Potential Losses

This section discusses statewide vulnerability of exposed state assets (state buildings and roads) and critical facilities to the hurricane hazard.

State Assets

All state buildings are exposed to the wind and rain associated with a hurricane event. The spatial analysis utilizing the SLOSH data determined there are 654 state buildings (10.73%) located in the Category 4 SLOSH inundation area, of which the greatest number are located in the City and County of Honolulu (503 buildings with a replacement cost value of $2.807 billion). The majority of these buildings are occupied by the Department of Education. Table 4.9-5 summarizes the state buildings located in the Category 4 SLOSH inundation area by county; Table 4.9-6 summarizes by agency. Estimated potential losses to state buildings as a result of the storm surge Category 4 hurricane were not calculated as part of the 2023 SHMP Update.

Table 4.9-5. State Buildings Located in the Category 4 SLOSH Inundation Area by County

County	Total Number of State Buildings	Total Replacement Cost Value (structure and contents)	Number of State Buildings in Hazard Area	Percent (%) of Total State Buildings	Total Value of State Buildings in Hazard Area (structure and contents)	Percent (%) of Total Value
County of Kauaʻi	531	$990,850,824	82	15.44%	$165,931,851	16.75%
City and County of Honolulu	3,472	$17,393,945,915	503	14.49%	$2,807,560,873	16.14%
County of Maui	831	$3,097,491,689	51	6.14%	$179,762,806	5.80%
County of Hawaiʻi	1,261	$4,638,567,141	18	1.43%	$87,811,399	1.89%
Total	**6,095**	**$26,120,855,568**	**654**	**10.73%**	**$3,241,066,929**	**12.41%**

Source: *Federal Emergency Management Agency; National Weather Service; National Oceanic and Atmospheric Administration; State of Hawaiʻi Risk Management Office 2017*

Table 4.9-6. State Buildings Located in the Category 4 SLOSH Inundation Area by Agency

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Hazard Area	Percent (%) of Total State Buildings	Value in the Hazard Area	Percent (%) of Total Value
Dept of Accounting & General Services	66	$953,963,738	11	16.67%	$162,105,561	16.99%
Dept of Agriculture	70	$147,607,399	13	18.57%	$25,977,208	17.60%
Dept of Attorney General	15	$108,425,480	4	26.67%	$31,246,321	28.82%
Dept of Budget & Finance	16	$28,968,679	3	18.75%	$21,515,418	74.27%
Dept of Business, Economic Development and Tourism	25	$645,480,379	6	24.00%	$560,518,082	86.84%
Dept of Commerce & Consumer Affairs	2	$40,197,360	0	0.00%	$0	0.00%
Dept of Defense	69	$267,352,836	9	13.04%	$29,801,107	11.15%
Dept of Education	4,090	$10,598,205,739	403	9.85%	$902,271,366	8.51%
Dept of Hawaiian Home Lands	12	$110,427,352	1	8.33%	$5,489,080	4.97%
Dept of Health	44	$387,068,440	3	6.82%	$7,922,830	2.05%
Dept of Human Resources Development	1	$5,973,872	0	0.00%	$0	0.00%
Dept of Human Services	130	$480,212,294	29	22.31%	$178,734,660	37.22%
Dept of Labor and Industrial Relations	22	$90,076,209	4	18.18%	$59,693,544	66.27%
Dept of Land and Natural Resources	90	$101,441,821	26	28.89%	$13,075,258	12.89%
Dept of Public Safety	154	$440,774,415	15	9.74%	$36,397,935	8.26%
Dept of Taxation	1	$7,174,162	1	100.00%	$7,174,162	100.00%
Dept of Transportation	68	$2,935,208,214	40	58.82%	$397,604,634	13.55%
Hawaiʻi State Ethics Commission	1	$984,533	0	0.00%	$0	0.00%
Hawaiʻi Health Systems Corporation	106	$1,230,852,871	1	0.94%	$936,734	0.08%
Hawaiʻi Housing Finance & Development Corporation	86	$360,851,671	5	5.81%	$118,247,972	32.77%
Hawaiʻi Public Housing Authority	273	$982,981,701	37	13.55%	$85,423,311	8.69%
Hawaiʻi State Legislature	2	$48,555,381	0	0.00%	$0	0.00%
Hawaiʻi State Public Library System	53	$525,584,082	11	20.75%	$32,473,857	6.18%

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Hazard Area	Percent (%) of Total State Buildings	Value in the Hazard Area	Percent (%) of Total Value
Judiciary	41	$534,877,354	7	17.07%	$75,272,153	14.07%
Legislative Reference Bureau	1	$2,996,162	0	0.00%	$0	0.00%
Office of Hawaiian Affairs	11	$54,125,645	6	54.55%	$43,013,415	79.47%
Office of the Auditor	2	$1,921,180	0	0.00%	$0	0.00%
Office of the Governor	1	$2,996,162	0	0.00%	$0	0.00%
Office of the Lieutenant Governor	2	$4,588,849	0	0.00%	$0	0.00%
Office of the Ombudsman	1	$1,818,060	0	0.00%	$0	0.00%
Research Corporation of the University of Hawaiʻi	3	$4,189,026	0	0.00%	$0	0.00%
University of Hawaiʻi	637	$5,014,974,503	19	2.98%	$446,172,321	8.90%
Total	**6,095**	**$26,120,855,568**	**654**	**10.73%**	**$3,241,066,929**	**12.41%**

Source: Federal Emergency Management Agency; National Weather Service; National Oceanic and Atmospheric Administration; State of Hawaiʻi Risk Management Office 2017

Roads and bridges are also considered critical infrastructure, particularly those providing ingress and egress for evacuees and those allowing emergency vehicles access to those in need. Throughout the state, roads may become flooded as a result of storm surge inundation. The roads may be undermined or fully submerged under water for a period, thus degrading the integrity of the road and isolating population and communities. Sometimes the damage is apparent—a road that washes away, a sinkhole that appears, a bridge that crumbles—but often the damage is less obvious on the surface. Table 4.9-7 summarizes the length of state road in the Category 1 through 4 hurricane storm surge inundation areas by county. While the County of Hawaiʻi has the most total length in square miles at 379.2, it is the City and County of Honolulu that has the most length exposed to SLOSH inundation areas for each category hurricane. A complete list of state roads located in Category 1 through 4 hurricane storm surge inundation areas is included in Appendix F (State Profile and Risk Assessment Supplement).

Table 4.9-7. State Roads Exposed to SLOSH Inundation Areas by County

County	Total Length (Sq. Miles)	Category 1 Hurricane		Category 2 Hurricane		Category 3 Hurricane		Category 4 Hurricane	
		Length	Percent (%) of Total	Length	Percent (%) of Total	Length	Percent (%) of Total	Length	Percent (%) of Total
County of Kauaʻi	103.7	2.5	2.41%	4.2	4.05%	9	8.68%	12.4	11.96%
City and County of Honolulu	374.9	14.6	3.89%	26.7	7.12%	34.3	9.15%	43.4	11.58%
County of Maui	245.9	7.4	3.01%	11.9	4.94%	17.2	6.99%	20.2	8.21%
County of Hawaiʻi	379.2	0.1	0.03%	0.1	0.03%	0.4	0.11%	1.7	0.45%
Total	**1,103.70**	**24.6**	**2.23%**	**42.9**	**3.89%**	**60.9**	**5.52%**	**77.7**	**7.04%**

Source: Federal Emergency Management Agency; National Weather Service; National Oceanic and Atmospheric Administration; State of Hawaiʻi Department of Transportation 2022

Community Lifelines and Critical Facilities

A hurricane could have significant impacts on community lifelines and critical facilities including airports, harbors, transportation and utility infrastructure and other public services. The interruption of these critical services and operations utility will impact resident and visitor travel, and all forms of economic activity. According to the Oʻahu Metropolitan Planning Organization *Transportation Asset Climate Change Risk Assessment* report, in terms of vessels, there is sufficient warning time associated with a hurricane to direct out to sea until the storm passes. Of greater concern is the effect of storm surge on the piers and storage areas, as well as containers that could fall into Honolulu Harbor, blocking ships from accessing the piers themselves. The largest disruption would be to the supply chain (i.e., food, goods materials and fuel) with cascading impacts statewide (SSFM International 2011).

The Port of Honolulu is the single major supply port for the state. All petrol products arrive by sea. In addition, millions of tons of food and supplies enter the port each year. The ports and electrical systems are interdependent and a disaster event such a hurricane that may close or damage port assets will result in impacts cascading throughout the state (State of Hawai'i 2018).

The Honolulu International Airport is the largest airport in the state and accommodates approximately 60% of the state's air passengers. The airport is approximately 13 feet above sea level. In the event of a severe hurricane event, it is estimated the airport would experience one-to-two-week downtime from commercial flights and one to three days of downtime for emergency response. Due to the City and County of Honolulu's population, tourism, and employment base, damage to the airport could have long-term, devastating social and economic consequences to the island and the entire state (SSFM International 2011).

Table 4.9-8 and Table 4.9-9 summarize the community lifelines and critical facilities in the Category 4 SLOSH inundation area. The City and County of Honolulu has the largest number of community lifelines (129) located within the Category 4 SLOSH inundation area. The food, water, shelter, safety and security, and communications categories have the greatest number of facilities exposed. Additional Category 1 through 3 hurricane storm surge analyses on critical facilities are included in Appendix F. Economic loss resulting from impacts to critical facilities was not monetized as part of the 2023 SHMP Update.

Table 4.9-8. Community Lifelines and Critical Facilities Located in the Category 4 SLOSH Inundation Areas, by County

County	Community Lifeline Categories								Additional Critical Facilities
	Communications	Energy	Food, Water, Shelter	Hazardous Material	Health & Medial	Safety & Security	Transportation	Total in the Hazard Area	
County of Kauaʻi	1	2	10	0	0	8	2	23	2
City and County of Honolulu	27	22	45	1	6	26	2	129	5
County of Maui	3	0	12	0	5	10	7	37	1
County of Hawaiʻi	0	1	10	1	0	1	5	18	2
Total	**31**	**25**	**77**	**2**	**11**	**45**	**16**	**207**	**10**

Source: Federal Emergency Management Agency; National Weather Service; National Oceanic and Atmospheric Administration; Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020

Table 4.9-9. Community Lifelines and Critical Facilities Located in the Category 4 SLOSH Inundation Areas, by Category

Category	Total Number of Facilities	Total Replacement Cost Value	Number of Facilities in Hazard Area	Percent of Total Facilities	Value in the Hazard Area	Percent (%) of Total Value
Communications	188	$776,797,683	31	16.49%	$94,805,112	12.20%
Energy	89	$3,093,949,530	25	28.09%	$865,785,050	27.98%
Food, Water, Shelter	345	$11,847,189,588	77	22.32%	$2,604,539,490	21.98%
Hazardous Material	12	$436,474,800	2	16.67%	$73,534,800	16.85%
Health and Medical	193	$4,606,713,364	11	5.70%	$118,029,014	2.56%
Safety and Security	486	$38,164,188,232	45	9.26%	$3,159,828,837	8.28%
Transportation	56	$2,039,091,600	16	28.57%	$582,597,600	28.57%
Additional Critical Facilities	106	$447,698,794	10	9.43%	$39,426,004	8.81%
Total	**1,475**	**$61,412,103,591**	**217**	**14.71%**	**$7,538,545,906**	**12.28%**

Source: Federal Emergency Management Agency; National Weather Service; National Oceanic and Atmospheric Administration; Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020

Assessment of Local Vulnerability and Potential Losses

For this vulnerability assessment, it is assumed that the entire State of Hawaii's resident and visitor population and property is exposed to the hurricane hazard, though the impact of a hurricane/tropical cyclone on life, health, and safety is dependent upon several factors, including the severity of the event and whether or not adequate warning time was provided.

The local HMPs were reviewed to integrate risk assessment results into the 2023 SHMP Update; a summary of information available is below.

- **County of Kauaʻi** –The County HMP combines tropical cyclones and high winds into one hazard. The County of Kauaʻi included a qualitative assessment of risks presented by tropical cyclones, including storm surge, wind damage, and rainfall/flooding. Tropical cyclone storm surge impacts were assessed using storm surge inundation mapping for a Category 4 hurricane, as determined using the NOAA National Hurricane Center's SLOSH (Sea, Lake and Overland Surges from Hurricanes) methodology. The County performed a Level 2 Hazus analysis for a Category 4 hurricane and found that over 14,100 households would be displaced, and total losses would amount to more than $9.1 billion (County of Kauaʻi 2020).
- **City and County of Honolulu** – The City and County of Honolulu included a qualitative assessment of risks presented by tropical cyclones, including storm surge and wind damage. The HMP discusses the vulnerability of different housing types to wind damage. A Hazus-MH study found that Average Annualized Loss is $140 million. (City and County of Honolulu 2020).
- **County of Maui** – The Maui County HMP combines hurricanes, tropical storms, and Kona storms into one hazard. The County of Maui included a qualitative assessment of risks presented by hurricanes, including storm surge, wind damage, and rainfall/flooding. 34 critical facilities were found to be in the storm surge area in Maui County. Additionally, the HMP lists residents who are most vulnerable to flood risk, including single parent and dependent households, residents living below the poverty line, residents without adequate communication infrastructure and/or limited English proficiency, residents living in properties built prior to the 1950s, and residents with limited mobility (County of Maui 2020).

- **County of Hawaiʻi** – The County of Hawaiʻi included a qualitative assessment of risks presented by tropical cyclones, including three major categories of threat: storm surge, wind damage, and rainfall/flooding. The HMP used Hazus to model wind and storm surge for a Category 4 storm. Population impacts were found to be county-wide for wind damage; 1,081 residents would be impacted by storm surge. 523 critical facilities would be impacted by a Category 4 storm, with over $11.2 billion in property damages. Socially vulnerable populations, such as the economically disadvantaged and elderly, were found to be at particular risk (County of Hawaiʻi 2020).

Socially Vulnerable and Total Population

The entire population in the state is vulnerable to the hurricane hazard. Downed trees, damaged buildings, and debris carried by high winds can lead to injury or loss of life. Storm surge inundation is a significant threat to the population along the coast. To estimate the population that may be impacted by a Category 4 hurricane event, the FEMA Hazus wind model was used to estimate displacement and sheltering needs, and the SLOSH Category 4 spatial layer was used to estimate the population along the coast located in the inundation area. It is recognized that combining the population from these separate analyses may overestimate the vulnerable population. Refer to Table 4.9-10.

Table 4.9-10. Estimated Population Impacted by a Category 4 Hurricane

County	Total Population	SLOSH Category 4			
		Total Population Located in the Storm Surge Area	Population Exposed as Percent (%) of Total Population	Socially Vulnerable Population Located in Hazard Area	Socially Vulnerable Population Exposed as Percent (%) of Total Population
County of Kauaʻi	71,949	2,462	3.42%	189	0.26%
City and County of Honolulu	979,682	135,313	13.81%	29,010	2.96%
County of Maui	167,093	3,755	2.25%	812	0.49%
County of Hawaiʻi	201,350	1,092	0.54%	309	0.15%
Total	**1,420,074**	**142,622**	**10.04%**	**30,320**	**2.14%**

Source: Federal Emergency Management Agency; National Weather Service; National Oceanic and Atmospheric Administration; U.S. Census Bureau 2020; Centers for Disease Control and Prevention 2018

As a result of the statewide Category 4 Hazus wind analysis, the City and County of Honolulu has the greatest number of estimated displaced households and the greatest number of short-term sheltering needs. These sheltering estimates are based on Census population. This analysis does not include the tourist, visitor, and homeless populations in the state and therefore sheltering needs may be higher.

Socially vulnerable populations are most susceptible based on many factors, including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Economically disadvantaged populations are likely to evaluate their risk and make decisions based on the major economic impact to their family and may not have funds to evacuate. Vulnerable populations are the elderly, low income or linguistically isolated populations, people with life threatening illnesses, and residents living in areas that are isolated from major roads. Power outages can be life-threatening to those dependent on electricity for life support and are a significant concern. These populations face isolation and exposure during hurricanes and could suffer more secondary effects of the hazard.

Floods resulting from a hurricane and its aftermath present numerous threats to public health and safety, including unsafe food, contaminated drinking and washing water and poor sanitation, mosquitoes and animals, mold and mildew, carbon monoxide poisoning, and mental stress and fatigue. Refer to Section 4.6 (Flood) for further details on these impacts. Current loss estimation models such as Hazus are not equipped to measure public health impacts. The best preparation for these effects includes awareness that they can occur, education of the public on prevention, and planning to deal with them during responses to hurricane events.

Land Use Districts

Table 4.9-11 summarizes the area and percent of total area in each state land use district statewide exposed to the Category 4 hurricane storm surge inundation area; Appendix F shows results by county. More than 11% of the Urban District land in the state is exposed to storm surge impacts from a Category 4 hurricane, especially when considering that only 2.5% of the Urban District land area statewide is located in coastal high hazard areas with mandatory construction standards that account for wave action (see Section 4.6 Flood for more information). Only a very small amount of Conservation District lands are exposed statewide. Conservation District Lands contain valuable environmental resources. Additional discussion of exposure and vulnerability of these resource areas can be found in the Environmental Resources section below.

Table 4.9-11. State Land Use Districts Located in Category 4 SLOSH Inundation Area

Land Use District	Total (square miles)	Square Miles in Category 4 SLOSH Area	% of Total Area
Agricultural	2,973.6	17.9	0.60%
Conservation	3,202.9	11.7	0.37%
Rural	16.3	1.3	7.96%
Urban	319.1	37.0	11.59%
Total	**6,511.95**	**67.9**	**1.04%**

Source: Federal Emergency Management Agency; National Weather Service; National Oceanic and Atmospheric Administration; State Land Use Commission, Hawaiʻi Statewide GIS Program 2021; Honolulu County GIS 2022

General Building Stock

All structures in the state are exposed to the hurricane hazard. Hurricane-force winds (74 mph or higher) can destroy buildings and mobile homes. Street signs, roofing material, siding and small items left outside become flying objects during a storm and not only cause property damage but may injure residents. Exposure is particularly severe along the coastline and in areas prone to riverine flooding due to the heavy rains that accompany these storm events and/or high wind gusts. Damages to buildings can displace people from their homes, threaten life safety and impact a community's economy and tax base.

Once all counties adopt the Hawaiʻi State Building Code, it requires new structures to be built to withstand a Category 3 hurricane wind speed. The Category 4 hurricane storm surge inundation areas may extend beyond the boundaries of regulatory flood zones discussed in Section 4.6, meaning that currently enforced standards offer some level of protection but are likely not sufficient to prevent damage from a Category 4 hurricane in many areas. Information regarding the year built and current building conditions was not factored into this analysis.

Table 4.9-12 summarizes the number of buildings located in the Category 4 storm surge inundation area based on the spatial analysis and the estimated potential losses to structures from Category 4 winds generated by Hazus. Overall, the City and County of Honolulu has the highest percent (21.52%) of building exposure to Category 4 hurricane storm inundation, followed by the County of Kauaʻi (11.07% of the county total building stock replacement cost value). The Hazus wind analysis estimates greater than $51 billion in potential building loss in the City and County of Honolulu as a result of the Category 4 hurricane scenario evaluated. All counties are estimated to experience millions in building damages.

Table 4.9-12. General Building Stock Exposure to SLOSH Category 4

County	Total RCV	SLOSH Category 4	
		RCV in Cat 4 SLOSH area	Percent (%) of Total RCV
County of Kauaʻi	$24,246,497,228	$2,685,058,109	11.07%
City and County of Honolulu	$239,152,051,766	$51,463,869,170	21.52%
County of Maui	$50,796,693,140	$3,597,621,126	7.08%
County of Hawaiʻi	$58,395,349,136	$1,113,740,437	1.91%
Total	**$372,590,591,270**	**$58,860,288,842**	**15.80%**

Source: Federal Emergency Management Agency; National Weather Service; National Oceanic and Atmospheric Administration; NIYAM IT 2022; United States Army Corps of Engineers 2022

Environmental Resources

The state has numerous environmental resources along the shore, including beaches, wetlands, critical habitats (habitats that are essential for an endangered or threatened species) and parks and reserves. Further, natural features such as coral reefs, wetlands, beaches, and dunes provide protection from storms and rising sea levels (Virginia Institute of Marine Science n.d.). Impacts to these assets will not only damage the natural environment but also have cascading impacts on the economy. Refer to the *Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report*, which further outlines impacts of flooding, storm surge, and sea level rise on the natural environment, including coral reefs and endangered and threatened species such as the Hawaiian monk seal and Hawaiian green turtle. Table 4.9-13 summarizes the environmental assets located in the Category 4 hurricane storm surge area.

Table 4.9-13. Environmental Assets Located in the Category 4 SLOSH Storm Surge Inundation Area

Environmental Asset	Statewide		
	Total Square Miles of Asset	Square Miles in Hazard Area	% of Total Asset Area
Critical Habitat [a]	951	1	0.1%
Wetlands	3,637	22	0.6%
Parks and Reserves	2,778	9	0.3%
Reefs [b]	55	1	2.4%
Total [c]	**7,420**	**33**	**3.4%**

Source: U.S. Fish and Wildlife Service, Pacific Islands Office, 2022, U.S. Fish and Wildlife Service 2021; 2017; Hawaiʻi State Department of Land and Natural Resources, Division of Forestry and Wildlife 2022; NOAA raster nautical charts 2020; State of Hawaiʻi Department of Land and Natural Resources, Division of State Parks 2021; Federal Emergency Management Agency; National Weather Service; National Oceanic and Atmospheric Administration

Notes:

a. Critical area mileage includes the combined area of coverage of individual critical habitat areas.

b. Reefs include artificial and coral reefs.

c. Total square miles includes environmental assets within 3 nautical miles of each county and may be over reported as some environmental asset areas may overlap.

Due to its geographic location and isolation, the state faces unique challenges in addressing disaster debris. With limited landfill capacity, advanced planning for large amounts of debris generated by a hurricane, which will include both tree debris and construction debris, is critical.

Cultural Assets

Cultural and historical resources are located near the shore and vulnerable to storm surge inundation. Beaches may erode, impacting fishing and cultural practices. Portions of the Hawaiian Home Lands may become flooded due to storm surge inundation. Table 4.9-14 summarizes the area of Hawaiian Home Lands located in the SLOSH Category 1 through 4 hurricane storm surge inundation areas. While the County of Hawai'i has the largest total area of Hawaiian Home Lands, the County of Maui has the largest area of Hawaiian Home Lands in each of the hurricane storm surge inundation categories. Table 4.9-15 summarizes the cultural resources located in the SLOSH Category 1 through 4 storm surge inundation areas. The cultural resource type with the largest total area and largest area in each of the storm surge inundation areas in the Historic District.

Table 4.9-14. Hawaiian Home Lands Located in the SLOSH Category 1 through 4 Hurricane Storm Surge Inundation Areas

County	Area (in square miles)								
	Total Area	Cat 1 Hazard Area	Hazard Area as % of Total Area	Cat 2 Hazard Area	Hazard Area as % of Total Area	Cat 3 Hazard Area	Hazard Area as % of Total Area	Cat 4 Hazard Area	Hazard Area as % of Total Area
County of Kaua'i	32.1	0.2	0.5%	0.2	0.7%	0.4	1.2%	0.4	1.3%
City and County of Honolulu	10.6	0.05	0.4%	0.1	0.6%	0.1	1.2%	0.2	1.5%
County of Maui	102.6	1.4	1.4%	1.6	1.6%	1.7	1.7%	1.8	1.7%
County of Hawai'i	191.5	0.05	<0.1%	0.1	0.0%	0.1	0.1%	0.2	0.1%
Total	**336.7**	**1.7**	**0.5%**	**2.0**	**0.6%**	**2.3**	**0.7%**	**2.5**	**0.7%**

Source: Federal Emergency Management Agency; National Weather Service; National Oceanic and Atmospheric Administration; Hawai'i State Department of Hawaiian Homelands 2021

Table 4.9-15. Cultural Resources Located in the SLOSH Category 1 through 4 Storm Surge Inundation Areas

Cultural Resource Site Type	Area in square miles								
	Total Area	Cat 1 Hazard Area	Hazard Area as % of Total Area	Cat 2 Hazard Area	Hazard Area as % of Total Area	Cat 3 Hazard Area	Hazard Area as % of Total Area	Cat 4 Hazard Area	Hazard Area as % of Total Area
Archaeology	90.9	2.7	3.0%	4.5	5.0%	6.6	7.2%	7.4	8.2%
Burial Sensitivity Area	2.1	0.1	3.2%	0.1	4.4%	0.1	5.7%	0.1	6.9%
Historic Building	2.7	0.1	4.4%	0.2	6.8%	0.2	9.3%	0.3	12.8%
Historic District	849.4	5.8	0.7%	8.2	1.0%	10.8	1.3%	13.6	1.6%

Cultural Resource Site Type	Area in square miles								
	Total Area	Cat 1 Hazard Area	Hazard Area as % of Total Area	Cat 2 Hazard Area	Hazard Area as % of Total Area	Cat 3 Hazard Area	Hazard Area as % of Total Area	Cat 4 Hazard Area	Hazard Area as % of Total Area
Historic Object	9.6	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
Historic Structure	20.7	0.0	0.2%	0.1	0.4%	0.2	0.9%	0.3	1.4%
Total	**975.4**	**8.7**	**0.9%**	**13.1**	**1.3%**	**17.9**	**1.8%**	**21.8**	**2.2%**

Source: Federal Emergency Management Agency; National Weather Service; National Oceanic and Atmospheric Administration; Department of Land and Natural Resources, Hawai'i State Historic Preservation Division 2022

Future Changes that May Impact State Vulnerability

Understanding factors of change that impact vulnerability in the state can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The state considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other conditions identified as relevant and appropriate, including the impacts of climate change.

Potential or Projected Development

Category 4 storm surge inundation areas were overlain on areas that may experience significant changes in development or redevelopment in future years [see Table 4.9-16; refer to Section 3 for more information on projected development areas; see Appendix F (State Profile and Risk Assessment Supplement) for Category 1 through 3]. The results of this analysis indicate that significant amounts of the Hawai'i Community Development Authority (HCDA) Community Development District areas are exposed to storm surge from a Category 4 hurricane event. In addition, development in coastal areas of the Enterprise Zones throughout the state would be impacted. The Category 4 hurricane storm surge inundation areas may extend beyond the boundaries of regulatory flood zones discussed in Section 4.6 (Flood), meaning that currently enforced standards offer some level of protection, but are likely not sufficient to prevent damage from a Category 4 hurricane in many areas. This is especially important for areas that experience 1.5 feet or greater wave heights due to their damaging effects on structures.

Table 4.9-16. HCDA Community Development Districts, Maui Development Projects, and Enterprise Zones Located in Category 4 SLOSH Hurricane Areas

County	Area (in square miles)								
	HCDA Community Development Districts (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area	Maui Development Projects (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area	Enterprise Zones (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area
County of Kauaʻi	0	0	0	0	0	0	251	10.3	4.10%
City and County of Honolulu	7.4	1.4	18.92%	0	0	0	297.3	16.3	5.48%
County of Maui	0	0	0	27.6	0.1	0.18%	1,059.80	11.6	1.09%
County of Hawaiʻi	0	0	0	0	0	0	1,274.90	3.5	0.27%
Total	**7.4**	**1.4**	**18.92%**	**27.6**	**0.1**	**0.18%**	**2,883.00**	**41.7**	**1.45%**

Source: Maui County Planning Department 2016; Hawaiʻi Community Development Authority 2021; Community Economic Development Program, Department of Business, Economic Development & Tourism, County Planning Departments 2021; Federal Emergency Management Agency; National Weather Service; National Oceanic and Atmospheric Administration

In addition to storm surge, any new development will be subject to impacts from winds associated with a hurricane event. Building codes for new construction in the state require greater protection from high wind events than those codes that were previously enforced in the state.

Projected Changes in Population

As the population in the state ages, additional resources may be needed to support evacuation efforts in advance of a hurricane and to support emergency power for medically necessary equipment during and after an event.

Other Factors of Change

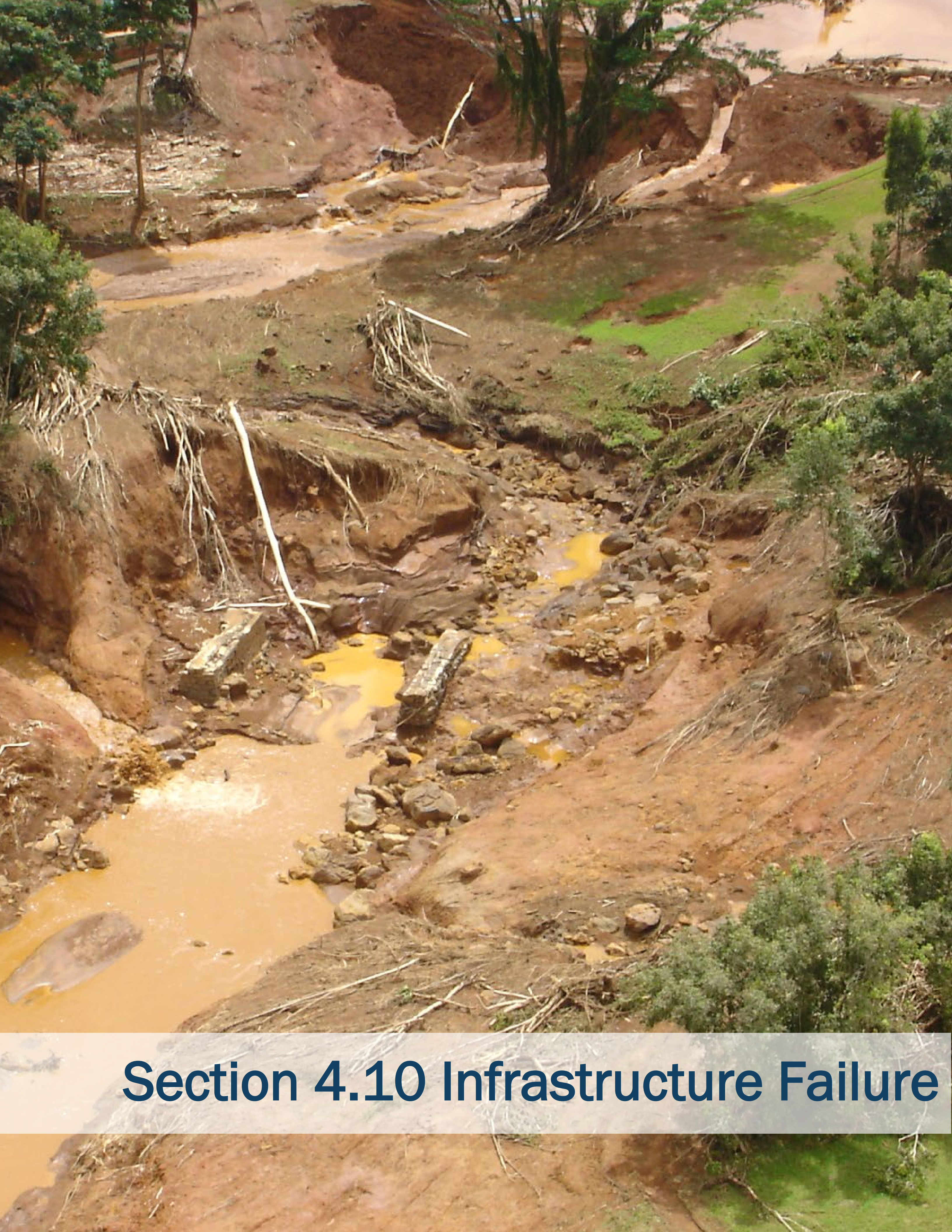
As sea levels rise, storm surge will reach further inland putting more people and property at risk. The storm surge modeling used for this assessment did not include projected sea level rise; however, increased exposure to storm surge and coastal flooding as a result of sea level rise is discussed in Section 4.2 (Climate Change and Sea Level Rise).

Hurricane Hazard Mitigation Success Story

Credit: HI-EMA

Federal funds through two different disaster declarations allowed the Honolulu Fire Department to install hurricane-resistant doors on the Waikīkī Fire Station 7. Existing aluminum doors were replaced with anodized aluminum doors, which provide higher protection from hazards, especially high winds and projectiles during severe weather conditions which will allow the fire department to provide uninterrupted essential services.

The Waikīkī Fire Station 7 is the primary response station for the Waikīkī area. The station covers nearly 29 street miles containing high-, mid-, and low-rise hotels, residential condominiums and several schools. The station serves an approximate population of 32,000, including some of the most vulnerable members of the community (HI-EMA 2021).



Section 4.10 Infrastructure Failure

Infrastructure Failure

Infrastructure failure is a broad term that encompasses the hazards that are created or exacerbated when incidents, both human-caused and natural, cause the failure of an infrastructure element. The statistics below focus on the high hazard dam inundation area.

CHANGES SINCE 2018

+0 Declared Disasters

+0 Events

COUNTIES MOST VULNERABLE

Kaua'i Honolulu **Maui** Hawai'i

SOCIALLY VULNERABLE POPULATION

0.9% Of Total Population

12,510 Persons

HAZARD RANKING

Low Medium **High**

COMMUNITY LIFELINES

21 Total

Safety and Security — Greatest

CLIMATE PROJECTIONS

Increased drought and heavy rain events will cause an increase in flash flooding, infrastructure damage, runoff, and sedimentation

Increased rainfall from El Niño may lead to an increased risk of dam failure

Spillway overflow events may increase due to an increase in flooding potential

197 State Buildings

SQUARE MILES

9 Environmental Resources

2 Hawaiian Home Lands

3 Cultural Resources

26 Miles of State Road

CONTENTS

TABLES

[1] *Section Cover Photo: Remainder of the Morita Reservoir wall and a road, downstream of the 400+ million-gallon flow from the Ka Loko dam failure in 2006. Photo courtesy of Kauaʻi Emergency Management Agency*

SECTION 4. RISK ASSESSMENT

4.10 INFRASTRUCTURE FAILURE

2023 SHMP Update Changes

- ❖ The infrastructure failure profile is new for the 2023 update; however, it primarily focuses on dam failure, which was previously a stand-alone section.
- ❖ Dam failure events that occurred in the State of Hawaiʻi from January 1, 2018, through December 31, 2022, were researched for this 2023 SHMP Update.
- ❖ New and updated figures from federal, state, and local agencies were incorporated.
- ❖ This section now includes a discussion of how infrastructure failure impacts socially vulnerable populations and community lifelines.
- ❖ Six types of cultural resources (archaeology, burial sensitivity area, historic building, historic district, historic object, and historic structure) were added to the vulnerability assessment.
- ❖ This section now includes an analysis of the exposure of state and county assets to high hazard dam inundation areas.

4.10.1 HAZARD PROFILE

Infrastructure failure is a broad term that encompasses the hazards that are created or exacerbated when incidents, both human-caused and natural, cause the failure of an infrastructure element. These incidents include disasters like dam/hydrological failure, pre-building code engineering mishaps, interruption of operations, and structural windborne debris and transportation infrastructure failure at the harbor or airport (State of Hawaiʻi Emergency Management Agency 2022). This section focuses on dam failure, while other types of infrastructure failure are addressed as cascading effects of other hazards within Section 4 Risk Assessment.

Dams and reservoirs in the State of Hawaiʻi were predominantly developed for irrigation purposes by the agriculture industry in the early 20th century. More than 100 years later, dams and reservoirs continue to be used by the agriculture industry, in addition to providing storage for drinking water, flood control, hydropower, recreation, and other purposes. The Hawaiʻi Dam Safety Program was started in 1987 when the statutes were passed by the legislature and was followed up in 1989 with the Hawaiʻi Administrative Rules that were set up by the Department of Land and Natural Resources (DLNR). Most existing dams were built before regulatory construction standards were established.

Key Terms

- **Dam** – An artificial barrier that has the ability to impound water, wastewater, or any liquid-borne material, for the purpose of storage or water control (FEMA 2016).
- **State-Regulated Dam** – Any artificial barrier that can or does impound or divert water and is 25 feet or more in height or impounds 50 acre-feet or more (Hawaiʻi Administrative Rules, Chapter 190.1.)
- **Dam Failure** – An uncontrolled release of impounded water.

Only dams that meet certain jurisdictional size criteria (height and volume) are regulated by the state's Dam and Reservoir Safety Program. Regulated dams are identified as having artificial barriers which are 25 feet or more in height or have an impounding capacity of 50 acre-feet (approximately 17 million gallons) or more.

This section provides general information on the dam failure hazard. Flooding caused by chronic coastal flooding is discussed in Section 4.6 (Flood), event-based flooding is discussed in Section 4.6 (Flood), and storm surge is discussed in Section 4.9 (Hurricane).

Hazard Description

A dam is an artificial barrier that has the ability to impound water, wastewater, or any liquid-borne material, for the purpose of storage or water control (FEMA 2016). A dam impounds water in the upstream area or reservoir. The amount of water impounded, or stored, is measured in acre-feet, referring to the volume of water that covers an acre of land to a depth of one foot (USGS 1995).

Dam failures can occur with little to no warning. Dam failures are most likely to occur for one of five reasons, including:

- Overtopping caused by water spilling over the top of a dam
- Foundational defects, including settlement and slope instability, cause about 30% of all dam failures
- Cracking caused by movements like the natural settling of a dam
- Inadequate maintenance and upkeep
- Piping is when seepage through a dam is not properly filtered, and soil particles continue to progress and form sinkholes in the dam
- (Association fo State Dam Safety Officials 2022)

Location

DLNR maintains the online *Dam Inventory System* which includes detailed information and evacuation zones for each of the 126 state-regulated dams. As of December 31, 2021, 118 of the 126 state-regulated dams have a classification of "high hazard" (Association of State Dam Safety Officials 2021). A detailed inventory of dams, by county, is listed in Appendix F (State Profile and Risk Assessment Supplement). Table 4.10-1 summarizes the total number of dams in each county. A majority of the dams (55 total) are located in the County of Maui, followed by the County of Kauaʻi with 48 dams. Table 4.10-2 summarizes the total square miles of high hazard dam inundation area by county. The Counties of Kauaʻi and Maui have the greatest inundation area, followed by the City and County of Honolulu.

Table 4.10-1. Total Number of Dams and Reservoirs in Each County

County	Total Number of Dams and Reservoirs
County of Kauaʻi	48
City and County of Honolulu	13
County of Maui	55
County of Hawaiʻi	10
Total	**126**

Source: DLNR n.d.

Table 4.10-2. Total Square Miles of High Hazard Dam Inundation Area in Each County

County	Total County Area (square miles)	Total Square Miles of Dam Failure Inundation Area	Percent (%) of Total Area
County of Kauaʻi	624.29	16.5	2.64%
City and County of Honolulu	598.57	8	1.34%
County of Maui	1176.28	30.1	2.56%
County of Hawaiʻi	4039.64	10.3	0.25%
Total	**6,438.78**	**64.9**	**1.01%**

Source: Department of Land and Natural Resources 2022; Pacific Disaster Center 2022
Note:
Area was calculated based upon the spatial layer provided by Pacific Disaster Center. All dam failure inundation areas were merged for each county to remove overlap.

High hazard dams throughout the state are indicated in Figure 4.10-1. Inundation area mapping for high hazard dams can be found in Appendix D (Map Atlas). DLNR, with coordination from the Pacific Disaster Center, provided the data for the high hazard dam locations and inundation areas represented in this SHMP Update.

Obstacles and Challenges

DLNR continues to address obstacles and challenges for overall dam safety in the state by maintaining updated data on the following website: Engineering Division, Dam Safety (hawaii.gov). The information and interactive mapping increases understanding of the dam failure risk in Hawaiʻi. Both state and federal sources are used to fund the DLNR State Dam Safety Program. Continued access to funding is critical to keep information up to date as climate conditions, including extreme precipitation events, change in the state.

EXTENT

It is common practice among federal and state dam safety offices to classify a dam according to the potential impact a dam failure (breach) or misoperation (unscheduled release) would have on the downstream areas from the dam. The State of Hawaiʻi classifies dams and reservoirs in a three-tier hazard rating system based on the probable loss of human life and impacts on the economy and environment. The hazard potential categories are listed below and summarized in Table 4.10-3.

Figure 4.10-1. High Hazard Dams Statewide

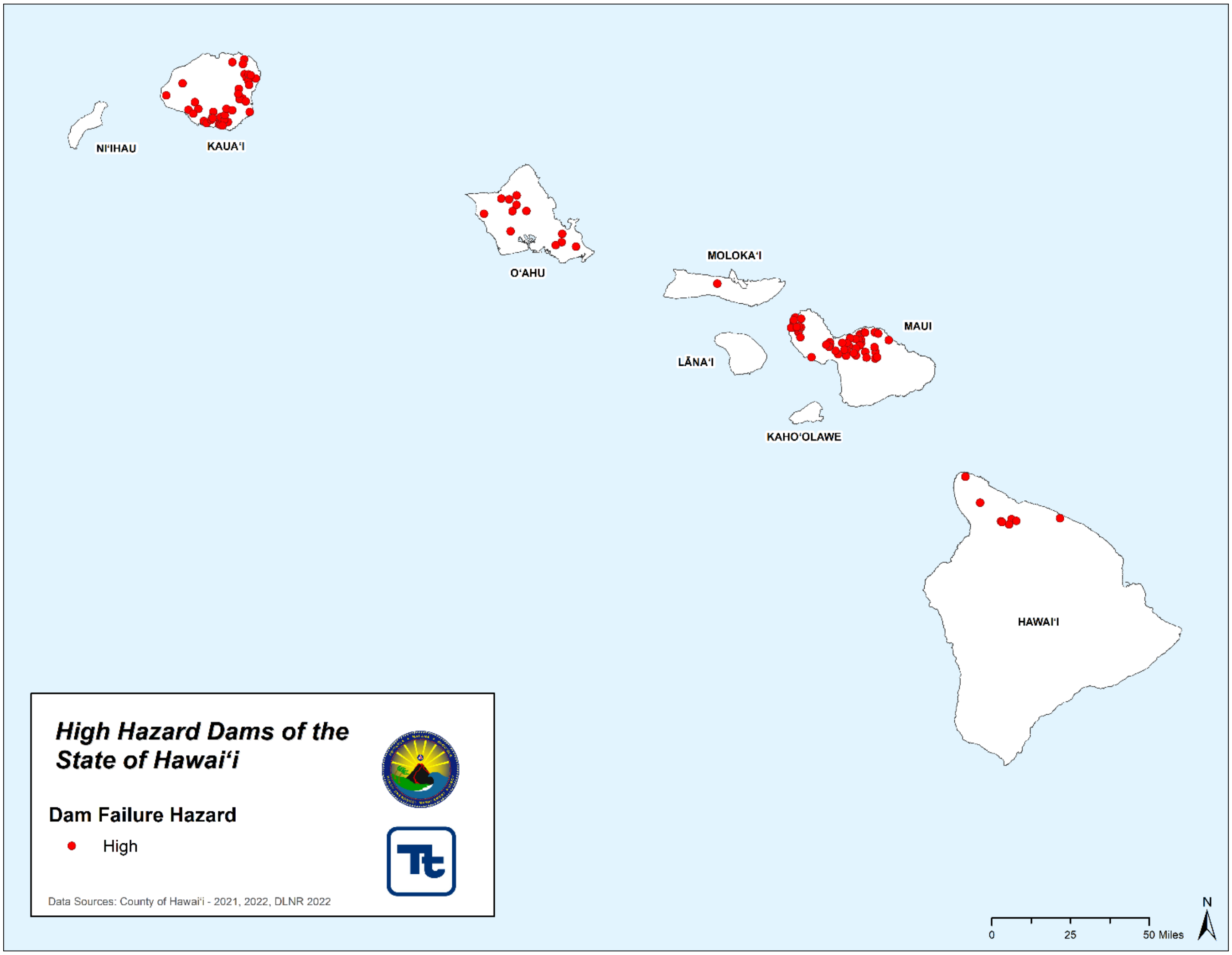


Table 4.10-3. Dam Hazard Potential Classification

Category	Loss of Life	Property Damage	Hazard Description
Low	None expected	Low and generally limited to owner property	Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and in low economic and/or environmental losses. Losses are principally limited to the owner's property.
Significant	None expected	Yes	Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in the predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.
High	Probable, one or more expected	Yes (but not necessary for this classification)	Dams assigned the high hazard potential are those where failure or misoperation will probably cause loss of human life.

Source: DLNR 2017

Warning Time

Warning time for dam failure varies depending on the cause of the failure. In events of extreme precipitation, evacuations can be planned with sufficient time. In the event of a structural failure because of an earthquake, there may be no warning time. A dam's structural type also affects warning time. Earthen dams do not tend to fail completely or instantaneously. Once a breach is initiated, discharging water erodes the breach until either the reservoir water is depleted or the breach resists further erosion (Association of State Dam Safety Officials 2021). Concrete gravity dams also tend to have a partial breach as one or more monolith sections are forced apart by escaping water. The time of breach formation ranges from a few minutes to a few hours (Veale and Davison 2013).

High and significant hazard dam owners are required to prepare and maintain an Emergency Action Plan (EAP). The EAP is to be used in the event of a potential dam failure or uncontrolled release of stored water. Owners are also required to have established protocols for flood warning and response to imminent dam failure in the flood warning portion of their adopted emergency operations plans. These protocols are tied to the EAPs created by the dam owners. These documents are customarily maintained as confidential information, although copies are required to be provided to DLNR. DLNR has an EAP for every regulated dam in the State of Hawaiʻi (DLNR 2022).

Previous Occurrences and Losses

Event History

The 2018 SHMP discussed specific dam failure events that occurred in the State of Hawaiʻi through 2017. For this 2023 SHMP Update, dam failure events were summarized between January 1, 2018, and December 31, 2022. For events prior to 2018, please refer to Appendix E (Hazard Profile Supplement). Between 2018 and 2022, no dam failure incidents occurred in the State of Hawaiʻi; however, following heavy rains in March 2021, the Kaupakalua Dam crested, causing evacuations of homeowners. This event led to discussions of the dam being slated for removal (DLNR 2021).

Disaster and Emergency Declarations

Between 1955 and December 2022, the State of Hawaiʻi experienced one federal disaster associated with a dam failure, Kaloko Dam (DR-1640), in March 2006. This is described further in Appendix E (Hazard Profile Supplement).

Probability of Future Hazard Events

Overall Probability

Causes for dam failure can be mitigated through proper design, proper construction, regular inspections by qualified personnel, and a commitment to strong enforcement in order to correct identified deficiencies. Risks to downstream life and property can be substantially reduced with effort to limit some development adjacent to streams and rivers. As water control structures continue to age, the likelihood or probability of failure increases.

Since the 2006 breach of the Ka Loko Dam, the State of Hawaiʻi has increased its monitoring procedures, and the probability of a dam failure has been significantly reduced statewide. A major dam failure event is considered rare; however, there is the potential for a dam failure to occur during or after extreme rainfall events, earthquakes, or landslides. Additionally, there is a risk of a dam failure should an event occur beyond those that the dam was designed to withstand. Overall, the probability of any type of dam failure is presumed to be low due to dam safety regulations and oversight.

Climate Change Impacts

Small changes in rainfall and runoff may have significant impacts for water resource systems, such as dams. Dams are designed partly based on assumptions about a stream's flow behavior, expressed as hydrographs. Changes in weather patterns can have significant effects on the hydrograph used for the design of a dam. If the hygrograph changes, it is conceivable that the dam can lose some or its entire designed margin of safety, also known as freeboard. Loss of designed margin of safety may cause floodwaters to more readily overtop the dam or create unintended loads. Since dams throughout the state were primarily built for irrigation purposes before regulatory construction standards were established and long before the anticipated impacts of climate change, the frequency and duration of extreme precipitation events directly corresponds to the frequency and duration of potential dam failure incidents. However, the probable maximum flood used to design each dam may be able to accommodate changes in climate.

Additionally, dams are constructed with safety features known as "spillways," which provide a safety measure in the event of the reservoir filling too quickly. Spillway overflow events result in increased discharges downstream and increased flooding potential. Although climate change may not increase the probability of catastrophic dam failure, it may increase the probability of spillway flows.

It is projected that the state will experience increased drought and heavy rain events, causing an increase in flash flooding, infrastructure damage, runoff, and sedimentation (State of Hawai'i 2022). In addition to a warming climate, the State of Hawaiʻi has experienced the impacts of El Niño and La Niña. El Niño leads to increase rainfall, flooding, and sediment runoff, which may lead to an increased risk of dam failure as some dams may not be designed to withstand an increase in rain totals (NOAA 2015). For specific details regarding climate change, refer to Section 4.2 (Climate Change and Sea Level Rise).

4.10.2 VULNERABILITY ASSESSMENT

For the 2023 SHMP Update, the total number of state assets located in all high hazard dam failure inundation areas were examined. However, it is highly unlikely that all high hazard dams would fail at the same time.

ASSESSMENT OF STATE VULNERABILITY AND POTENTIAL LOSSES

This section discusses statewide vulnerability of state assets (state buildings and roads) and critical facilities exposed to the dam failure hazard.

State Assets

For the purposes of this risk assessment, an asset is considered potentially vulnerable if it is in an identified hazard area. To assess the vulnerability of the state buildings, GIS software was used to overlay the statewide dam inundation hazard area with the buildings. Table 4.10-4 and Table 4.10-5 summarize the state buildings located in the statewide dam failure inundation area per county and state agency, respectively.

Table 4.10-4. State Buildings Exposure to Statewide High Hazard Dam Inundation Areas by County

County	Total Number of State Buildings	Total Replacement Cost Value (structure and contents)	Number of State Buildings in the Hazard Area	Percent (%) of Total Buildings	Total Value of State Buildings in the Hazard Area (structure and contents)	Percent (%) of Total Value
County of Kaua'i	531	$990,850,824	18	3.39%	$13,195,343	1.33%
City and County of Honolulu	3,472	$17,393,945,915	108	3.11%	$694,271,214	3.99%
County of Maui	831	$3,097,491,689	38	4.57%	$98,035,539	3.16%
County of Hawai'i	1,261	$4,638,567,141	33	2.62%	$412,057,638	8.88%
Total	**6,095**	**$26,120,855,568**	**197**	**3.23%**	**$1,217,559,734**	**4.66%**

Source: *Department of Land and Natural Resources 2022; Pacific Disaster Center 2022; State of Hawai'i Risk Management Office 2017*

Table 4.10-5. State Buildings Exposure to Statewide High Hazard Dam Inundation Areas by Agency

Agency	Total Number of State Buildings	Total Replacement Cost Value (structure and contents)	Number of State Buildings in the Hazard Area	Percent (%) of Total Buildings	Value in the Hazard Area	Percent (%) of Total Value
Dept of Accounting & General Services	66	$953,963,738	2	3.03%	$12,312,612	1.29%
Dept of Agriculture	70	$147,607,399	7	10.00%	$15,101,709	10.23%
Dept of Attorney General	15	$108,425,480	1	6.67%	$1,288,081	1.19%
Dept of Budget & Finance	16	$28,968,679	1	6.25%	$4,806,631	16.59%
Dept of Business, Economic Development & Tourism	25	$645,480,379	0	0.00%	$0	0.00%
Dept of Commerce & Consumer Affairs	2	$40,197,360	0	0.00%	$0	0.00%
Dept of Defense	69	$267,352,836	2	2.90%	$8,951,140	3.35%
Dept of Education	4,090	$10,598,205,739	95	2.32%	$506,980,435	4.78%
Dept of Hawaiian Home Lands	12	$110,427,352	0	0.00%	$0	0.00%
Dept of Health	44	$387,068,440	1	2.27%	$642,741	0.17%
Dept of Human Resources Development	1	$5,973,872	0	0.00%	$0	0.00%
Dept of Human Services	130	$480,212,294	9	6.92%	$21,728,493	4.52%
Dept of Labor & Industrial Relations	22	$90,076,209	0	0.00%	$0	0.00%
Dept of Land & Natural Resources	90	$101,441,821	4	4.44%	$3,377,505	3.33%
Dept of Public Safety	154	$440,774,415	0	0.00%	$0	0.00%
Dept of Taxation	1	$7,174,162	0	0.00%	$0	0.00%
Dept of Transportation	68	$2,935,208,214	9	13.24%	$44,441,751	1.51%
Hawai'i State Ethics Commission	1	$984,533	0	0.00%	$0	0.00%
Hawai'i Health Systems Corporation	106	$1,230,852,871	2	1.89%	$3,086,734	0.25%
Hawai'i Housing Finance & Development Corporation	86	$360,851,671	0	0.00%	$0	0.00%
Hawai'i Public Housing Authority	273	$982,981,701	29	10.62%	$139,214,142	14.16%
Hawai'i State Legislature	2	$48,555,381	0	0.00%	$0	0.00%

Agency	Total Number of State Buildings	Total Replacement Cost Value (structure and contents)	Number of State Buildings in the Hazard Area	Percent (%) of Total Buildings	Value in the Hazard Area	Percent (%) of Total Value
Hawaiʻi State Public Library System	53	$525,584,082	5	9.43%	$22,596,333	4.30%
Judiciary	41	$534,877,354	0	0.00%	$0	0.00%
Legislative Reference Bureau	1	$2,996,162	0	0.00%	$0	0.00%
Office of Hawaiian Affairs	11	$54,125,645	2	18.18%	$26,025,298	48.08%
Office of the Auditor	2	$1,921,180	0	0.00%	$0	0.00%
Office of the Governor	1	$2,996,162	0	0.00%	$0	0.00%
Office of the Lieutenant Governor	2	$4,588,849	0	0.00%	$0	0.00%
Office of the Ombudsman	1	$1,818,060	0	0.00%	$0	0.00%
Research Corporation of the University of Hawaiʻi	3	$4,189,026	0	0.00%	$0	0.00%
University of Hawaiʻi	637	$5,014,974,503	28	4.40%	$407,006,130	8.12%
Total	**6,095**	**$26,120,855,568**	**197**	**3.23%**	**$1,217,559,734**	**4.66%**

Source: Department of Land and Natural Resources 2022; Pacific Disaster Center 2022; State of Hawaiʻi Risk Management Office 2017

The spatial analysis indicates that there are 197 state buildings (3.2%) vulnerable to dam failure statewide. Of these, the greatest number are in the City and County of Honolulu (108 buildings with a replacement cost value of $694 million. The majority of these buildings are occupied by the Department of Education (95) and Hawaiʻi Public Housing Authority (29).

There are portions of state roads that are exposed to flood waters should a dam failure occur. Flood waters can undermine or fully submerge roads for a period of time, resulting in closures and cutting off critical access to communities. In addition, the flood waters can degrade the integrity of the roads. Sometimes the damage is apparent – a road that washes away, a sinkhole that appears, a bridge that crumbles, but often the damage is less obvious on the surface. Table 4.10-6 shows the length of state roads in the dam inundation areas by county. Maui County has the greatest length of state road (13.3 miles) exposed to the dam inundation areas that were analyzed. A complete list of state roads is included in Appendix F (State Profile and Risk Assessment Supplement).

Table 4.10-6. State Road Exposure to Statewide High Hazard Dam Inundation Areas by County

County	Length (in miles)		
	Total Length	Length of Road in the Hazard Area	Percentage (%) of Total Length
County of Kauaʻi	103.7	2.7	2.60%
City and County of Honolulu	374.9	9.2	2.45%
County of Maui	245.9	13.3	5.41%
County of Hawaiʻi	379.2	0.4	0.11%
Total	**1,103.70**	**25.6**	**2.32%**

Source: State of Hawaiʻi Dept. of Transportation 2022; Department of Land and Natural Resources 2022; Pacific Disaster Center 2022

Community Lifelines and Critical Facilities

Transportation routes are vulnerable to dam inundation and have the potential to be wiped out, creating isolation issues. This includes all roads and bridges in the path of the dam inundation. Those that are most vulnerable are those that are already in poor condition and would not be able to withstand a large water surge. Utility infrastructure is also vulnerable; interruption of services may not only impact vulnerable populations but may also impact facilities that need to be in operation during a disaster.

Table 4.10-7 summarizes the total number of community lifelines and critical facilities by category located in the dam failure inundation areas statewide by county. The City and County of Honolulu has the greatest number of critical facilities (41) within the analyzed dam inundation areas, with the majority of the facilities being categorized as Energy. Table 4.10-8 summarizes the number and percentage of exposed community lifelines and critical facilities by category. Energy facilities have 16.85% of their facilities within the analyzed dam inundation areas.

Table 4.10-7. Community Lifelines and Critical Facilities Exposure to Statewide High Hazard Dam Inundation Areas, by County

County	Community Lifeline Categories								Additional Critical Facilities
	Communications	Energy	Food, Water, Shelter	Hazardous Material	Health & Medial	Safety & Security	Transportation	Total in the Hazard Area	
County of Kaua'i	0	0	0	0	0	2	0	2	1
City and County of Honolulu	7	13	6	0	3	12	0	41	0
County of Maui	4	2	12	0	3	7	8	36	3
County of Hawai'i	1	0	3	0	1	0	0	5	1
Total	**12**	**15**	**21**	**0**	**7**	**21**	**8**	**84**	**5**

Source: Department of Land and Natural Resources 2022; Pacific Disaster Center 2022; Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020

Table 4.10-8. Community Lifeline and Critical Facility Exposure to Statewide High Hazard Dam Inundation Areas, by Category

Category	Total Number of Facilities	Total Replacement Cost Value	Number of Facilities in Hazard Area	Percent (%) of Total Facilities	Value in the Hazard Area	Percent (%) of Total Value
Communications	188	$776,797,683	12	6.38%	$47,000,315	6.05%
Energy	89	$3,093,949,530	15	16.85%	$557,941,340	18.03%
Food, Water, Shelter	345	$11,847,189,588	21	6.09%	$740,398,300	6.25%
Hazardous Material	12	$436,474,800	0	0.00%	$0	0.00%
Health and Medical	193	$4,606,713,364	7	3.63%	$95,885,988	2.08%
Safety and Security	486	$38,164,188,232	21	4.32%	$3,036,032,806	7.96%
Transportation	56	$2,039,091,600	8	14.29%	$290,352,000	14.24%
Additional Critical Facilities	106	$447,698,794	5	4.72%	$86,491,270	19.32%
Total	**1,475**	**$61,412,103,591**	**89**	**6.03%**	**$4,854,102,018**	**7.90%**

Source: Department of Land and Natural Resources 2022; Pacific Disaster Center 2022; Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020

ASSESSMENT OF LOCAL VULNERABILITY AND POTENTIAL LOSSES

The local HMPs were reviewed to integrate risk assessment results into the 2023 SHMP Update; a summary of information available is below.

- **County of Kauaʻi** – The County HMP included dam risk assessment maps in an appendix. Exposure and potential loss estimates were not available in the main plan (County of Kauaʻi 2020).
- **City and County of Honolulu** – The two dams for which failure is considered to have the greatest impact, due to their high populations downstream of the dams, are the Nuʻuanu Reservoir dam and the Kāneʻohe Dam (City and County of Honolulu 2020).
- **County of Maui** – The Maui County HMP conducted an exposure analysis using dam failure evacuation area mapping for all state-regulated dams. The building exposure (in dollars) for each evacuation area was analyzed by overlaying each evacuation area on the general building stock inventory used. Exposure estimates for each evacuation area are listed by dam. In total, there is over $25 billion in building value (structure and contents) exposed to the dam failure hazard in Maui County. Three dams were chosen for a more in-depth exposure and vulnerability analysis: Horner Reservoir and Wailuku Water 6 on Maui and Kualapuʻu on Molokaʻi. These dams were selected because they represent the largest, non-overlapping exposure areas on each island (County of Maui 2020).
- **County of Hawaiʻi** – Dam failure scenarios were modeled for all registered dams in the county and impacts to population, transportation, building infrastructure, and critical facilities were considered. These results are not reported in the public plan and are for official use only (County of Hawaiʻi 2020).

Socially Vulnerable and Total Population

Vulnerable populations are all populations downstream from dam failures that are unable to escape the area within the necessary time. This includes the elderly, the young, individuals with disabilities, and individuals with access or functional needs who may be unable to get out of the inundation area. The vulnerable population also includes those who may lack broadband or cell access and would not have adequate warning from the emergency warning system (e.g., television or radio); this includes residents and visitors. The population adversely affected by a dam failure may also include those beyond the disaster area that rely on the dam for providing potable water.

Floods created from a dam failure and their aftermath present numerous threats to public health and safety, including exposure to unsafe food, contaminated drinking and washing water, mosquitoes, animals, mold, and mildew. For more detailed descriptions of these and additional threats to public health and safety, refer to Section 4.6 (Flood). Current loss estimation models such as Hazus are not equipped to measure public health impacts such as these. The best preparation for these effects includes awareness that they can occur, education of the public on prevention, and planning to deal with them during responses to dam failure events.

The population exposed to a high hazard dam failure is summarized in Table 4.10-9. The City and County of Honolulu has the greatest population (23,842) and the greatest number of the high vulnerability population (8,588) located in the dam failure inundation hazard area; however, the County of Maui has the highest population percentage (4.31%) and highest vulnerable population percentage (2.25%) exposed. This analysis does not include all dams statewide and does not include the number of tourists and visitors in the state; therefore, this estimate may be underestimating exposure and vulnerability.

Table 4.10-9. 2020 U.S. Census Population Located in the High Hazard Dam Inundation Areas by County

County	Population				
	Total Population	Population in the Hazard Area	Population Exposed as % of Total Population	Socially Vulnerable Population in the Hazard Area	Socially Vulnerable Population Exposed as % of Total Population
County of Kaua'i	71,949	2,369	3.29%	130	0.18%
City and County of Honolulu	979,682	23,842	2.43%	8,588	0.88%
County of Maui	167,093	7,201	4.31%	3,756	2.25%
County of Hawai'i	201,350	912	0.45%	36	0.02%
Total	**1,420,074**	**34,324**	**2.42%**	**12,510**	**0.88%**

Source: U.S. Census Bureau 2020; Centers for Disease Control and Prevention 2018; Department of Land and Natural Resources 2022; Pacific Disaster Center 2022

Land Use Districts

Table 4.10-10 shows the total area of each state land use district in the dam inundation hazard areas that were analyzed; refer to Appendix F (State and Risk Assessment Supplement) for results by county. Of those dams chosen for analysis, Agricultural District Lands comprise the greatest area in the inundation areas. Conservation District Lands account for only a small amount of the dam inundation areas analyzed, likely due to the selection of particularly high impact dams. Conservation District Lands contain valuable environmental resources. Additional discussion of exposure and vulnerability of these resource areas can be found in the subsection below. An assessment of the combined inundation areas and the relative exposure of the state land use districts was not conducted for this 2023 SHMP Update. As local hazard mitigation plans are updated, the full extent of this hazard in each county should be further analyzed.

Table 4.10-10. State Land Use Districts Located in the High Hazard Dam Inundation Areas

Land Use District	Total (square miles)	Square Miles in Dam Inundation Area	Percent (%) of Total Area
Agricultural	2,973.6	30.7	1.03%
Conservation	3,202.9	3.4	0.11%
Rural	16.3	0.13	0.80%
Urban	319.1	9.5	2.98%
Total	**6,511.95**	**43.73**	**0.67%**

Source: Department of Land and Natural Resources 2022; Pacific Disaster Center 2022; State Land Use Commission, Hawai'i Statewide GIS Program 2021; Honolulu County GIS 2022

General Building Stock

The economic impact of dam failures depends on the location and severity of the failure. Potential economic impacts include agriculture, business, tourism, and the loss of buildings and tax base. To further assess what is at risk, each county's general building stock's exposure was examined in relation to the high hazard dam inundation areas. The general building stock in the inundation area is considered exposed to a dam failure. Structures closest to the inundation area would experience the largest, most destructive surge of water. Damages to buildings can displace people from their homes, threaten life safety, and impact a community's economy and tax base. Table 4.10-11 summarizes the building replacement cost value located in the high hazard dam inundation areas.

Table 4.10-11. General Building Stock Exposure to the High Hazard Dam Inundation Areas

County	Total Replacement Cost Value (structure and contents)	Value Located in Dam Inundation Area	Percent (%) of Total Value
County of Kaua'i	$24,246,497,228	$1,415,139,425	5.84%
City and County of Honolulu	$239,152,051,766	$6,939,077,118	2.90%
County of Maui	$50,796,693,140	$4,848,480,535	9.54%
County of Hawai'i	$58,395,349,136	$1,080,164,946	1.85%
Total	**$372,590,591,270**	**$14,282,862,024**	**3.83%**

Source: NIYAM IT 2022; U.S. Army Corps of Engineers 2022

Approximately $14 billion, which represents 38.3% of the total building stock replacement cost value in the state, is located in the high hazard dam inundation area. The County of Maui has the largest percent (9.54%) of their building stock located in the high wildfire risk hazard area, while the City and County of Honolulu has the highest dollar amount exposure with over $6.9 billion. The replacement cost value of buildings exposed is provided as an estimate for total loss.

Environmental Resources

The environment is vulnerable to a number of risks in the event of a dam failure. Water releases from dams usually contain very little suspended sediment; this can lead to scouring of river beds and banks. The inundation may introduce foreign elements into local waterways, resulting in destruction of downstream habitat and impacting many animal and plant species, especially endangered species and coral ecosystems. Environmental resources, including critical habitat (or habitats that are known to be essential for an endangered or threatened species), wetlands, parks and reserves, and reefs located in dam inundation areas evaluated are summarized by county in Table 4.10-12.

Table 4.10-12. Environmental Resources Located in the High Hazard Dam Inundation Areas

Environmental Asset	Total Area (square miles)	Area in the Dam Failure Inundation Area (square miles)	Percent (%) of Total Area
Critical Habitat [a]	951	0	0.04%
Wetlands	3,637	6	0.17%
Parks and Reserves	2,778	2	0.09%
Reefs [b]	55	0	0.04%
Total [c]	**7,420**	**9**	**0.12%**

Source: PDC 2018; U.S. Fish and Wildlife Service 2017; 2017; State Office of Planning 2017; Department of Land and Natural Resources 2015; Hawai'i Division of Aquatic Resources 2005; NOAA 2002

Notes:

a. *Critical area mileage includes the combined area of coverage of individual critical habitat areas*
b. *Reefs include artificial and coral reefs*
c. *Total square miles includes environmental assets within 3 nautical miles of each county and may be over reported as some environmental asset areas may overlap.*

Cultural Assets

Portions of the Hawaiian Home Lands are located in high hazard dam inundation hazards areas; land is vulnerable in the Counties of Hawai'i and Maui (see Table 4.10-13). The County of Maui has the greatest number of square miles (1.12) and the highest percentage (1.09%) of Hawaiian Home Lands located in dam inundation hazard areas.

Table 4.10-13. Hawaiian Home Lands Located in High Hazard Dam Inundation Areas

County	Area		
	Total Area (square miles)	Dam Failure Inundation Area (square miles)	Percent (%) of Total Area
County of Kaua'i	32.09	0.17	0.53%
City and County of Honolulu	10.61	0.02	0.15%
County of Maui	102.59	1.12	1.09%
County of Hawai'i	191.46	0.56	0.29%
Total	**336.75**	**1.87**	**0.55%**

Source: *Hawai'i State Department of Hawaiian Homelands 2021; Department of Land and Natural Resources 2022; Pacific Disaster Center 2022*

Table 4.10-14 discusses the cultural resources in dam inundation hazard areas. The cultural resource type with the largest total area and largest area in the hazard area is the Historic District; however, the district with the largest percentage of area in the dam inundation hazard area is the Burial Sensitivity Area.

Table 4.10-14. Cultural Resources Located in the High Hazard Dam Inundation Areas

Cultural Resource Site Type	Area (in square miles)		
	Total Square Miles of Asset	Total Square Miles in Hazard Area	Percent (%) of Total Asset Area
Archaeology	90.9	1.2	1.4%
Burial Sensitivity Area	2.1	0.1	2.9%
Historic Building	2.7	0.1	2.4%
Historic District	849.4	1.7	0.2%
Historic Object	9.6	0.0	0.0%
Historic Structure	20.7	0.1	0.3%
Total	**975.4**	**3.2**	**0.3%**

Source: *Department of Land and Natural Resources, Hawai'i State Historic Preservation Division 2022; Department of Land and Natural Resources 2022; Pacific Disaster Center 2022*

FUTURE CHANGES THAT MAY IMPACT STATE VULNERABILITY

Understanding factors of change that impact vulnerability in the state can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The state considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

Potential or Projected Development

Dam failure inundation areas were overlain on areas that may experience significant changes in development or redevelopment in future years (see Table 4.10-15 below; refer to Section 3 for more information on projected development areas). There are 9.94 square miles exposed to dam inundation areas in the County of Kaua'i, 11.11 square miles exposed in the City and County of Honolulu, roughly 47 square miles in the County of Maui, and 2.3 square miles in the County of Hawai'i. This analysis does not include all dam failure risk within the state because only a subset of dam inundation areas was analyzed. It is likely that there are other dams whose failures would impact these areas. While existing floodplain development regulations in place at the county level may offer some protection for new development located in these areas, such protections would likely not be sufficient in many instances in the event of a catastrophic dam failure. This results from a number of factors, such as the extent of the dam inundation areas may be larger than the regulated floodplain and water depths and velocities may be stronger and higher than the 1% annual chance flood event.

Table 4.10-15. HCDA Community Development Districts, Maui Development Projects, and Enterprise Zones Located in High Hazard Dam Inundation Areas

County	Area (in square miles)								
	HCDA Community Development Districts	Total Area Exposed to Hazard	Hazard Area as % of Total Area	Maui Development Projects (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area	Enterprise Zones (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area
County of Kaua'i	0	0	0.0%	0	0	0.0%	251.0	9.94	4.0%
City and County of Honolulu	7.4	0	0.0%	0	0	0.0%	297.3	4.7	1.6%
County of Maui	0	0	0.0%	27.62	0.8	2.9%	1,059.8	19.7	1.9%
County of Hawai'i	0	0	0.0%	0	0	0.0%	1,274.9	2.3	0.2%
Total	**7.4**	**0**	**0.0%**	**27.62**	**0.8**	**2.9%**	**2,883**	**36.64**	**1.3%**

Source: Maui County Planning Department 2016; Hawai'i Community Development Authority 2021; Community Economic Development Program, Department of Business, Economic Development & Tourism, County Planning Departments 2021; Department of Land and Natural Resources 2022; Pacific Disaster Center 2022

Projected Changes in Population

As population in the state continues to increase, there is the potential that more people will reside or work within dam inundation areas. Increased density and development are most likely to occur in Urban District Lands, so careful attention should be paid to ensuring local zoning codes consider these risks. Additionally, as the population in the state ages (more than 23% of the population is projected to be 65 years of age or older by 2040), more residents may face challenges quickly evacuating an area in the event of an impending failure.

Other Factors of Change

The impacts of climate change in the state have the potential to increase the probability of future dam failure events as discussed in the Probability of Future Hazard Events section above; however, the direct impacts of a dam failure would not be likely to change. High hazard dam inundation areas were overlain on areas that may experience significant changes in development or redevelopment in future years (see Table 4.10-15 below and Section 3 (State Profile) for more information on projected development areas). The results of this exercise indicate that the Enterprise Areas in the County of Hawaiʻi make up roughly half (1,274.9) of the total area located in high hazard dam inundation areas.

Section 4.11 Landslide and Rockfall

Landslide and Rockfall

Landslides are generally characterized as the downward and outward movement of soil and/or rocks on a slope such as a hill, cliff, or mountain. Rockfalls are caused by large boulders or rocks that become detached and fall from the side of a slope or cliff. They can be caused by changes in groundwater level, seismic and volcanic activity, and human activities such as road construction and deforestation. Statistics below represent the high landslide susceptibility area.

CHANGES SINCE 2018

+3 Declared Disasters

+8 Landslide Events

COUNTIES MOST VULNERABLE

Kauaʻi Honolulu Maui **Hawaiʻi**

SOCIALLY VULNERABLE POPULATION

1.04% Of Total Population

14,823 Persons

HAZARD RANKING

COMMUNITY LIFELINES

95 Total

Food, Water, Shelter — Greatest

CLIMATE PROJECTIONS

Increased droughts, which may lead to wildfire, may reduce the vegetation on steep slopes, causing landslides and rockfalls

Projected heavier rainfalls may cause an increase in landslides and rockfalls

357 State Buildings

151 Miles of State Road

SQUARE MILES

642 Environmental Resources

119 Hawaiian Home Lands

89 Cultural Resources

CONTENTS

TABLES

FIGURES

[1] *Section Cover Photo: Landslide covering Pali Highway, Oʻahu. Photo courtesy of Hawaiʻi Department of Transportation*

SECTION 4. RISK ASSESSMENT

4.11 LANDSLIDE AND ROCKFALL

2023 SHMP Update Changes

- Landslide events, including rockfalls and mudslides, that occurred in the State of Hawaiʻi from January 1, 2018, through December 31, 2022, were researched for the 2023 SHMP Update.
- New and updated figures from federal and state agencies were incorporated.
- This section now includes a discussion of how landslides and rockfalls impact socially vulnerable populations and community lifelines.
- Reefs (both artificial and coral) are now separated out for all hazards in the Environmental Resources analysis and listed along with critical habitat, wetlands, and parks and reserves.
- Six types of cultural resources (archaeology, burial sensitivity area, historic building, historic district, historic object, and historic structure) are added to the vulnerability assessment.

4.11.1 HAZARD PROFILE

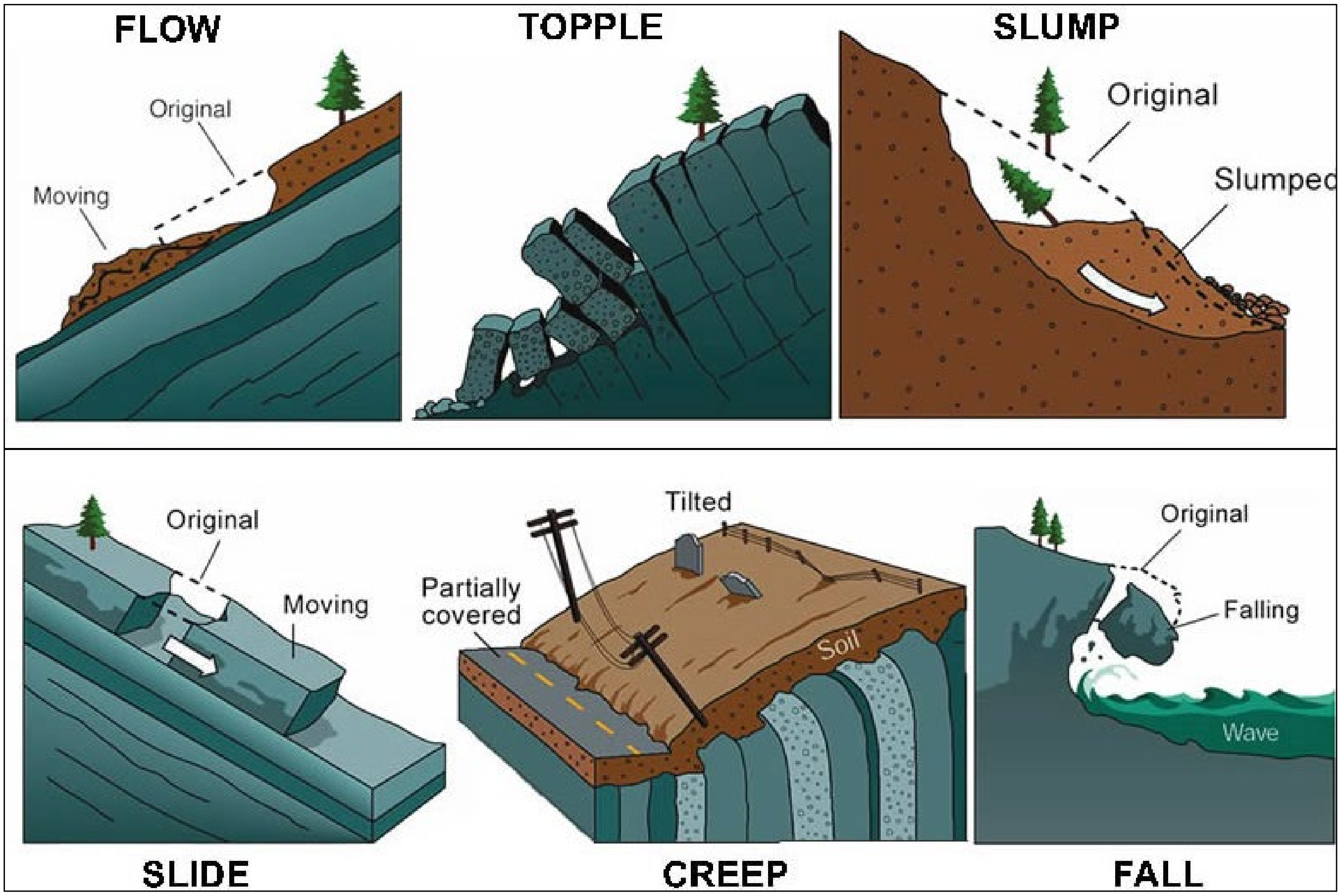
HAZARD DESCRIPTION

Landslide is the broad term that describes the downward and outward movement of soil and/or rock. Landslides may be differentiated by the kinds of materials involved and the type of slope movement. The main types of movements are: flows, topples, slumps, slides, creeps, and falls (USGS 2016). Figure 4.11-1 illustrates the movement mechanisms in graphical form. In addition, avalanches can involve slumps, falls, and flows of soil, rock, and debris. For the purposes of the 2023 SHMP Update, this section focuses on landslides (inclusive of all types of soil/rock movement and debris flow) and rockfalls.

Key Terms

- **Landslide** – The movement of a mass of rock and/or soil down a slope; can also refer to masses of material.
- **Debris Flow** – A form of rapid mass movement in which a combination of loose soil, rock, organic matter, air, and water mobilize as a slurry that flows downslope; can also refer to masses of material.
- **Rockfall** – The falling of newly detached mass of rock from a cliff or down a very steep slope.

Figure 4.11-1. Types of Landslides



Source: Tara 2017

Many factors cause landslides and rockfalls, but the following are particularly prevalent in the State of Hawaiʻi: water changes, seismic activity, volcanic activity, and human activity.

- **Water** – Intense rainfall, changes in groundwater level, and water level changes along coastlines, earthen dams, and the banks of lakes, reservoirs, and rivers are the primary triggers of landslides and rockfalls. Landslides and flooding are closely related because both can be triggered by precipitation, runoff, and saturation of the ground. They commonly occur simultaneously in a given area (USGS 2016).
- **Seismic Activity** – Earthquakes in landslide-prone areas greatly increase the likelihood that landslides will occur, either due to ground shaking alone or shaking-caused dilation of soil materials. Rockfalls can also occur as a result of earthquakes because the shaking loosens rocks (USGS 2016).
- **Volcanic Activity** – Landslides caused by volcanoes are some of the most devastating types of landslides. Landslides are common on volcanic cones because they are tall, steep, and contain weak rock layers. The ascent of molten rock can further weaken volcanic layers. Volcanic gases and hydrothermal systems in volcanoes also weaken rock by altering minerals to clay (USGS 2016).
- **Human Activity** – Landslides and rockfalls may result directly or indirectly from human activities. Construction activity that undercuts or overloads dangerous slopes or that redirects the flow of surface or groundwater can trigger slope failures.

Landslides

Landslides are mass movements of material, where a distinct zone of weakness separates the slide material from the more stable underlying material (USGS 2016). Several phenomena may be noticeable prior to a landslide. These phenomena include:

- Springs, seeps, or saturated ground in areas that have not typically been wet before
- New cracks or unusual bulges in the ground, street pavements, or sidewalks
- Soil moving away from foundations
- Ancillary structures such as decks and patios tilting and/or moving relative to the main house
- Tilting or cracking of concrete floors and foundations
- Broken water lines and other underground utilities
- Leaning telephone poles, trees, retaining walls, or fences
- Offset fence lines
- Sunken or down-dropped road beds
- Rapid increase in creek water levels, possibly accompanied by increased turbidity (soil content)
- Sudden decrease in creek water levels though rain is still falling or just recently stopped
- Sticking doors and windows, and visible open spaces indicating jambs and frames out of plumb
- A faint rumbling sound that increases in volume is noticeable as the landslide nears
- Unusual sounds, such as trees cracking or boulders knocking together, might indicate moving debris (USGS n.d.)

Debris flows, commonly referred to as mudslides, mudflows, or lahars, are common types of fast-moving landslides and occur in a wide variety of environments. Flows are characterized by deformation distributed throughout a mass of material. Flows typically are distinguished from slides by high water content and distribution of velocities within the flowing material that resembles that of viscous fluids.

Debris flows are a form of rapid mass movement in which loose soils, rocks, and organized matter, combined with air and water, form slurries that flow downslope. Debris flows generally occur during periods of intense rainfall (USGS 2019).

Rockfall

Rockfalls typically result from a combination of rock fracture, erosion, chemical weathering, and the presence of a steep slope. Volcanic rocks in Hawaiʻi commonly fracture as they originally form. Subsequently, a variety of processes can cause old or new fractures to grow, such as increases in water pressure in fractures, the wedging action of plant roots, and flexure of the rock. Erosion can undercut slopes and occur by rainfall runoff, stream erosion, or wave action. Wave action occurring during higher sea levels over geologic time can undermine loose, weak rock. Chemical weathering can weaken rock layers and make them more susceptible to failure. These processes can act in tandem. For example, withdrawal of support in a slope by erosion or lava tube collapse can alter the stresses in the slope, cause fractures to open and grow, and concurrently increase the surface area available for chemical weathering.

Rockfalls occur where a source of rock exists above a slope steep enough to allow rapid downslope movement of dislodged rocks by falling, rolling, bouncing, and sliding. Rockfall sources include bedrock outcrops or boulders on steep mountainsides or near the edges of escarpments such as cliffs, bluffs, and terraces (UGS 2019).

Location

The State of Hawaiʻi has several characteristics that make it susceptible to landslides and rockfalls: steep hillsides, heavy rainfall, a warm climate, lush vegetation, and residential development and other types of construction in upland areas. Areas that may be considered prone to landslides and rockfalls include the following:

- On existing old landslides
- On or at the base of slopes
- In or at the base of minor drainage hollows
- At the base or top of an old fill slope
- At the base or top of a steep cut slope
- Developed hillsides where leach field septic systems are used
- (USGS n.d.)

Heavy or prolonged rainfall is the most common trigger of landslides and rockfalls (USGS n.d.). These slope failure events are particularly common during or immediately after severe rainfall of more than 3 inches in a peak 6-hour period. Figure 4.11-2 illustrates the State of Hawaii's average annual rainfall total in inches from 1920 to 2012. In general, high mean rainfall is found on the windward side of the mountains, and low rainfall prevails in leeward lowlands and on the upper slopes of the highest mountains. High-intensity rainfall events are particularly common in areas of high mean annual rainfall, but they can also occur on the drier leeward sides of the islands.

Sites of wildfire and/or where vegetation has been destroyed on slopes are particularly vulnerable to landslides during and after heavy rain events (CDC 2003). Refer to Section 4.15 (Wildfire) for further discussion on high-risk wildfire areas in the state.

Landslide susceptibility data for the County of Hawaiʻi was provided by the Pacific Disaster Center (PDC). Figure 4.11-3 through Figure 4.11-6 illustrate the high, moderate, and low landslide susceptibility areas in the Hawaiian Islands. Refer to Section 4.1 (Overview) for more information on the methodology followed to develop this data.

Areas of slope were assigned low, moderate, and high landslide susceptibility categories to align with the slope categories for the County of Hawaiʻi (refer to Section 4.1 for more details on the methodology). These data are considered suitable for planning purposes only.

For the purposes of the 2023 SHMP Update, the high landslide susceptibility areas were evaluated further in the vulnerability assessment later in this section. Table 4.11-1 shows the high landslide susceptibility area in square miles and the percent of the total area in each county. According to the PDC and USGS, the County of Hawaiʻi has the largest percent (23.39%) of high landslide susceptibility areas.

Figure 4.11-2. Average Annual Rainfall in the State of Hawai'i, 1920 to 2012

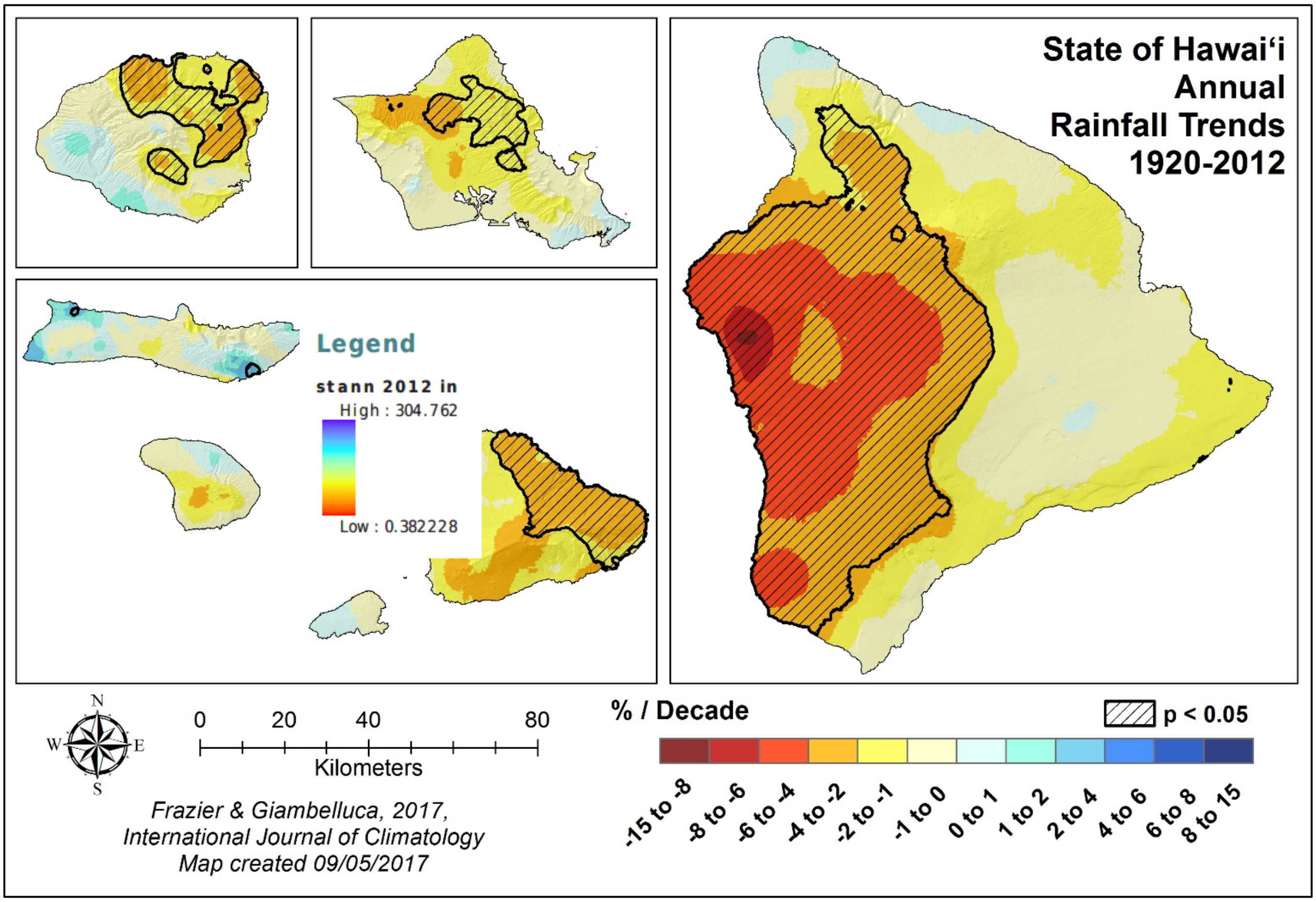
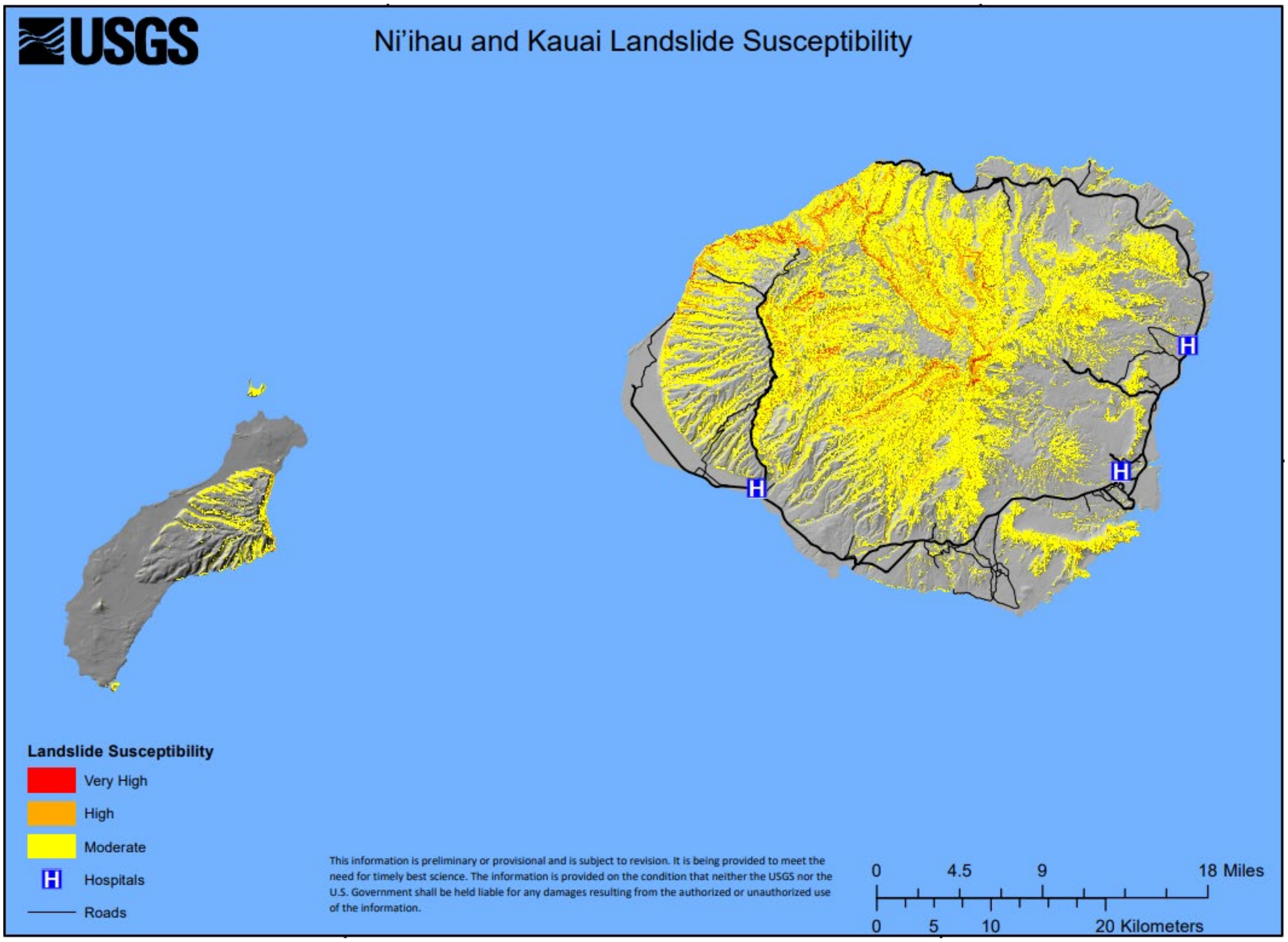
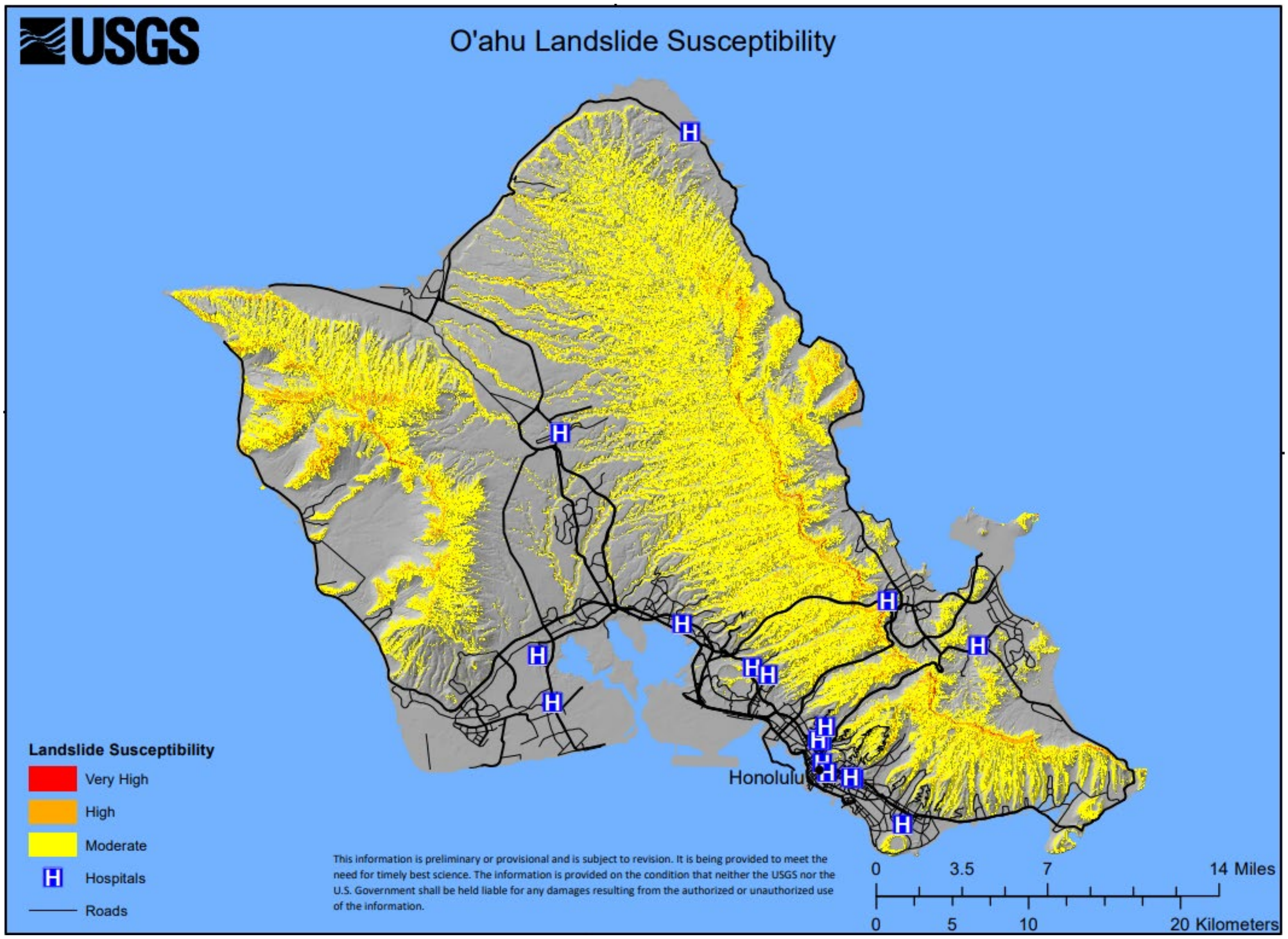


Figure 4.11-3. Landslide Susceptibility in the County of Kaua'i



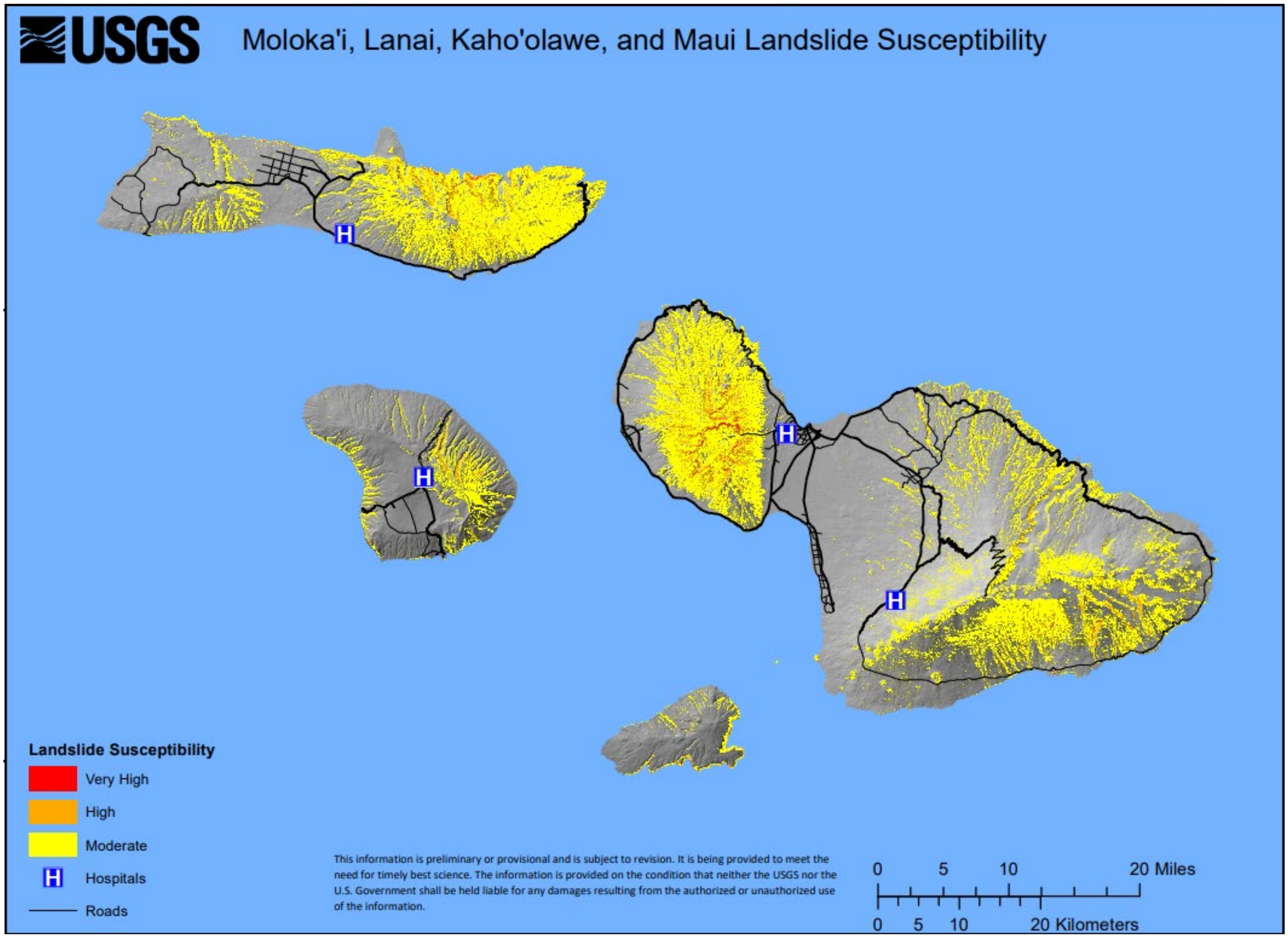
Source: USGS 2018

Figure 4.11-4. Landslide Hazard Areas in the City and County of Honolulu



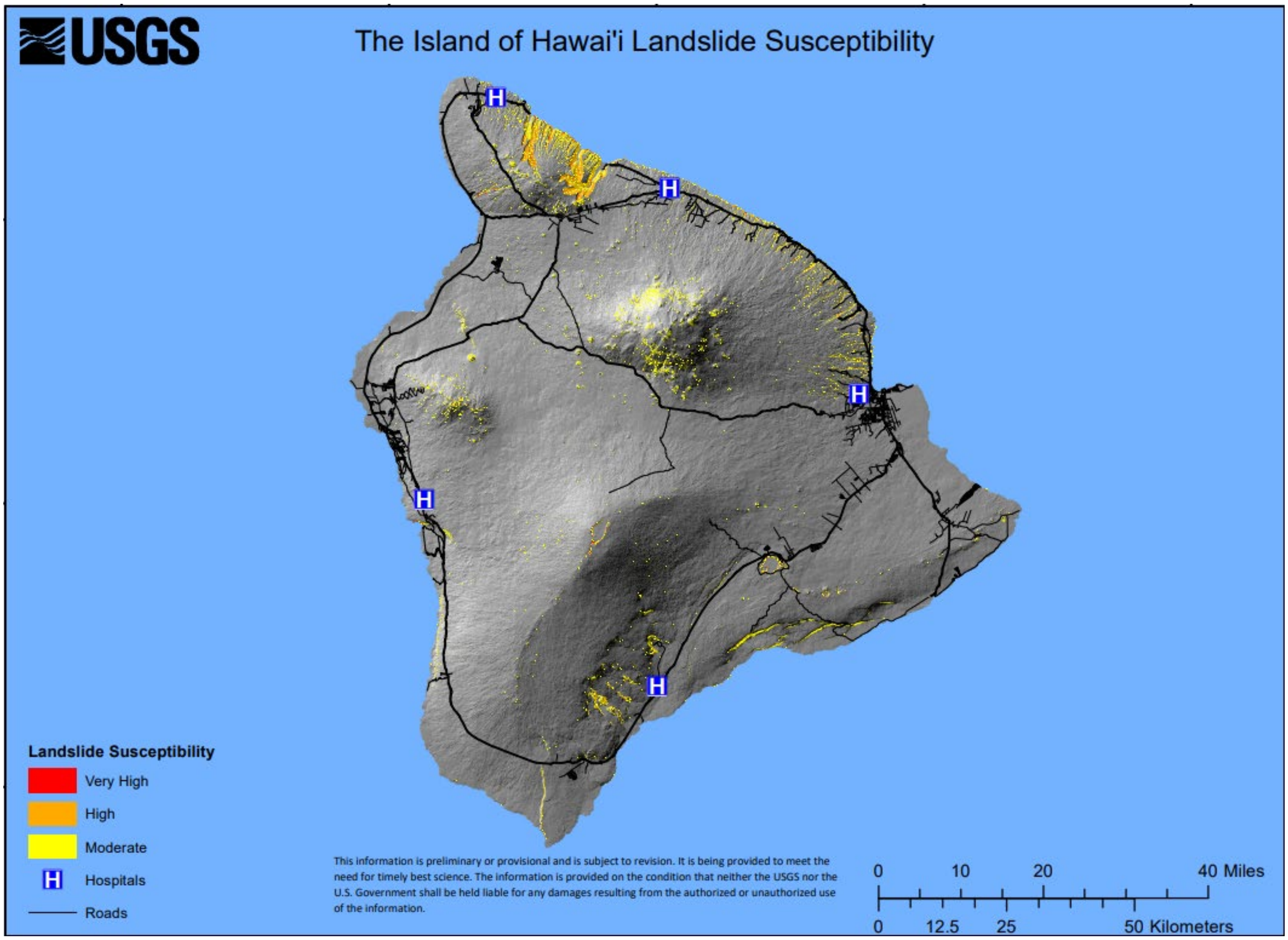
Source: USGS 2018

Figure 4.11-5. Landslide Hazard Areas in the County of Maui



Source: USGS 2018

Figure 4.11-6. Landslide Hazard Areas in the County of Hawaiʻi



Source: USGS 2018

Table 4.11-1. Total High Landslide Susceptibility Area by County

County	Total Area	High Landslide Susceptibility Area	High Susceptibility as Percent (%) of Total Area
County of Kauaʻi	624.2914	69	11.05%
City and County of Honolulu	598.5707	54.9	9.17%
County of Maui	1,176.28	82.5	7.01%
County of Hawaiʻi	4,039.64	944.9	23.39%
Total	**6,438.78**	**1,151**	**17.88%**

Source: Pacific Disaster Center 2017; United States Geological Survey 2016

The following provides details, by county, of where landslides typically occur.

- **County of Kauaʻi** – Debris avalanches and slides typically occur on the western side or northern side of the County of Kauaʻi. Landslides also occur frequently near road cuts. Significant historical landslides have occurred along the highways and coastal roads. High-risk areas include portions of Kaumualiʻi Highway (State Highway 50) near Kalāheo and Lawaʻi, portions of Kūhiō Highway (State Highway 56) between Hāʻena and Hanalei (see Figure 4.11-7), and portions of Kuamoo Road (State Highway 580) near Kapaʻa (County of Kaua'i 2021).
- **City and County of Honolulu** – Several key contributors to debris flows exist in the City and County of Honolulu: steep hillsides, heavy rainfall, and residential development in upland areas. Significant events that have impacted the eastern part of the Honolulu District and in the Kuliʻouʻou and Hahaʻione valleys. Additionally, 66 highways sites were identified as having high risk of rockfall. The affected highways include Pali Highway, Kalanianaʻole Highway, Kamehameha Highway, and Farrington Highway (City and County of Honolulu Plan 2020).
- **County of Maui** – There is a high risk of landslides from earthquakes in the County of Maui caused by the volcanic activity in the County of Hawaiʻi. Landslides, debris flows, and rockfalls occur along coastal highways in the county, especially where highways are along mountain slopes (County of Maui 2020).
- **County of Hawaiʻi** – Several areas along the Hāmākua Coast on the island of Hawaiʻi are chronic problem areas for landslides, particularly during periods of heavy rainfall (see Figure 4.11-8). Also, the three major gulches of Maulua, Laupāhoehoe and Kaʻawaliʻi are areas prone to rockfalls (County of Hawaiʻi 2020).

EXTENT

Landslides and rockfalls are natural events that can vary widely in extent, from a single rock tumbling down a hillside to a major landslide or mudflow that covers several acres. Landslide severity is directly related to the results of an event.

Debris flows exhibit a broad range of characteristics. The consistency of debris flow ranges from watery mud to wet rocky debris. Debris flows can carry large items such as boulders, trees, and cars, and they can cause extensive damage. Debris flows from multiple sources can combine in channels, greatly increasing their destructive power. As they flow down hills and through channels, they grow in volume with the addition of water, sand, mud, boulders, trees, and other materials. When the flows reach flatter ground, the debris spreads over a broad area, locally accumulating in thick deposits that can wreak havoc in developed areas. Once started, debris flows can travel even over gently sloping ground. The most hazardous areas are valley bottoms, stream channels, areas near outlets of valleys, and slopes for buildings and roads (USGS 2016a).

Warning Time

Landslides exhibit a wide range of speeds—from a slow creep of inches per year to many feet per second, depending on slope angle, material, and water content. As a result of the range of speeds, the amount of warning time ranges widely.

Figure 4.11-7. Landslide Covering Prince Kūhiō Highway on Kaua'i, 2018

Source: Hawai'i Department of Transportation

Figure 4.11-8. Landslide on Hawaiʻi Island, 2018

Source: Hawaiʻi Emergency Management Agency

The warning time for landslides depends on the geology, the vegetation, and the amount of predicted precipitation for an area. The current standard operating procedure is to monitor situations on a case-by-case basis and respond after the event has occurred (Wieczorek and Snyder 2009). Generally accepted warning signs for landslide activity include:

- Springs, seeps, or saturated ground in areas that have not typically been wet before
- New cracks or unusual bulges in the ground, street pavements, or sidewalks
- Soil moving away from foundations
- Ancillary structures such as decks and patios tilting and/or moving relative to the main house
- Tilting or cracking of concrete floors and foundations
- Broken water lines and other underground utilities
- Leaning telephone poles, trees, retaining walls, or fences
- Offset fence lines
- Sunken or down-dropped road beds
- Rapid increase in creek water levels, possibly accompanied by increased turbidity (soil content)
- Sudden decrease in creek water levels though rain is still falling or just recently stopped
- Sticking doors and windows, and visible open spaces indicating jambs and frames out of plumb
- A faint rumbling sound that increases in volume is noticeable as the landslide nears
- Unusual sounds, such as trees cracking or boulders knocking together, might indicate moving debris (USGS n.d.)

Real-time data on rainfall, soil water content and soil water pressure can be combined with numerical modeling to assist with the development of real-time debris flow warning systems. The following findings may assist with predicting landslides:

- Seasonal variation in soil moisture affects the susceptibility of a hillside to landslides
- Wetness of the soil before a storm that triggers landslides affect the rainfall threshold for an area
- Low moisture content of hillsides in the dry season allows the hillsides to tolerate much greater amounts of rainfall before sliding than during the wet season
- Soil does not have to be completely saturated with water for landslides to occur
- Positive pore-water pressure (which contributes to the initiation of landslides) occurs at select locations on a hillside only briefly (hours) a few times per year during heavy rainfall
- Measurement of soil water content and water suction or pressure in hillside soils gives a more accurate estimate of slope stability than rainfall or soil water content measurements alone (USGS 2018)

Previous Occurrences and Losses

Many sources provided information regarding previous occurrences and losses associated with landslide and rockfall events throughout the State of Hawaiʻi. The 2018 SHMP discussed specific landslide and rockfall events that occurred in the state through 2017. For the 2023 SHMP Update, events for all hazards assessed were summarized between January 1, 2018, and December 31, 2022.

Disaster and Emergency Declarations

Table 4.11-2 lists landslide events that were included in federal disaster declarations.

- **Federal disaster (DR) or emergency (EM) declarations, 1955 – 2022**: 9 events, classified as landslide, mudslide, or combination of both
- **USDA agricultural disaster declarations, 2012 – 2022**: 1 event classified as landslide
- **Hawaiʻi state emergency proclamations, 2018 – 2022**: 6 events classified as landslide, flood, heavy rains, or combination

Table 4.11-2. Landslide and Mudslide-Related Federal Declarations, 2018 to 2022

Event Type	Date Declared	Declaration	Counties Affected
Severe Storms, Flooding, Landslides, and Mudslides	May 8, 2018	DR-4364-HI	Honolulu, Kauaʻi
Severe Storms, Flooding, and Landslides	May 13, 2021	DR-4604-HI	Maui
Severe Storms, Flooding, and Landslides	February 15, 2022	DR-4639-HI	Honolulu, Maui

Source: FEMA 2023

Table 4.11-3 lists major landslide and rockfall events that occurred in the state between 2018 and 2022. For events prior to 2018, please refer to Appendix E (Hazard Profile Supplement).

Table 4.11-3. Landslide Events in the State of Hawaiʻi, 2018 to 2022

Date(s) of Event	Event Type and Federal Disaster Declaration (if applicable)	Counties Affected	Description
February 22, 2018 – February 23, 2018	Debris Flow	Kaua’i	With an upper trough west of the islands and a surface trough over the state, heavy showers, including thunderstorms, formed across the local area. Heavy snow also fell over the summits of Mauna Loa and Mauna Kea on the Big Island of Hawaiʻi. The cost of any damages was not available. There were no reports of serious injuries. A debris flow occurred on the southbound lane of Kūhiō Highway in northern Kauaʻi between Waikoko Beach and Waipa Farmers Market. A debris flow occurred near Wainiha in northern Kauaʻi along Kūhiō Highway. When county workers tried to clear the debris, a larger flow occurred, which then closed both lanes of the highway.
March 15, 2018	Debris Flow	Kaua’i	An area of low pressure west of Hawaiʻi produced heavy showers and thunderstorms. The precipitation led to flash flooding over portions of Kauaʻi and Maui. There were no reports of significant injuries. The cost of any damages was not available. A debris flow covered part of Kūhiō Highway near Lumahai in northern Kauaʻi.

Date(s) of Event	Event Type and Federal Disaster Declaration (if applicable)	Counties Affected	Description
April 13, 2018 – April 14, 2018	Debris Flow (FEMA-DR-4365)	Honolulu and Kauaʻi	A developing upper low northwest of the state, in combination with tropical moisture, induced periods of heavy showers and thunderstorms, and generated historic flash flooding conditions over the Garden Isle of Kauaʻi. An apparent 24-hour rainfall total of 49.69 inches, ending at 1245 HST April 15, was recorded at an automated rain gauge in Waipa, Kauaʻi, about a mile west of Hanalei. The deluge, mainly over northern Kauaʻi but also affecting East Oahu, damaged or destroyed farms and various structures, including 532 homes; downed trees and power lines; flooded homes, businesses and vehicles; and closed and damaged numerous roadways with water and debris flows, with highway and road repairs estimated at $35 million. There were apparently no significant injuries, but material losses will be extremely exorbitant, with public property damages alone estimated at $19.7 million. Hawaii's state legislature already approved, as of April 25, $100 million in relief aid for flood-ravaged communities on Kauaʻi and Oahu. (The aid package was later increased to $125 million.). Mudslide (debris flow) caused a partial road blockage at Kalanianaole Highway and Keolu Drive near Kailua on the windward side of Oahu. Three landslides (debris flows) closed Kūhiō Highway between Wainiha and Waikoko in northern Kauaʻi.
September 12, 2018	Debris Flow	Maui	As Tropical Storm Olivia approached the islands from the east-northeast and then made a double landfall in Maui County on September 12, it brought gusty winds and heavy precipitation. Most of its effects were concentrated over Maui, Molokai, and Oahu. The system downed trees, caused power outages and debris flows, and generated flash flooding. The costs of damages had not yet been assessed. There were no reports of serious injuries. Hana Highway closed in both directions one mile west of Keanae on Maui due to a debris flow from heavy rain.
December 25, 2019	Debris Flow	Honolulu	A cold front with good upper-level support pushed its way through the island chain around the Christmas holiday, bringing periods of heavy precipitation, isolated thunderstorms, and strong to high winds. The weather system caused a flash flood and felled trees and power poles, especially on the Garden Isle of Kauaʻi. No significant injuries were reported. On Oahu, a rock slide occurred along Pali Highway near the tunnel, closing the Kailua-bound lanes for a time starting at Waokanaka Street.
January 11, 2020	Debris Flow	Hawaiʻi	With plenty of moisture near the surface and unstable conditions aloft, heavy rainfall and isolated thunderstorms developed across much of the state. Flash flooding occurred on the Big Island of Hawaiʻi, as well. No serious injuries were reported. The costs of any damages were not available. Hawaiʻi Police and the Department of Transportation reported a landslide on Highway 19 at the Laupāhoehoe Gulch in the Hāmākua District on the Big Island of Hawaiʻi.

Date(s) of Event	Event Type and Federal Disaster Declaration (if applicable)	Counties Affected	Description
March 06, 2021 – March 12, 2021	Debris Flow (DR-4604-HI)	Hawaiʻi, Honolulu, Kauaʻi, Maui	A slow-moving surface trough, heading east to west, and an upper disturbance triggered heavy showers and isolated thunderstorms that caused flash flooding in some instances. Damages occurred to public and private property, including roads and bridges washed out. Nine homes were destroyed, 44 suffered major damage, and 55 suffered minor damage. No significant injuries were reported. In Kaua'i County, rocks and soil caused the closure of one lane of Kūhiō Highway at mile marker 4.5, near Waikoko on Kauaʻi's north shore. Both lanes of Kūhiō Highway were impacted at Hanalei Hill approaching Hanalei Bridge. Kūhiō Highway was reopened for two-way traffic in mid-October after emergency construction was completed. Approximately $3.9 million in property damages occurred. In Maui County, Hana Highway was closed between mile post 10 and mile post 13, about 2 miles west-northwest of Keanae in windward East Maui. The closure was caused by large boulders blocking the roadway. In the County of Hawai'i, one lane of Highway 19 in windward Big Island near Hakalau, and the Hakalau Bridge, was closed due to debris on the roadway. In Honolulu County Kalanianaole Highway was closed between Hanauma Bay and the Halona Blowhole due to debris on the roadway on the island of Oahu, there was a partial closure of Kamehameha Highway near Waimea Bay on Oahu's North Shore (see Figure 4.11-9), and a small section of the Pali Highway, in the Kaneohe-bound lane, was blocked by debris from the nearby steep terrain.
December 05, 2021 – December 10, 2021	Debris Flow (DR-4639-HI)	Honolulu, Kalawao, Maui	Torrential rains triggered a landslide in Palolo Valley. The National Weather Service confirms the area received over 9 inches of rain in a 24-hour period. The slow-moving weather system dumped more than 20 inches of rain on areas of Hawaiʻi, at as much as 3 inches an hour. It caused widespread flooding, power outages, landslides, and damage.

Sources: NOAA NCEI 2022; FEMA 2023

Figure 4.11-9. A Mudslide Coats Kamehameha Highway on Oʻahu, 2021

Source: Craig T. Kojima/Associated Press

Probability of Future Hazard Events

Overall Probability

As discussed in detail earlier, landslides and rockfalls are commonly related to precipitation (e.g., tropical cyclone events, heavy rain on saturated ground), earthquakes, volcanic activity, and human activity. Therefore, landslide and rockfall event frequency is often related to the frequency of these other events. Refer to Section 4.6 (Earthquakes), Section 4.11 (Hurricane), and Section 4.14 (Volcanic Hazards) for details regarding the probability of future hazard events for each of these hazards.

Climate Change Impacts

Climate change may impact storm patterns and increase the probability of more frequent, intense storms with varying duration. Climate projections for the State of Hawaiʻi indicate an overall decline in rainfall; however, the state is expected to experience an increase in heavy rain events potentially causing an increase in landslides and rockfalls. Warming temperatures may increase the occurrence and duration of droughts, which could increase the probability of wildfire, reducing the vegetation that helps to support steep slopes. All these factors may increase the probability of landslide occurrences.

Each county in the state has topography susceptible to increased landslides and rockfalls from climate change impacts. Increased drought and wildfires may especially impact the leeward side of each island which will be more likely to experience landslides during extreme precipitation events after a wildfire has altered the landscape. However, landslides triggered by the increase of extreme precipitation can happen in any sloped area. Landslide impacts resulting from severe rain events may be minor with small rocks and mud coating a roadway, to a major slope failure covering an entire highway for weeks or months as was experience on Kauaʻi in 2018 after the extreme rain event. The frequency of these climate change impacts on the landslide hazard is directly related to the frequency of increased wildfire and extreme precipitation events.

4.11.2 VULNERABILITY ASSESSMENT

A statewide assessment was conducted based on landslide susceptibility data from two sources. For the County of Hawaiʻi, landslide susceptibility data was provided by the Pacific Disaster Center (PDC). The data are based on topographic slope, geology, and soil moisture as described in Section 4.1. For the Counties of Kauaʻi, Maui, and the City and County of Honolulu, landslide susceptibility data were not available; therefore, the topographic slope was calculated using a USGS 10-meter DEM (USGS 2016). Slopes were assigned to landslide susceptibility categories consistent with the slope categories used by the County of Hawaiʻi:

- Low—slope less than 20 degrees
- Moderate—slope of 20 to 40 degrees
- High—slope greater than 40 degrees

Landslide Hazard Area

High Landslide Susceptibility Hazard Area – To assess vulnerability to the landslide hazard, the high landslide susceptibility areas were used.

A qualitative discussion of the relationship between slope angles and rockfall impacts is included below.

Assessment of State Vulnerability and Potential Losses

This section discusses vulnerability of state assets (state buildings and roads) and critical facilities in areas exposed to high landslide susceptibility. Assets located in the moderate landslide susceptibility area are presented in Appendix F (State Profile and Risk Assessment Supplement).

State Assets

There are 357 state buildings located in high landslide susceptibility areas statewide. Almost all of the state buildings exposed are located in the County of Hawaiʻi (353 buildings with a replacement cost value of $2.032 billion). The remaining four buildings are located in the City and County of Honolulu. The vast majority of the buildings exposed in the County Hawaiʻi are occupied by the Department of Education (67.1%). Table 4.11-4 summarizes the state buildings located in the high landslide susceptibility areas by county. Table 4.11-5 summarizes the state buildings located in the high landslide susceptibility areas by agency.

Table 4.11-4. State Buildings Located in High Landslide Susceptibility Areas by County

County	High Landslide Susceptibility	
	Number of State Buildings in Hazard Area	Total Replacement Cost Value of State Buildings in Hazard Area
County of Kauaʻi	0	$0
City and County of Honolulu	4	$11,561,110
County of Maui	0	$0
County of Hawaiʻi	353	$2,032,000,622
Total	**357**	**$2,043,561,732**

Source: Pacific Disaster Center 2017; United States Geological Survey 2016; State of Hawai'i Risk Management Office 2017

Table 4.11-5. State Buildings Located in High Landslide Susceptibility Areas by Agency

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Hazard Area	Percent of Total Buildings	Replacement Cost Value in the Hazard Area	Percent (%) of Total Value
Dept of Accounting & General Services	66	$953,963,738	14	21.21%	$9,484,078	0.99%
Dept of Agriculture	70	$147,607,399	12	17.14%	$11,531,395	7.81%
Dept of Attorney General	15	$108,425,480	0	0.00%	$0	0.00%
Dept of Budget & Finance	16	$28,968,679	1	6.25%	$466,382	1.61%
Dept of Business, Economic Development and Tourism	25	$645,480,379	0	0.00%	$0	0.00%

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Hazard Area	Percent of Total Buildings	Replacement Cost Value in the Hazard Area	Percent (%) of Total Value
Dept of Commerce & Consumer Affairs	2	$40,197,360	0	0.00%	$0	0.00%
Dept of Defense	69	$267,352,836	4	5.80%	$12,857,832	4.81%
Dept of Education	4,090	$10,598,205,739	258	6.31%	$1,719,366,025	16.22%
Dept of Hawaiian Home Lands	12	$110,427,352	2	16.67%	$2,281,602	2.07%
Dept of Health	44	$387,068,440	2	4.55%	$1,220,303	0.32%
Dept of Human Resources Development	1	$5,973,872	0	0.00%	$0	0.00%
Dept of Human Services	130	$480,212,294	5	3.85%	$8,619,142	1.79%
Dept of Labor and Industrial Relations	22	$90,076,209	2	9.09%	$5,459,152	6.06%
Dept of Land and Natural Resources	90	$101,441,821	0	0.00%	$0	0.00%
Dept of Public Safety	154	$440,774,415	14	9.09%	$33,842,195	7.68%
Dept of Taxation	1	$7,174,162	0	0.00%	$0	0.00%
Dept of Transportation	68	$2,935,208,214	2	2.94%	$1,363,600	0.05%
Hawaiʻi State Ethics Commission	1	$984,533	0	0.00%	$0	0.00%
Hawaiʻi Health Systems Corporation	106	$1,230,852,871	21	19.81%	$171,901,454	13.97%
Hawaiʻi Housing Finance & Development Corporation	86	$360,851,671	0	0.00%	$0	0.00%
Hawaiʻi Public Housing Authority	273	$982,981,701	3	1.10%	$8,864,400	0.90%
Hawaiʻi State Legislature	2	$48,555,381	0	0.00%	$0	0.00%
Hawaiʻi State Public Library System	53	$525,584,082	4	7.55%	$15,073,630	2.87%
Judiciary	41	$534,877,354	5	12.20%	$7,614,067	1.42%
Legislative Reference Bureau	1	$2,996,162	0	0.00%	$0	0.00%
Office of Hawaiian Affairs	11	$54,125,645	0	0.00%	$0	0.00%
Office of the Auditor	2	$1,921,180	0	0.00%	$0	0.00%
Office of the Governor	1	$2,996,162	0	0.00%	$0	0.00%
Office of the Lieutenant Governor	2	$4,588,849	0	0.00%	$0	0.00%
Office of the Ombudsman	1	$1,818,060	0	0.00%	$0	0.00%
Research Corporation of the University of Hawaiʻi	3	$4,189,026	0	0.00%	$0	0.00%
University of Hawaiʻi	637	$5,014,974,503	8	1.26%	$33,616,475	0.67%
Total	**6,095**	**$26,120,855,568**	**357**	**5.86%**	**$2,043,561,731**	**7.82%**

Source: *Pacific Disaster Center 2017; United States Geological Survey 2016; State of Hawaiʻi Risk Management Office 2017*

The state has jurisdiction over many roads and highways in all four counties; many of these thoroughfares are adjacent to slopes subject to rockfall and landslide events. A Rockfall Hazard Rating System (Publication No. FWHA SA-93-057, November 1993) allows transportation agencies to evaluate and rate the risk of rockfall sites and may be used to prioritize construction funds. Both preliminary and detailed rating methodologies exist. The preliminary rockfall rating subjectively groups hazard conditions into three classes (A, B, and C) based on historic rockfall activity and the probability of falling rocks reaching roadway pavement (U.S. DOT 1993). The detailed rating is based on the following factors:

- Slope height
- Ditch effectiveness
- Average vehicle risk, derived from Average Daily Traffic (ADT)
- Percentage of decision sight distance

- Roadway width
- Structural condition, Case One slopes (movement along discontinuities)
- Rock friction
- Structural condition, Case Two slopes (differential erosion or over-steepening leads to rockfall)
- Erosion rate
- Expected volume of a rockfall event
- Climate and the presence of water on slope
- Rockfall history

The City and County of Honolulu implemented a study to evaluate potential rockfall sites along 79 state highways and roadways and develop a rockfall hazard management system for the State of Hawaiʻi using a rockfall hazard rating. Overall, 66 highway sites were identified as having a high risk to rockfall (State of Hawai'i 2018).

The State of Hawaiʻi Department of Transportation mitigates landslides near roadways by erecting metal meshes around the edge of cliffs. The meshes prevent rocks and other debris from sliding or falling onto the roadways. Since the identification of high-risk sites along highways and roads in the City and County of Honolulu, many have been mitigated, including a site along the Diamond Head State Monument trail, completed in December 2017.

Due to the County of Kauaʻi's mountainous terrain, few roads connect the island. Many roads are under the jurisdiction of the State of Hawaiʻi Department of Transportation (e.g., Kūhiō Highway and Kaumualiʻi Highway). The roads are connected by bridges, with few areas for roadway bypass or alternate routes (County of Kaua'i 2020). Impacts on main roadways in the county from natural hazard events can have devastating impacts on residents and visitors. Roadway closures due to a landslide or rockfall, as demonstrated by the April 2018 event, can isolate communities; prevent residents from getting to work; and cut off access for emergency response.

The County of Maui has a history of recurring landslides, debris flows, and rockfalls. Many of these events have occurred along coastal highways that are against mountain slopes (State of Hawai'i 2018). The Kīholo Bay and Mahukona Earthquakes of October 15, 2006, resulted in several landslides and rockfalls at various locations on the Island of Maui, including along Piʻilani Highway (State Highway 30). As is the case on other islands, road closures on Maui due to a landslide can isolate communities. In some cases, it can take years to fully repair a roadway and reopen (County of Kaua'i 2020).

The County of Hawaiʻi has the greatest state road exposure to landslide hazards in the state. Owing to the lack of redundancy in the road network there, the closure of roads due to landslides will significantly hamper emergency response and potentially isolate communities. Table 4.11-6 shows the length of state roads in high landslide susceptibility areas by county and confirms that the County of Hawaiʻi has, by far, the greatest number of exposed miles of any county in the state (147.1 miles out of 150.63 miles). A complete list of state roads located in the high landslide susceptibility areas is included in Appendix F.

Community Lifelines and Critical Facilities

There are 78 community lifelines in high landslide susceptibility areas in the state and 17 additional critical facilities (see Table 4.11-7). The County of Hawaiʻi has the greatest number such facilities. Table 4.11-8 summarizes the exposed critical facilities by category. The majority of these facilities are categorized as Food, Water, and Shelter.

Table 4.11-6. State Roads Located in High Landslide Susceptibility Areas by County

County	Length (in miles)		
	Total Length	Length in the Hazard Area	Length in the Hazard Area as Percent (%) of Total Length
County of Kaua'i	103.7	0.23	0.22%
City and County of Honolulu	374.9	1.8	0.48%
County of Maui	245.9	1.5	0.61%
County of Hawai'i	379.2	147.1	38.79%
Total	**1,103.70**	**150.63**	**13.65%**

Source: Pacific Disaster Center 2017; United States Geological Survey 2016; State of Hawai'i Risk Management Office 2017

Table 4.11-7. Community Lifelines and Critical Facilities Located in High Landslide Susceptibility Areas, by County

County	Community Lifeline Categories								Additional Critical Facilities
	Communications	Energy	Food, Water, Shelter	Hazardous Material	Health & Medial	Safety & Security	Transportation	Total in the Hazard Area	
County of Kaua'i	0	0	0	0	0	0	0	0	0
City and County of Honolulu	1	0	2	0	0	0	0	3	0
County of Maui	0	0	0	0	0	1	0	1	0
County of Hawai'i	13	0	21	2	19	19	0	74	17
Total	**14**	**0**	**23**	**2**	**19**	**20**	**0**	**78**	**17**

Source: Pacific Disaster Center 2017; United States Geological Survey 2016; Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020

Table 4.11-8. Community Lifelines and Critical Facilities Located in High Landslide Susceptibility Areas, by Category

Category	Total Number of Facilities	Total Replacement Cost Value	Number of Facilities in Hazard Area	Percent (%) of Total Facilities	Replacement Cost Value in the Hazard Area	Percent (%) of Total Value
Communications	188	$776,797,683	14	7.45%	$45,723,339	5.89%
Energy	89	$3,093,949,530	0	0.00%	$0	0.00%
Food, Water, Shelter	345	$11,847,189,588	23	6.67%	$835,555,050	7.05%
Hazardous Material	12	$436,474,800	2	16.67%	$72,588,000	16.63%
Health and Medical	193	$4,606,713,364	19	9.84%	$508,897,856	11.05%
Safety and Security	486	$38,164,188,232	20	4.12%	$776,190,099	2.03%
Transportation	56	$2,039,091,600	0	0.00%	$0	0.00%
Additional Critical Facilities	106	$447,698,794	17	16.04%	$54,245,500	12.12%
Total	**1,475**	**$61,412,103,591**	**95**	**6.44%**	**$2,293,199,844**	**3.73%**

Source: Pacific Disaster Center 2017; United States Geological Survey 2016; Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020

Assessment of Local Vulnerability and Potential Losses

This section provides a summary of vulnerability and potential losses to population, general building stock, environmental resources, and cultural assets by county. Similar to the analysis for state assets, a spatial exposure analysis was conducted, and the results are summarized below. Landslide and rockfall events do not just impact assets located in the defined hazard area. Cascading impacts affect surrounding communities that rely on assets that are damaged or lost as a result of a disaster.

The local HMPs were reviewed to integrate risk assessment results into the 2023 SHMP Update; a summary of information available is below.

- **County of Kaua'i** – The County provided a qualitative overview of risks posed by a landslide hazard. (County of Kaua'i 2020).
- **City and County of Honolulu** – The County provided a qualitative overview of risks posed by a landslide hazard. The HMP also discusses rockfall risk, with a focus on rockfalls occurring along transportation routes (City and County of Honolulu 2020).
- **County of Maui** – The County provided a qualitative overview of risks posed by a landslide hazard, including descriptions of different categories of landslides (County of Maui 2020).
- **County of Hawai'i** – The County provided a qualitative overview of risks posed by a landslide hazard. The HMP includes a landslide susceptibility map from the Pacific Disaster Center demonstrating areas of high landslide vulnerability in the county (County of Hawai'i 2020).

Socially Vulnerable and Total Populations

According to the CDC, health threats from landslides include: 1) trauma caused by rapidly moving water and debris; 2) broken electrical, water, gas and sewage lines that can lead to injury or illness; and 3) disrupted roadways that can endanger motorists and disrupt transport and access to health care (CDC 2018). Disasters can exacerbate stressful social conditions. Populations considered most vulnerable to natural hazard events include children, the elderly (persons over the age of 65), people with access and functional needs, and individuals experiencing poverty. The high vulnerability population located in the landslide and rockfall hazard area makes up about 22.8% of the total population of the State of Hawai'i.

Flash flooding or ongoing heavy rains can be precursors to landslide and rockfall events. The concurrent hazard of flooding further disrupts access to roadways and endangers motorists. Landslide and rockfall events can hinder evacuation routes, prevent the delivery of necessary goods to vulnerability populations, and can delay emergency and medical responses to the area. Some residential areas in Hawai'i that are susceptible to landslides and rockfalls have just one means of ingress and egress, making them highly vulnerable in the event of an evacuation.

The population in the hazard area (65,049) and percentage of population exposed (4.58%) does not include the number of tourists and visitors in the state or the impacted population located outside of high landslide susceptibility areas. Historic landslide and rockfall events in the state have caused road closures and bridge failures, which isolated residents and prevented access to evacuation routes and medical services. Therefore, the analysis conducted and figures reported may be underestimating landslide exposure and vulnerability.

Overall, the County of Hawai'i has the highest population exposed as a percentage, both for population in the hazard area (25.95%) and high vulnerability population in the hazard area (5.98%). Table 4.11-9 summarizes the 2020 U.S. Census population residing in high landslide susceptibility areas by county.

Table 4.11-9. 2020 U.S. Census Population Located in High Landslide Susceptibility Areas by County

County	Total Population	Population			
		Population in Hazard Area	Population Exposed as Percent (%) of Total Population	Socially Vulnerable Population in the Hazard Area	Socially Vulnerable Population Exposed as Percent (%) of Total Population
County of Kauaʻi	71,949	1,029	1.43%	469	0.65%
City and County of Honolulu	979,682	10,376	1.06%	2132	0.22%
County of Maui	167,093	1,388	0.83%	191	0.11%
County of Hawaiʻi	201,350	52,256	25.95%	12,031	5.98%
Total	**1,420,074**	**65,049**	**4.58%**	**14,823**	**1.04%**

Source: Pacific Disaster Center 2017; United States Geological Survey 2016; U.S. Census Bureau 2020; Centers for Disease Control and Prevention 2018

General Building Stock

To further assess what is at risk, each county's general building stock exposure was examined. The general building stock located in high landslide susceptibility areas is considered exposed and potentially vulnerable. Damages to buildings can displace people from their homes, threaten life safety, and impact a community's economy and tax base. Table 4.11-10 indicates that the County of Hawaiʻi has the greatest replacement cost value ($14,831,484,138) for general building stock located in high landslide susceptibility areas.

Table 4.11-10. General Building Stock Located in High Landslide Susceptibility Areas

County	Total Replacement Cost Value	Replacement Cost Value in Hazard Area	Percent of Total in Hazard Area
County of Kauaʻi	$24,246,497,228	$3,809,018	0.02%
City and County of Honolulu	$239,152,051,766	$61,415,806	0.03%
County of Maui	$50,796,693,140	$12,861,364	0.03%
County of Hawaiʻi	$58,395,349,136	$14,831,484,138	25.40%
Total	**$372,590,591,270**	**$14,909,570,325**	**4.00%**

Source: Pacific Disaster Center 2017; United States Geological Survey 2016; NIYAM IT 2022; United States Army Corps of Engineers 2022

The Honolulu district in the City and County of Honolulu has a high concentration of inventoried rock hillslopes. This reflects the high density of development in areas of high topographic relief that require significant earthwork and grading. More than 1,779 landslides and debris flows have been recognized in aerial photographs of the Honolulu District taken during a period of approximately 50 years from 1940 to 1989 (USGS 1993). Most of the debris flows caused relatively little direct property damage because they occurred in undeveloped or relatively inaccessible upland areas. However, some of the areas affected by past debris flows have since been developed, and if development continues in these upland areas, the impacts from debris flows in future storms could become even more frequent and costly (State of Hawai'i 2018).

The geography in the County of Kauaʻi includes the two mountains, Kawaikini Peak and Mount Waiʻalʻale, that are among the rainiest places on Earth. The county receives an estimated 460 inches of rain annually. Steep slopes and climatic conditions make the county highly vulnerable to flooding and landslides as well as mudslides and rockslides (County of Kaua'i 2020). In April 2018, flash flooding and mudslides that resulted from heavy rainfall caused major damage to roads, including Kūhiō Highway, and bridges across the mountainous island. Many communities became isolated, and homes damaged or destroyed.

Mudslides can cause damage either directly by impacting man-made structures or indirectly by plugging drainage systems so that flood waters are diverted out of their channels. Debris flows also can sever or cover roads, block access to (or egress from) neighborhoods, and thus interfere with emergency operations and evacuations (State of Hawai'i 2018).

Land Use Districts

Table 4.11-11 shows the number of square miles of high landslide susceptibility areas in each state land use district statewide; refer to Appendix F for results for each county. Approximately 4.5% of the Urban District lands statewide are located in high landslide susceptibility areas. Urban development on steep slopes or unstable soils could result in adverse visual impacts and exacerbate hazardous conditions. Most of the vacant lands in the state urban district with steep slopes or unstable soils are located in valley and hillside neighborhoods. Where hillside locations have stable soils, the primary impact is aesthetic, since structures built along the slopes tend to be visually prominent and can interrupt the silhouette of the natural ridgeline when viewed from below. Building on the lower slopes of valley walls can also have a visual impact. Where these valley locations have deposits of unstable soils, slow-moving landslides can cause property damage; situations like this in Mānoa and Moanalua have prompted claims against the City and County of Honolulu (State of Hawai'i 2018).

Table 4.11-11. State Land Use Districts Located in High Landslide Susceptibility Areas

Land Use District	Total (square miles)	Square Miles in High Landslide Susceptibility Areas	Percent (%) of Total Area
Agricultural	2,973.6	645.5	21.71%
Conservation	3,202.9	512.8	16.01%
Rural	16.3	0.2	1.22%
Urban	319.1	14.4	4.51%
Total	**6,511.95**	**1,172.90**	**18.01%**

Source: Pacific Disaster Center 2017; United States Geological Survey 2016; State Land Use Commission, Hawai'i Statewide GIS Program 2021; Honolulu County GIS 2022

Environmental Resources

The state's abundant natural resources are one of the many elements that attract visitors to the islands, and as discussed, tourism is a major contributor to the local and state economy. Unfortunately, natural hazard events, including landslide and rockfall events, can harm the environment. Landslides can lead to flooding by blocking stream channels or culverts, allowing water to back up and overflow. Landslide events can also lead to overtopping of reservoirs and/or reduced capacity of reservoirs to store water (USGS 2004).

Monetizing impacts to environmental resources as a result of hazard events is a challenge. To understand which environmental resources are exposed to landslide hazards, a spatial analysis was conducted using the available critical habitats (or habitats that are known to be essential for an endangered or threatened species), wetlands, and parks and reserves spatial layers. These results are summarized in Table 4.11-12. As noted, large areas of critical habitats, parks, and reserves are vulnerable to landslide events.

Table 4.11-12. Environmental Resources Located in the High Landslide Susceptibility Area

Environmental Resource	Total Square Miles of Resource (square miles)	Resource Area in the Hazard Area (square miles)	Percent (%) of the Total Asset Area
Critical Habitat [a]	951	216	22.7%
Wetlands	3,637	14	0.4%
Parks and Reserves	2,778	413	14.9%
Reefs [b]	55	0	0.0%
Total [c]	**7,420**	**642**	**8.7%**

Source: U.S. Fish and Wildlife Service, Pacific Islands Office, 2022a, U.S. Fish and Wildlife Service 2021e; 2017b, Hawai'i State Department of Land and Natural Resources, Division of Forestry and Wildlife 2022, NOAA raster nautical charts 2020b, State of Hawai'i Department of Land and Natural Resources, Division of State Parks 2021; Pacific Disaster Center 2017; United States Geological Survey 2016

Notes:

a. Critical area mileage includes the combined area of coverage of individual critical habitat areas.

b. Reefs include artificial and coral reefs.

c. Total square miles includes environmental assets within 3 nautical miles of each county and may be over reported as some environmental asset areas may overlap.

Cultural Assets

Loss of native species and ecosystems, and harm to them, will adversely impact the Hawaiian cultural traditions and practices, which are closely tied to the natural environment. To understand what portion of the Hawaiian Home Lands are exposed to the high landslide susceptibility area, an exposure analysis was conducted. Nearly 60% of the Hawaiian Home Lands in the County of Hawaiʻi are located in landslide hazard areas (Table 4.11-13).

Table 4.11-13. Hawaiian Home Lands Located in High Landslide Susceptibility Areas by County

County	Hawaiian Home Lands Area (in square miles)		
	Total Area	Hawaiian Home Lands Located in the Hazard Area	Percent (%) of Total Area
County of Kauaʻi	32.09	1.34	4.19%
City and County of Honolulu	10.61	1.46	13.72%
County of Maui	102.59	2.16	2.10%
County of Hawaiʻi	191.46	114.47	59.79%
Total	**336.75**	**119.43**	**35.46%**

Source: Pacific Disaster Center 2017; United States Geological Survey 2016; Hawai'i State Department of Hawaiian Homelands 2021

Table 4.11-14 discusses the cultural resources in high landslide risk hazard areas. The cultural resource type with the largest total area and largest area in the hazard area is the Historic District; however, the district with the largest percentage of area in the high wildfire risk hazard area is the Archaeology.

Table 4.11-14. Cultural Resources Located in the High Landslide Susceptibility Areas

Cultural Resource Site Type	Area (in square miles)		
	Total Square Miles of Asset	Total Square Miles in the Hazard Area	Percent (%) of Total Asset Area
Archaeology	90.892401	12.976967	14.28%
Burial Sensitivity Area	2.074551	0.019907	0.96%
Historic Building	2.680785	0.278606	10.39%

Cultural Resource Site Type	Area (in square miles)		
	Total Square Miles of Asset	Total Square Miles in the Hazard Area	Percent (%) of Total Asset Area
Historic District	849.360596	75.417033	8.88%
Historic Object	9.6143	0.045768	0.48%
Historic Structure	20.739072	0.403678	1.95%
Total	**975.361705**	**89.141959**	**9.14%**

Source: Department of Land and Natural Resources, Hawai'i State Historic Preservation Division 2022; Pacific Disaster Center 2017; United States Geological Survey 2016

Future Changes that May Impact State Vulnerability

Understanding future changes that may impact vulnerability in the state can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The state considered the following factors in examining potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including impacts of climate change

High landslide susceptibility areas were overlain on areas that may experience significant changes in development or redevelopment in future years (see

Table 4.11-15 below and Section 3 [State Profile] for more information on projected development areas). The results of this exercise indicate that more than a third (36.69%) of the Enterprise Zones in the County of Hawaiʻi are located in high landslide susceptibility areas. Generally, county-level regulations for land use and development require special assessment and consideration of proposed development on steep slopes.

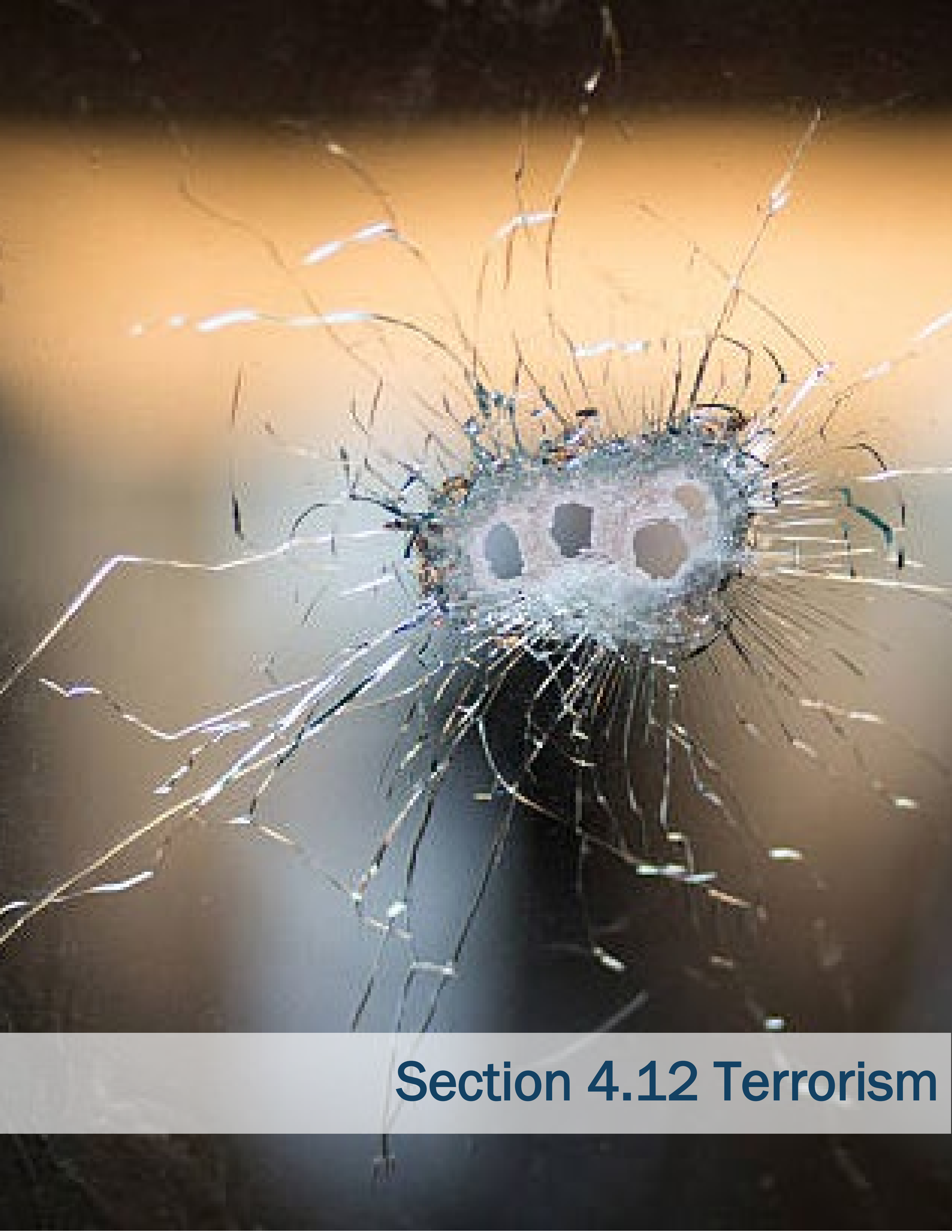
Table 4.11-15. HCDA Community Development Districts, Maui Development Projects, and Enterprise Zones located in High Landslide Susceptibility Areas by County

County	Area (in square miles)								
	Hawaiʻi Community Development Authority District (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area	Maui Development Projects (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area	Enterprise Zones (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area
County of Kauaʻi	0	0	0	0	0	0	251.0	4.6	1.83%
City and County of Honolulu	7.4	<0.1	<0.1%	0	0	0	297.3	22.8	7.67%
County of Maui	0	0	0	27.6	0.07	0.25%	1,059.8	73.4	6.93%
County of Hawaiʻi	0	0	0	0	0	0	1,274.9	467.7	36.69%
Total	**7.4**	**<0.1**	**<0.1%**	**27.6**	**0.07**	**0.25%**	**2,883.00**	**568.5**	**19.72%**

Source: Maui County Planning Department 2016; Hawaiʻi Community Development Authority 2021; Community Economic Development Program, Department of Business, Economic Development & Tourism, County Planning Departments 2021; Pacific Disaster Center 2017; United States Geological Survey 2016

Soil conditions and other geotechnical and engineering factors are supposed to be considered. Development in these areas may not be outright prohibited but are likely subject to close examination on a case-by-case basis. While these regulations may prevent development on steep slopes that would be impacted by landslides or contribute to their occurrence, new development in landslide runout areas (that is, areas at the foot of the slide where materials involved in a slide come to rest) or in areas downslope from rockfall areas are not likely to be similarly regulated and may be exposed to risk from landslide and rockfalls.

In addition, incremental build-out of hillsides and lower valley slopes can affect drainage systems, both natural and urbanized. Increased lot coverage by larger buildings and more extensive paving has increased the volume and rate of stormwater discharge. This problem is exacerbated in the interior reaches of the valleys and hillsides, where rainfall is higher. Over the long term, the cumulative impact of greater lot coverage threatens to promote the erosion of natural stream banks downstream. Mitigation efforts to curb this process could require expensive, aesthetically problematic, and ecologically undesirable structural hardening of drainage channels. Without successful mitigation efforts, the capacity of drainage systems could be exceeded, resulting in flooding. To prevent inappropriate development, hillside lands should be placed in preservation or low-density residential zoning districts. Such lands should also be subject to stricter development standards, such as maximum lot coverage and structural stability, than those that apply to level land (State of Hawai'i 2018).



Section 4.12 Terrorism

Terrorism

Although terrorism, complex coordinated terrorist attacks, and targeted/mass violence events are not common in Hawaiʻi, it is critical not to confound a lack of historical examples as a lack of risk. Several iconic locations throughout the state with year-round tourism industries create clear targets for terrorist attacks or other active assailant situations.

CHANGES SINCE 2018

+0

Declared Disasters

+12

Terrorism Events

COUNTIES MOST VULNERABLE

Kauaʻi Honolulu Maui Hawaiʻi

SOCIALLY VULNERABLE POPULATION

22.3%

Of Total Population

316,257

Persons

HAZARD RANKING

Low Medium High

COMMUNITY LIFELINES

1,369

Total

CLIMATE PROJECTIONS

While extremely unlikely, climate change impacts may act as an aggravating factor for terrorism

Climate impacts create the potential for the disadvantaged to turn to terrorism when the resources they need are unavailable

6,095

State Buildings

SQUARE MILES

7,420

Environmental Resources

337

Hawaiian Home Lands

975

Cultural Resources

1,104

Miles of State Road

CONTENTS

TABLES

[1] *Section Cover Photo: Stock photo*

SECTION 4. RISK ASSESSMENT

4.12 TERRORISM

2023 SHMP Update Changes

- The terrorism hazard profile is new to the 2023 plan update.
- Terrorism incidents that occurred in the State of Hawaiʻi from January 1, 2018, through December 31, 2022, were researched for this 2023 SHMP Update.

4.12.1 HAZARD PROFILE

Hazard Description

The term "terrorism" refers to intentional, criminal, malicious acts. The State of Hawaiʻi (Hawaiʻi Office of Homeland Security 2021) defines terrorism as:

"Any activity involving a criminally unlawful act that is dangerous to human life or potentially destructive of critical infrastructure or key resources, that appears intended to intimidate or coerce a civilian population; to influence government policy by intimidation or coercion; or to affect the conduct of a government by mass destruction, assassination, or kidnapping."

As the nature of this kind of threat evolves, most recently in the United States and elsewhere to include threat actors perpetrating acts of domestic violent extremism, the state's approach to this threat category includes targeted violence. Targeted violence refers to any incident of violence that implicates homeland security, and in which a known or knowable attacker selects a particular target prior to the violent attack (US Department of Homeland Security 2019).

Terrorism and targeted violence, as assessed for the 2023 Hawaiʻi State Hazard Mitigation Plan Update, includes the following:

- Mass shootings
- Arson or fire as a weapon
- Bombings/explosions
- Kidnapping or hostage-taking
- Vehicular attacks
- Other violent attacks meeting the definition of targeted violence, such as stabbings or active-shooter attacks

The effects of terrorism and targeted violence can include injuries, loss of life, property damage, or disruption of services such as electricity, water supplies, transportation, or communications. Effects may be immediate or delayed. Terrorists often choose targets that offer limited danger to themselves and areas with relatively easy public access. Foreign terrorists look for visible targets where they can avoid detection before and after an attack, such as international airports, large cities, major special events, and high-profile landmarks. Perpetrators of targeted violence currently assessed to pose the greatest threat to the homeland are lone actors radicalized online who look to attack soft targets with easily accessible weapons (Federal Bureau of Investigation 2020).

In dealing with terrorism and targeted violence, the unpredictability of human beings must be considered. People with a desire to perform such acts may seek out targets of opportunity that may not fall into established lists of critical areas or facilities. First responders train to respond not only to organized terrorism events but also to random acts by individuals who, for a variety of reasons ranging from fear to emotional trauma to mental instability, may choose to harm others and destroy property. While education, heightened awareness, and early warning of unusual circumstances may deter terrorism and targeted violence, intentional acts that harm people and property are possible at any time. Public safety and homeland security entities must react to the threat, locating, isolating, and neutralizing further damage and investigating potential scenes and suspects to bring criminals to justice.

Location

Terrorism and targeted violence can both occur in any place and at any time. Most instances of terrorism or targeted violence occur in locations with concentrated populations or locations of high economic or social value, such as stadiums, schools, prominent offices, or government buildings. Hawai'i has numerous locations of high economic and social value as well as densely populated beaches and shopping centers. The threat of terrorism and targeted violence does pose particular risks to the State of Hawai'i in these areas.

Extent

Acts of terrorism or targeted violence can range from minor to severe, with fatalities and damage that can fall into the same categories. Terrorist or targeted violence incidents involving the use of firearms, edged weapons, and similar weapons generally tend to result in fewer fatalities when compared to those incidents involving explosive devices, but active-shooter events that result in mass shootings present the potential to challenge this. Incidents may also damage surrounding buildings and structures, especially when explosive devices and firearms are utilized in the attack.

Warning Time

The National Terrorism Advisory System is designed to communicate information about terrorist threats by providing timely, detailed information to the American public. The Department of Homeland Security maintains the National Terrorism Advisory System. As of November 30, 2022, the system rates the national threat as “heightened threat environment.” This is, in part, due to ‘lone offenders and small groups motivated by a range of ideological beliefs and/or personal grievances continuing to pose a persistent and lethal threat to the Homeland; domestic actors and foreign terrorist organizations continuing to maintain a visible presence online in attempts to motivate supporters to conduct attacks in the Homeland.’

Previous Occurrences and Losses

Disaster and Emergency Declarations

No FEMA, USDA, or State of Hawaiʻi disaster declarations or proclamations related to terrorism have been issued relevant to Hawaiʻi or any of its counties (or nationally).

Event History

Table 4.12.1-1 summarizes terrorism and targeted violence incidents from 2018 to 2022. Although terrorism events are not common in Hawaiʻi, it is critical not to mistake a lack of historical examples for a lack of risk. As threats increase nationally and worldwide, Hawaiʻi can expect to see an increase in threats in the state. While not classified as terrorist incidents, several Hawaiʻi-based incidents in the recent past have exhibited characteristics of coordinated terrorist attacks.

Table 4.12.1-1. Terrorism and Targeted Violence Incidents from 2018 to 2022

Date of Incident	Event Type	Counties Affected	Impacts
2020	Stabbing, Shooting, Arson	Honolulu	3 dead, 1 wounded5 homes destroyed & additional damaged
2020	Bomb threat/assault	Maui	1 arrested
2020	Barricade/shooting	Honolulu	1 arrested
2020	Threat at school	Honolulu	Resolved
2020	Stabbing	Honolulu	School lock-down, 2 wounded, 1 arrested
2020	Threat to school	Honolulu	School lock-down
2019	Shooting	Honolulu	3 dead, 1 wounded
2019	Threats to schools	Kauaʻi	School lockdowns
2019	Shooting/Stand-off	Honolulu	1 arrested
2019	Barricade/kidnapping	Maui	1 arrested
2018	Terrorist aspirant	Honolulu	1 convicted
2018	Barricade/kidnapping	Honolulu	2 dead

Source: (Hawaiʻi Office of Homeland Security 2021)

Probability of Future Hazard Events

Overall Probability

Lack of historical data on terrorism and/or targeted violence incidents in Hawaiʻi (and nationally) impacts our ability to reasonably assign incident probability. However, even with such data, the risk to terrorism and/or targeted violence does not lend itself to probability analysis. Trend analysis, even in its broad-brush nature (where the likelihood of individual occurrences in specific localities is absent) can provide indications of preventative and protective activities to either thwart or mitigate the impacts of such unpredictable incidents..

Climate Change Impacts

While extremely unlikely, climate change impacts may act as an aggravating factor for terrorism (UN News 2021). Radicalization is when someone starts to believe or support extreme views, and in some cases, then participates in violent groups or acts. Radicalization is a highly individualized process determined by the complex interaction of various personal and structural factors. Climate impacts can impair governance in ways that reduce government capacity and legitimacy, intensify competition for resources and livable territory, and necessitate invidious policies. Radicalized actors could respond to these developments by using violence, either to influence government behavior or to replace the role of the government in certain areas.

Climate change impacts are not projected to change the location, intensity, frequency, or duration of terrorism.

4.12.2 VULNERABILITY ASSESSMENT

Overall, it is difficult to quantify potential losses due to terrorism because of the many variables that must be considered. Potential impacts may be local, regional, or statewide (and possible broader) depending on the magnitude and location of the event. A qualitative assessment is discussed below.

Assessment of State Vulnerability and Potential Losses

This section discusses statewide vulnerability of exposed state assets (state buildings and roads) and critical facilities to terrorism.

State Assets

All state-owned and leased facilities are vulnerable to terrorism.

Community Lifelines and Critical Facilities

All community lifelines and critical facilities are vulnerable to terrorism.

Assessment of Local Vulnerability and Potential Losses

This section provides a summary of vulnerability and potential losses to socially vulnerable and total populations, general building stock, and environmental resources and cultural assets. The local HMPs were reviewed, and their discussions of terrorism are summarized below:

- Kauaʻi County – The 2021 County of Kauaʻi Multi-Hazard Mitigation and Resilience Plan qualitatively discusses bioterrorism-related health hazards and mentions terrorism in relation to dam failure.
- City and County of Honolulu – The 2020 Multi-Hazard Pre-Disaster Mitigation Plan for the City and County of Honolulu briefly mentions terrorism in relation to a mutual aid agreement with the Hawaiʻi National Guard Civilian Support Team, which specializes in chemical, biological, radio-logical and nuclear hazards.
- Maui County – The 2020 County of Maui Hazard Mitigation Plan Update briefly mentions terrorist attacks in relation to hazardous materials incidents.
- Hawaiʻi County – The 2020 County of Hawaiʻi Multi-Hazard Mitigation Plan qualitatively discusses bioterrorism and includes a planning action focusing on terrorism at mass gatherings.

Socially Vulnerable and Total Populations

Because the entire population of the State of Hawai'i is exposed and vulnerable to terrorism, the exposed population in socially vulnerable communities is equal to the statewide population.

A survey found that persons with disabilities were more anxious about their personal risk from terrorism than were persons without disabilities, even when equally prepared. Another study reported that persons who increased their disaster preparations in response to the possibility of terrorist attacks included African Americans, Latinos, persons with disabilities or household dependents, and non–US-born populations (Eisenman, et al. 2009).

General Building Stock

All general building stock is vulnerable to terrorism.

Environmental Resources

Terrorism and targeted violence have the potential for harmful effects not only on economic and social life but also on the environment, particularly if such incidents impacts certain critical infrastructure such as water/wastewater, dams, or other systems that result in physical implications for the environment in which they reside. The environmental damage caused by terrorism includes but is not limited to terrestrial conflicts, terrorist camps and bases, training activities, and carbon dioxide emissions related to energy consumption (Bildirici and Gokmenoglu 2020).

Cultural Assets

All cultural assets are vulnerable to terrorism.

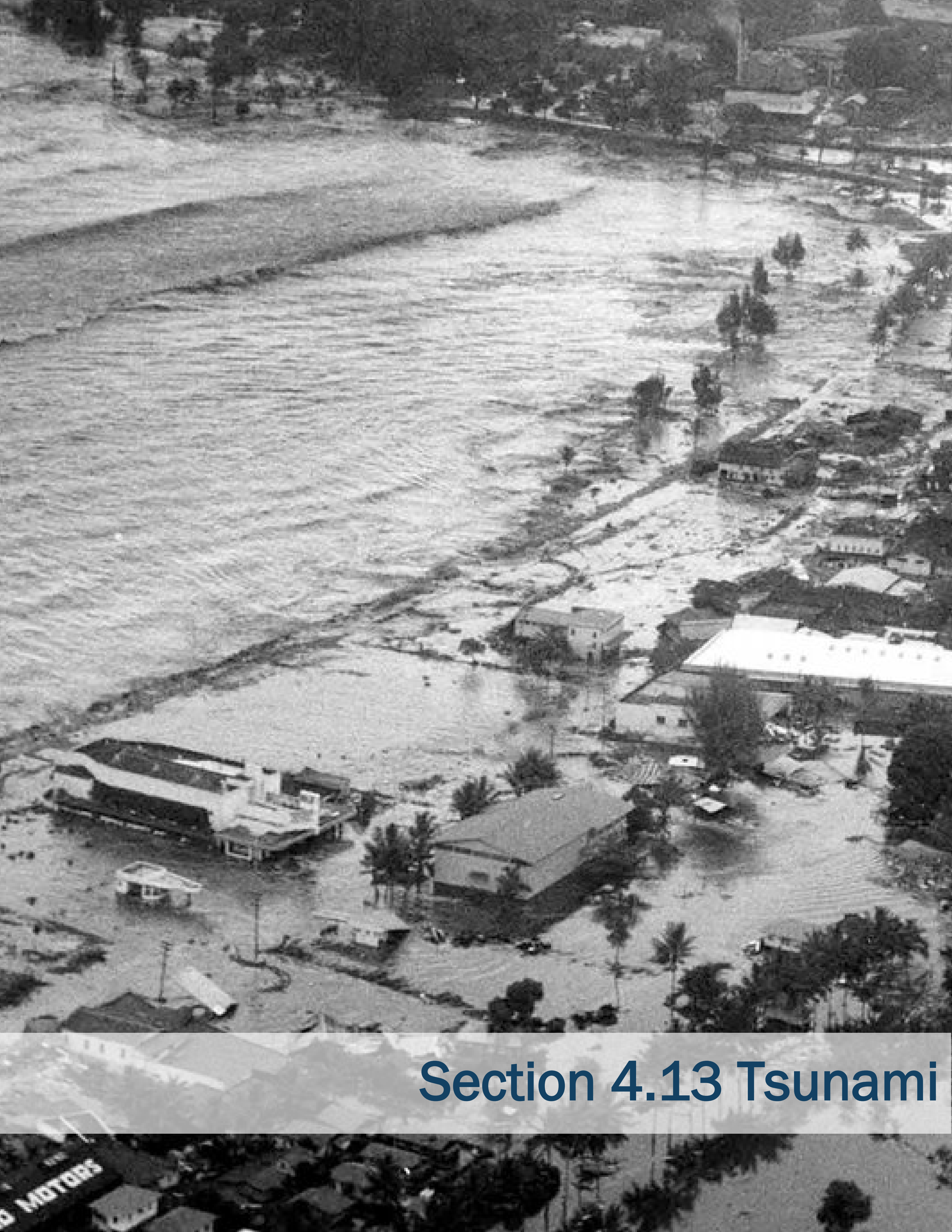
Future Changes that May Impact State Vulnerability

Understanding future changes that impact vulnerability in the state can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The state considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Change in the nature of terrorism/targeted violence threat actors of concern
- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate.

More than 2,900 acres of buildable land in the Hawaiʻi Community Development Authority (HCDA) Community Development Districts, Maui Development Projects, and Enterprise Zones is available for development statewide. Because the entire state is vulnerable to terrorism, any type of development of any of this land will be susceptible to damage and impacts from this hazard.

Section 4.13 Tsunami



Tsunami

Tsunamis are a single wave or a series of waves that are caused by earthquakes, landslides, or other disturbances in or near large bodies of water like seas and oceans. Tsunami waves can travel at hundreds of miles per hour and create waves as tall as 100 feet when they reach shore. Statistics below are based on the Great Aleutian Tsunami scenario.

CHANGES SINCE 2018

+0

Declared Disasters

+9

Tsunami Events

COUNTIES MOST VULNERABLE

Kauaʻi Honolulu Maui Hawaiʻi

SOCIALLY VULNERABLE POPULATION

2.8%

Of Total Population

37,701

Persons

CLIMATE PROJECTIONS

Higher sea levels will exacerbate the extent of coastal inundation from a tsunami.

Tsunami activity stimulated by potentially increased earthquakes may occur

HAZARD RANKING

Low Medium High

COMMUNITY LIFELINES

386

Total

Food, Water, Shelter

Greatest

1,204

State Buildings

SQUARE MILES

42

Environmental Resources

4

Hawaiian Home Lands

20.5

Cultural Resources

146

Miles of State Road

CONTENTS

TABLES

FIGURES

[1] *Section Cover Photo: 1946 tsunami in Hilo, Hawaiʻi Island. Photo courtesy of Pacific Tsunami Museum*

SECTION 4. RISK ASSESSMENT

4.13 TSUNAMI

2023 SHMP Update Changes

- Tsunami events that occurred in Hawaiʻi from January 1, 2018, through December 31, 2022, were researched for this 2023 SHMP Update.
- New and updated figures from federal and state agencies were incorporated.
- The School of Ocean & Earth Science & Technology (SOEST) and American Society of Civil Engineers (ASCE) inundation areas were added to assess exposure and vulnerability.
- This section now includes a discussion of how the tsunami hazard impacts socially vulnerable populations and community lifelines.
- In Environmental Resources, reefs (both artificial and coral) were analyzed in their own category.
- Six types of cultural resources (archaeology, burial sensitivity area, historic building, historic district, historic object, and historic structure) were added to the vulnerability assessment.

4.13.1 HAZARD PROFILE

Hazard Description

Tsunami Terms Defined

Distant-Source Tsunami – Originating from a faraway source that may arrive in more than three hours

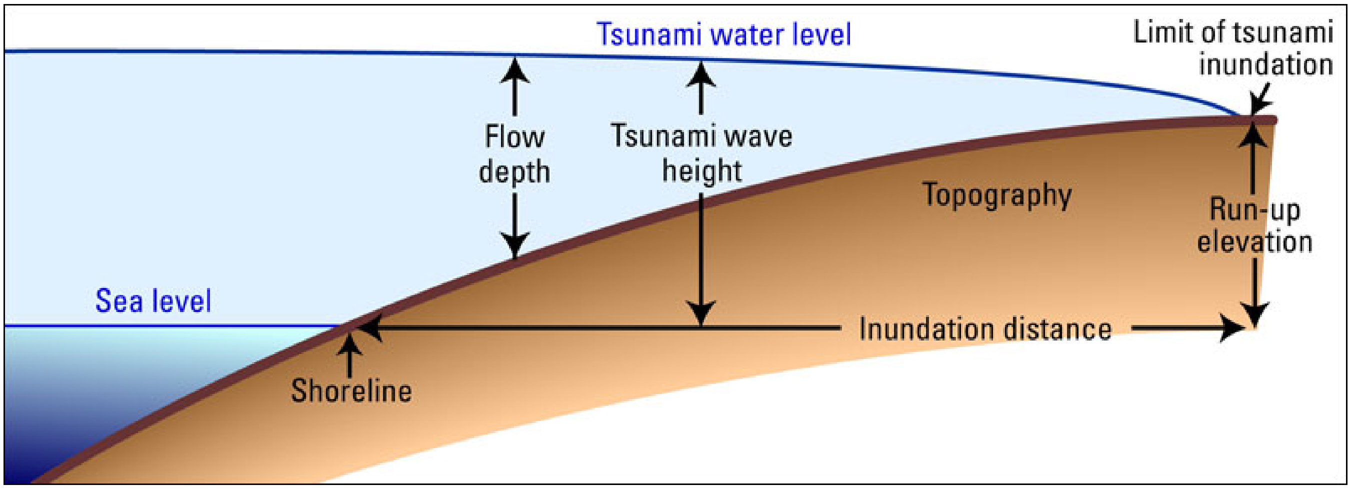
Inundation – The limit of flooding, measured horizontally from the shoreline

Local-Source Tsunami – Originating nearby that may arrive in less than one hour

Run-up – The maximum elevation water reaches onshore, measured from sea level

Tsunamis are a series of enormous waves created by an underwater disturbance such as an earthquake, landslide, volcanic eruption, or meteorite impact. The most common cause is earthquakes (Pacific Tsunami Museum 2022). A tsunami can move hundreds of miles per hour in the open ocean and smash into land with waves as high as 100 feet or more. From the area where the tsunami originates, waves travel outward in all directions. Once the wave approaches the shoreline, it builds in height. The topography of the ocean floor will influence the size of the wave. Figure 4.13-1 illustrates the makeup of a tsunami and associated terminology.

Figure 4.13-1. Illustration of Tsunami Terminology



Source: (U.S. Geological Survey n.d.)

Areas at greatest risk are those less than 25 feet above sea level and within a mile of the shoreline. The most common cause of death associated with tsunamis is drowning. Other hazards associated with tsunamis include flooding, contamination of drinking water, and fires from gas lines or ruptured tanks (International Tsunami Information Center 2023).

Earthquakes generate tsunamis when the sea floor abruptly deforms and displaces the overlying water from its equilibrium position. Waves are formed as the displaced water mass, acting under the influence of gravity, attempts to regain its equilibrium.

The main factor that determines the initial size of a tsunami is the amount of vertical sea floor deformation resulting from subduction zone earthquakes. The earthquake's magnitude, depth, fault characteristics, and coincident slumping of sediments or secondary faulting control the size of the tsunami (National Tsunami Warning Center n.d.). Refer to Section 4.5 (Earthquake) for details on the earthquake hazard.

Tsunamis are characterized as shallow-water waves; the ratio between the water depth and its wave length gets very small. Shallow-water waves are different from wind-generated surf waves. Wind-generated waves usually have a period (time between two successional waves) of 5 to 20 seconds and a wavelength (distance between two successional waves) of about 300 to 600 feet. A tsunami wave can have a period in the range of five minutes to two hours and an open ocean wavelength in excess of 300 miles. It is because of their long wavelengths that tsunamis behave as shallow-water waves. From the area where the tsunami originates, waves travel outward in all directions. Once the wave approaches the shore, it builds height (National Tsunami Warning Center n.d.).

When a tsunami finally reaches the shore, it typically appears as a rapidly rising or falling tide, or as a change in sea level marked by a series of breaking waves. Tsunamis generally appear as an advancing tide without a developed wave face and produce rapid flooding of low-lying coastal areas. Reefs, bays, entrances to rivers, undersea features and the slope of the beach all help to modify the tsunami as it approaches the shore. Because the long-period wave can bend around obstacles, the tsunami can enter bays and gulfs having the most intricate shapes. Unlike storm waves, tsunami waves may be very large in coastal bays, actually experiencing amplification in long funnel-shaped bays. Shorelines protected by reefs typically do not sustain extensive damage from tsunamis as the reefs reflect the wave energy. Low coral islands may experience reduced runup as the tsunami waves may reflect off the steep slopes around them.

LOCATION

All of the Hawaiian Islands can be impacted by tsunami events triggered by local sources or generated along the Pacific Ring of Fire surrounding the state (International Tsunami Information Center 2023). Tsunamis are a threat to life and property for all those living along or near the coastline. They can strike anywhere along the coastline of the State of Hawaiʻi. At sea level on the coast, there is no safe place during a tsunami. On low-lying shorelines, such as in the river and stream valleys that characterize so much of Hawaiʻi, a tsunami may occur as a rapidly growing high tide that rises over several minutes and inundates low coastal regions. The return of these flood waters to the sea causes much damage. At headlands, the refractive focusing of the wave crest leads to energy concentration and high-magnitude runup.

A worst-case scenario for the state is a magnitude 9+ earthquake in the eastern Aleutian Islands. The tsunami from such an earthquake would produce extensive flooding of lowlands throughout the entire State of Hawaiʻi. This extreme tsunami was modeled to understand potential impacts on the state and is called the Great Aleutian Tsunami (GAT). The expected recurrence interval for a GAT is 1,500 years.

The GAT as well as SOEST and ASCE inundation data were provided by the Pacific Disaster Center (PDC) for analysis in the 2023 SHMP Update. Table 4.13-1 shows the inundation areas in square miles and the percent of the total area by county. In general, the inundation areas are larger than the coastal flood inundation area depicted on FEMA FIRMs (discussed in Section 4.6 Flood). The City and County of Honolulu has the largest area that may be inundated (almost 77 square miles), followed by the County of Hawaiʻi. Maps of the inundation areas are presented in Figure 4.13-2 through Figure 4.13-5.

Table 4.13-1. GAT, SOEST, and ASCE Inundation Areas by County

County	Area (in square miles)						
	Total Area	GAT Hazard Area	GAT Hazard Area as Percent of Total Area	SOEST Hazard Area	SOEST Hazard Area as Percent of Total Area	ASCE Hazard Area	ASCE Hazard Area as Percent of Total Area
County of Kauaʻi	624.29	28.75	4.61%	21.04	3.37%	31.78	5.09%
City and County of Honolulu	598.57	55.18	9.22%	20.37	3.40%	76.67	12.81%
County of Maui	1,176.28	16.63	1.41%	11.66	0.99%	24.02	2.04%
County of Hawaiʻi	4,039.64	18.98	0.47%	7.38	0.18%	38.35	0.95%
Total	**6,438.78**	**119.54**	**1.86%**	**60.45**	**0.94%**	**170.82**	**2.65%**

Source: Tetra Tech Requested Data from Doug Bausch 2022

Figure 4.13-2. Great Aleutian Tsunami Inundation Area in the County of Kaua'i

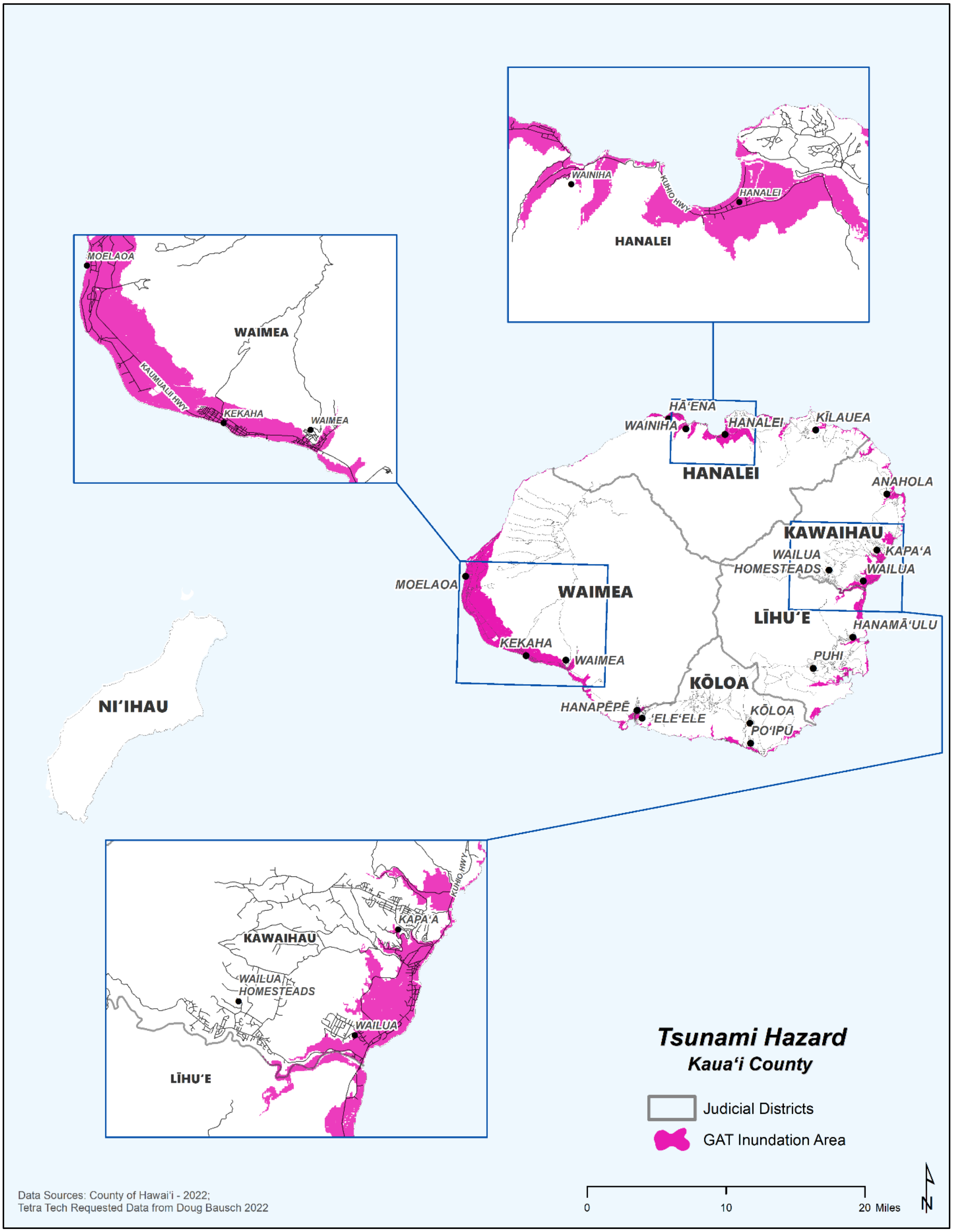


Figure 4.13-3. Great Aleutian Tsunami Inundation Area in the City and County of Honolulu

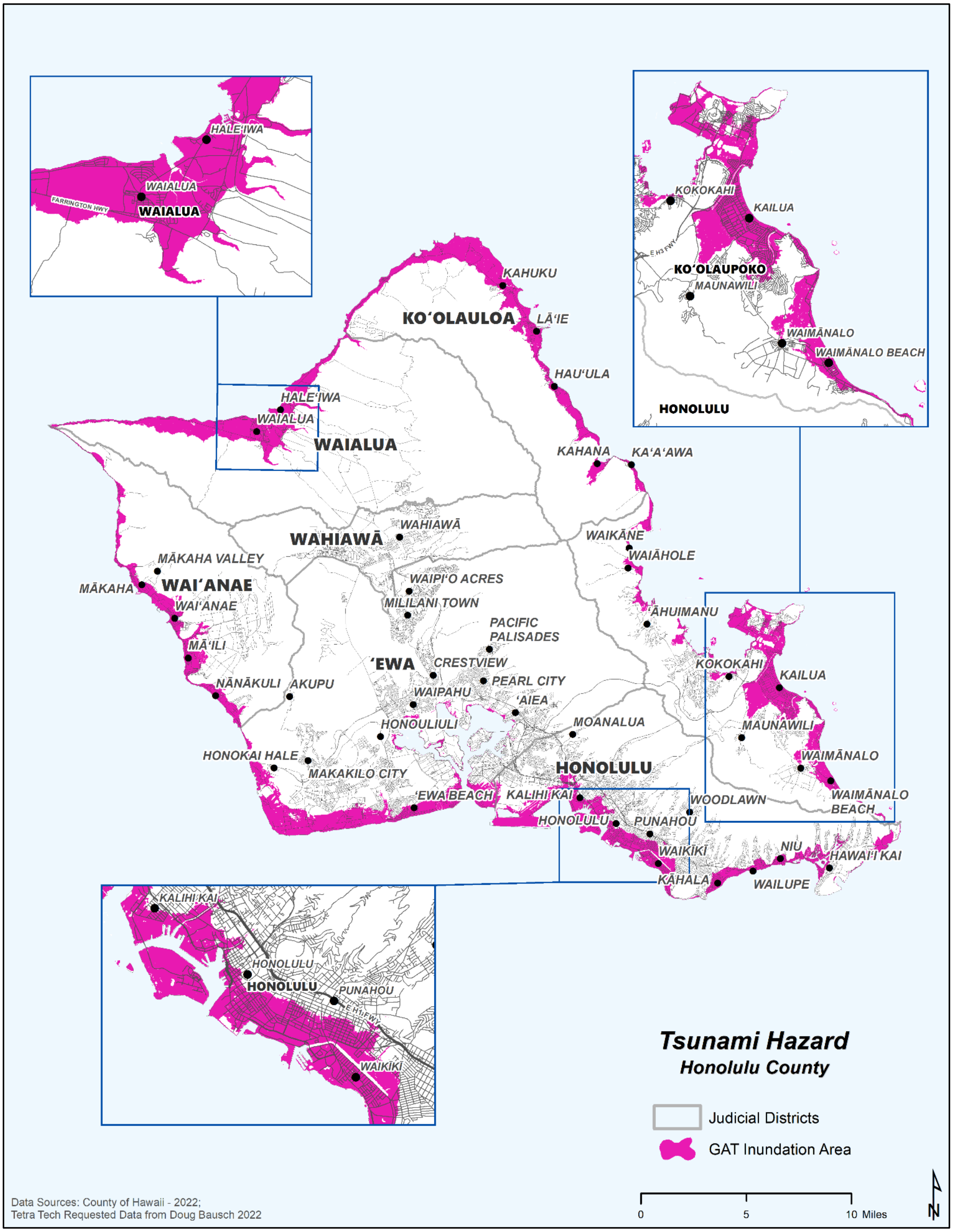


Figure 4.13-4. Great Aleutian Tsunami Inundation Area in the County of Maui

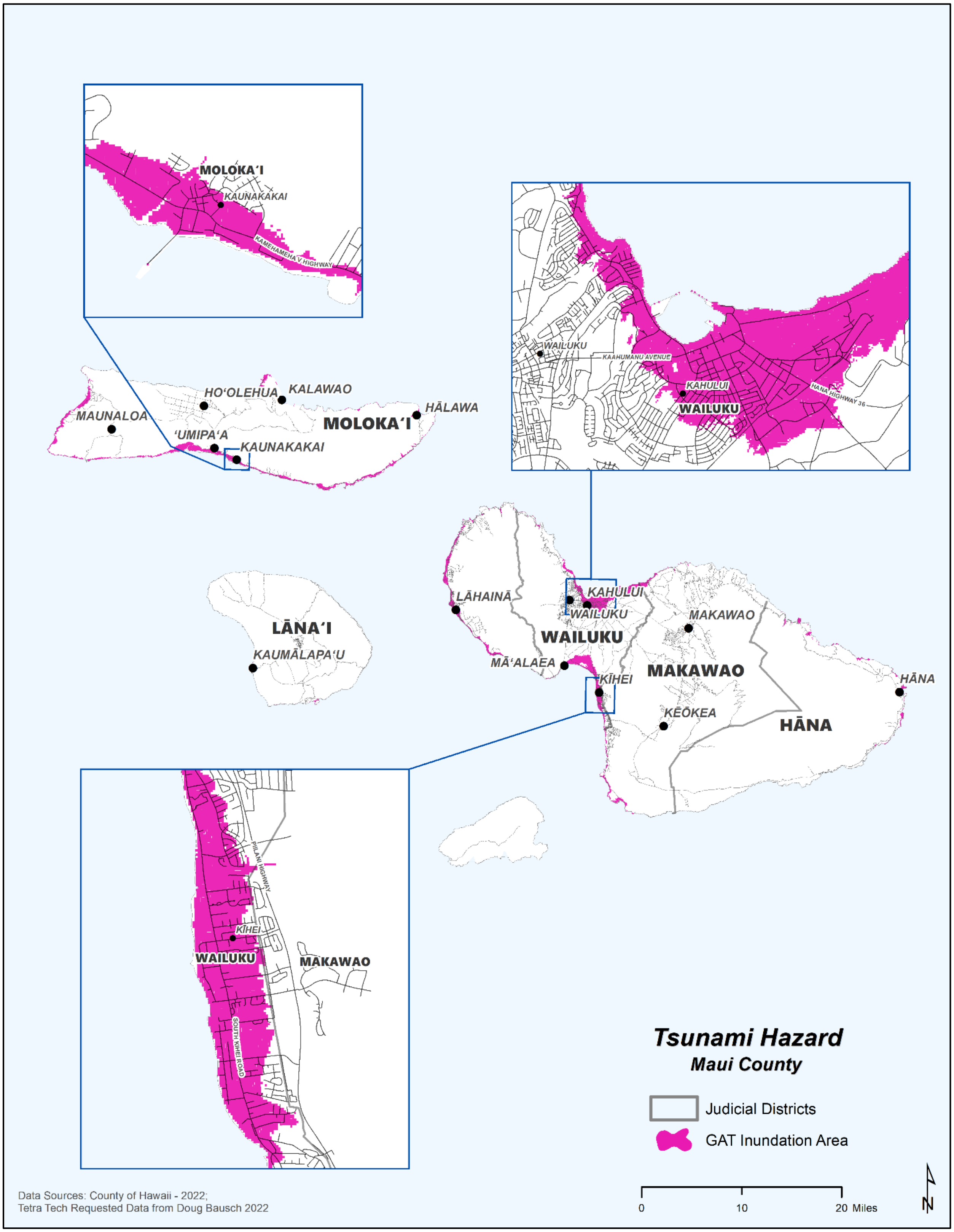
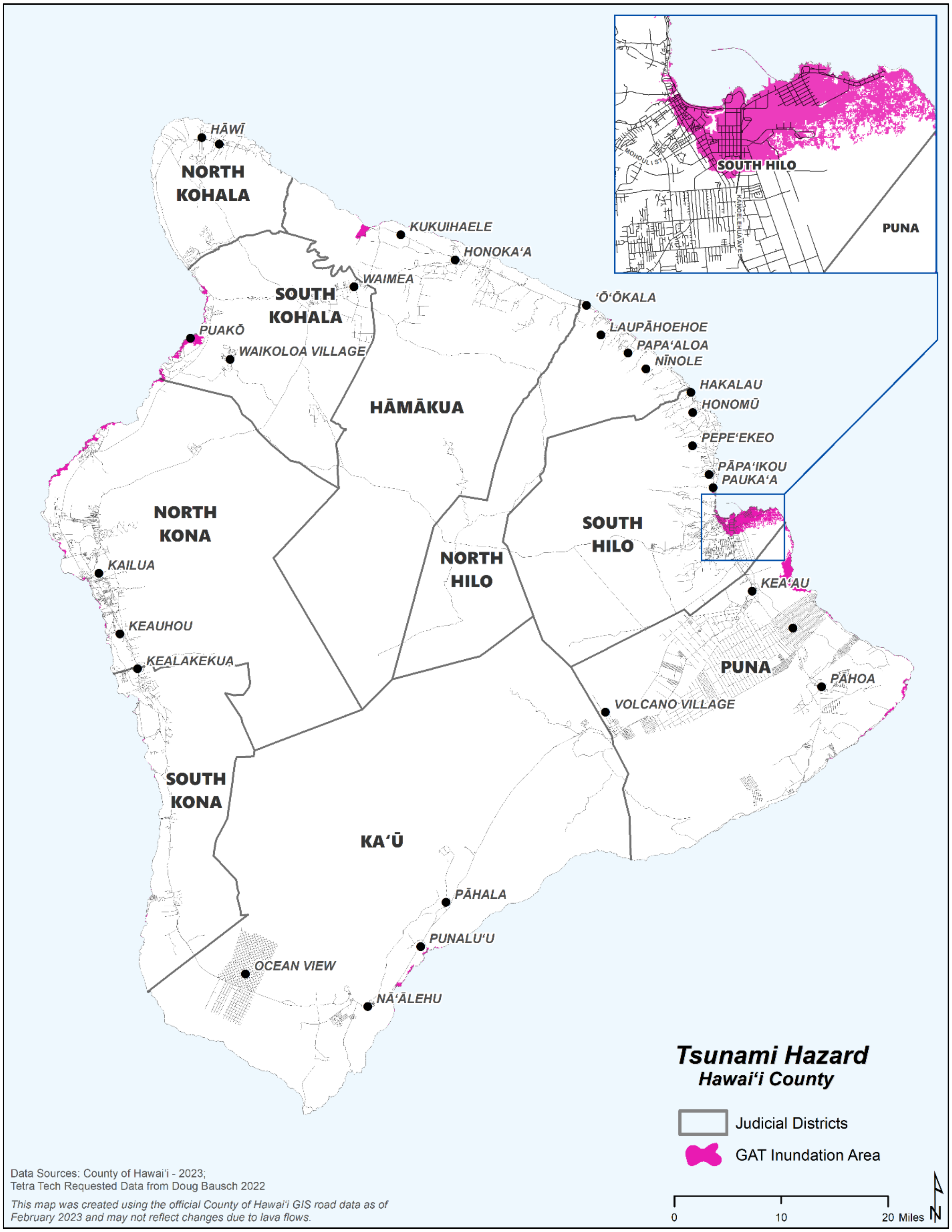


Figure 4.13-5. Great Aleutian Tsunami Inundation Area in the County of Hawaiʻi



EXTENT

A tsunami's effect at the shoreline is measured in terms of runup height and inundation (Figure 4.13-1). Runup and inundation can vary considerably over short distances. Runup tends to be highest at steep shorelines, while inundation is greatest along low-lying coastal plains.

When a tsunami reaches the shore, the water level can rise many feet. In extreme cases, the water level can rise to more than 50 feet for tsunamis of distant origin, and over 100 feet for tsunamis generated near the earthquake's epicenter. The first wave may not be the largest in the series of waves. One coastal area may see no damaging wave activity, while in another area destructive waves can be large and violent. Flooding tsunami waves can carry loose objects and people out to sea when they retreat (Pacific Tsunami Museum 2022). Figure 4.13-6 shows the effects after a flooding tsunami wave has receded.

Figure 4.13-6. Tsunami Wave Receding After Flooding the Pier and Aliʻi Drive in Kailua-Kona, 2011

Source: Pacific Tsunami Museum 2022

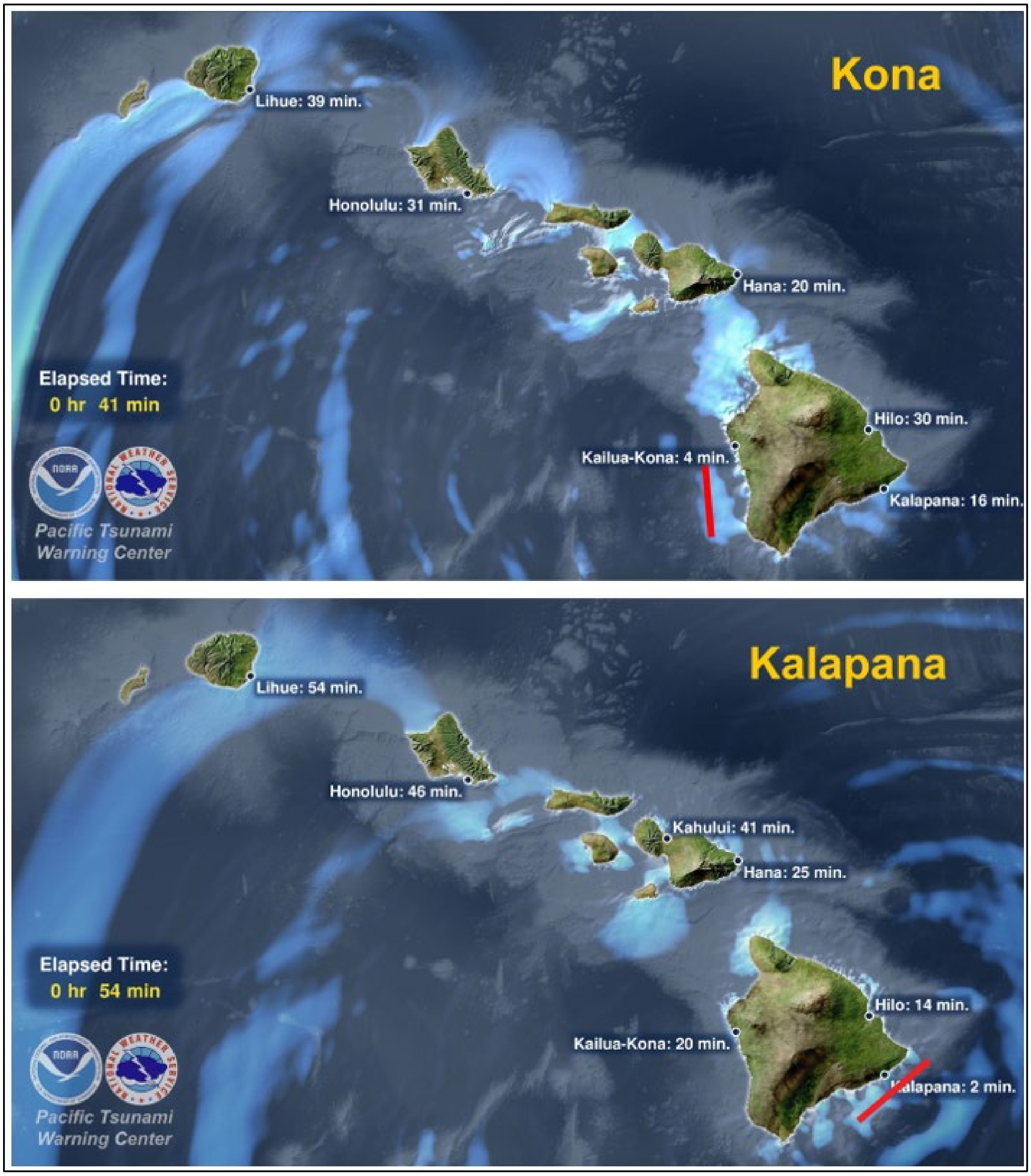
Warning Time

Tsunamis affecting the State of Hawaiʻi may be generated locally or may come from across the ocean. Local tsunamis may be generated by volcanic eruptions, earthquakes, large-scale subsidence or sub-aerial and submarine landslides.

Local-Source Events

Local-source events are most likely to be generated near the County of Hawaiʻi, primarily from earthquakes and large-scale subsidence along the south flank of Kīlauea, or the west flank of Mauna Loa. The local tsunami could reach the coastlines of most major Hawaiian Islands in less than one hour (International Tsunami Information Center 2023). Figure 4.13-7 shows the travel times of tsunamis originated from earthquakes within the Hawaiian Islands.

Figure 4.13-7. Approximate Travel Time of Tsunamis Generated in Hawaiʻi



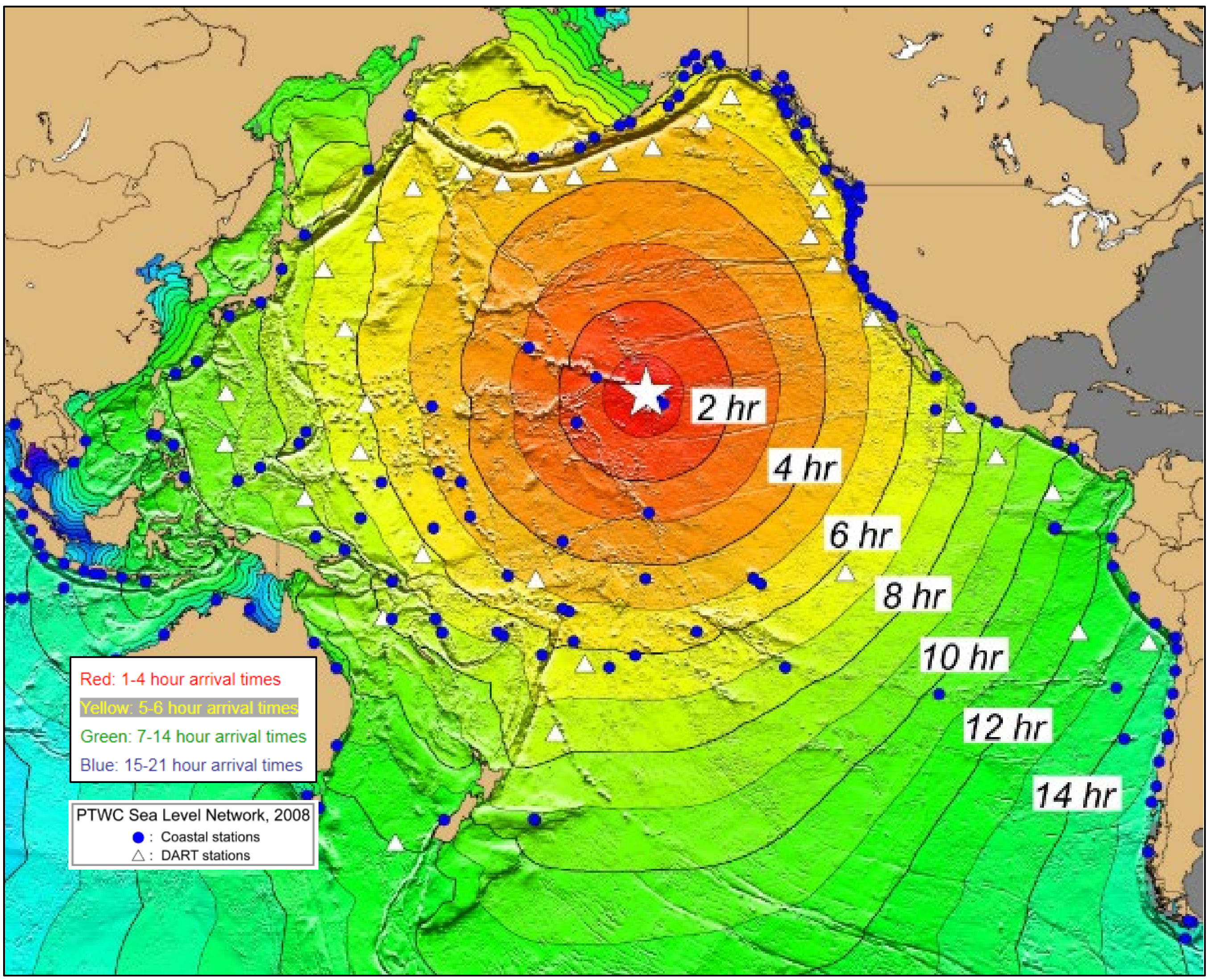
Source: International Tsunami Information Center 2023

Distant-Source Events

Distant-source tsunamis originate from a faraway source, generally more than 600 miles or more than three hours tsunami travel time from its source. The State of Hawai'i is exposed to these types of tsunamis as well. In particular, areas with subduction fault lines, such as the coasts of the State of Alaska's mainland and Aleutian Islands, the States of Washington, Oregon, and California, the countries of Chile and Japan, and Russia's Kamchatka Peninsula, are common places of earthquakes that generate tsunamis that have affected Hawai'i in the past.

Although these tsunamis originate from earthquakes with epicenters far away from Hawai'i, they lose little energy on the open ocean and can cause large devastation when they reach the Hawaiian Islands' coasts. For tsunamis from distant sources, the time for the waves to reach the islands is measured in hours. Figure 4.13-8 shows the travel times of tsunamis originated from earthquakes in the Pacific Rim.

Figure 4.13-8. Tsunami Travel Times to Hawai'i



Source: International Tsunami Information Center 2023

Evacuation Plans and Warning Systems

An effective early warning system is essential in protecting life and property. In the 20th century, an estimated 221 people were killed by tsunamis in Hawaiʻi (U.S. Geological Survey n.d.). Improving techniques and understanding of the tsunami hazard, in particular identifying areas most likely to be flooded, is a continuous effort. Scientists found that a M9.2 earthquake in the eastern Aleutian Islands would generate a tsunami inundation area exceeding flooding observed from past historical events. In response to these findings, additional evacuation maps (Tier 2) were developed for Kauaʻi, Honolulu, and Maui Counties. The Tier 2 evacuation maps represent an unlikely worst-case scenario and do not replace the Tier 1 evacuation maps that are based on historical tsunamis (International Tsunami Information Center 2023).

Tsunami Warning Centers

Tsunami warning centers have been established around the world as part of an international warning system. In the United States, NOAA has two tsunami warning centers that are staffed 24 hours a day, 7 days a week. Their mission is to provide early tsunami warnings on potentially destructive tsunamis and help protect life and property from them. The warning centers monitor for tsunamis and the earthquakes that may cause them, forecast tsunami impacts, and prepare and issue tsunami messages (National Oceanic and Atmospheric Administration 2022).

The Pacific Tsunami Warning Center (PTWC) provides the official tsunami warnings for the State of Hawaiʻi. The PTWCʻs products include: warnings, watches, advisories, information statements, seismic information statements, and warning cancelations (see Figure 4.13-9).

- A **Tsunami Warning** is issued when a potential tsunami with significant widespread inundation is imminent or expected. Generally, this means that the tsunami is expected to run up more than one meter above sea level somewhere in the state. Warnings alert the public that widespread, dangerous coastal flooding accompanied by powerful currents is possible and may continue for several hours after arrival of the initial wave. Warnings also alert emergency management officials to take action for the entire tsunami hazard zone. Appropriate actions to be taken by local officials may include the evacuation of low-lying coastal areas and the repositioning of ships to deep waters when there is time to safely do so. Warnings may be updated, adjusted geographically, downgraded, or canceled. To provide the earliest possible alert, initial warnings are normally based only on seismic information. The warning includes an estimate (usually good to within a few minutes) of when the first tsunami wave will arrive.
- A **Tsunami Advisory** is issued when the tsunami will be too small to require evacuation but is expected to be large enough to make beaches and near shore waters dangerous. Generally, this means that tsunami runup is expected to exceed 0.3 meters somewhere in the state but will not exceed 1.0 meters anywhere. A tsunami advisory means there is threat of a potential tsunami which may produce strong currents or waves dangerous to those in or near the water. Coastal regions historically prone to damage due to strong currents induced by tsunamis are at the greatest risk. The threat may continue for several hours after the arrival of the initial wave, but significant widespread inundation is not expected for areas under an advisory. Appropriate actions to be taken by local officials may include closing beaches, evacuating harbors and marinas, and the repositioning of ships to deep waters when there is time to safely do so. Advisories are normally updated to continue the advisory, expand/contract affected areas, upgrade to a warning, or cancel the advisory.

Figure 4.13-9. Tsunami Alerts

Source: National Oceanic and Atmospheric Administration 2022

- A **Tsunami Watch** is issued to alert emergency management officials and the public of a tsunami which may later impact the watch area. A tsunami watch will always be either upgraded to a warning or advisory—or canceled—based on updated information and analysis. Therefore, emergency management officials and the public should prepare to take action. Watches are normally issued based on seismic information before confirmation that a destructive tsunami has been generated. A tsunami watch is only issued if any potential tsunami is more than three hours away; if the potential tsunami will arrive within three hours a tsunami warning is issued instead.
- A **Tsunami Information Statement** is issued to inform emergency management officials and the public that an earthquake has occurred, but there is no threat of a destructive tsunami in Hawai'i. For earthquakes within the state, information statements are issued to prevent unnecessary evacuations as the earthquake may have been felt. An information statement may, in appropriate situations, caution about the possibility of minor wave activity. Information statements may be re-issued with additional information, though normally these messages are not updated. However, a watch, advisory or warning may be issued for the area, if necessary, after analysis and/or updated information becomes available.
- A **Tsunami Warning Cancelation** is the final product indicating the end of the damaging tsunami threat. A cancelation is usually issued after an evaluation of sea level data confirms that a destructive tsunami will not impact the warned area. In the event of a damaging tsunami, the cancelation is issued after coastal tide gauges show that waves have fallen below the danger level and no further damaging waves are expected (National Tsunami Warning System 2023).

Operational warning sirens for these warnings exist on the most densely populated coastal areas of all islands. When the PTWC issues a tsunami warning, a steady three-minute siren tone is the attention alert signal (International Strategy for Disaster Reduction n.d.).

Deep-ocean Assessment and Reporting of Tsunami (DART)

To detect tsunamis in real time as they travel across the open ocean, NOAA developed a tsunami measurement system called Deep-ocean Assessment and Reporting of Tsunami (DART). Figure 4.13-10 depicts the operation of the DART system.

The information collected by a network of DART systems positioned at strategic locations throughout the ocean plays a critical role in tsunami forecasting. There are 60 systems located throughout the world, with a majority of them located in the Pacific Ocean. There is one DART system located west of Kailua-Kona.

When a tsunami occurs, the first information available, from the worldwide network of seismometers, is about the earthquake source. That is enough to send out an initial warning message. As the tsunami wave propagates across the ocean and reaches coastal tide gauges or the DART systems, sea level measurements are reported back to the Tsunami Warning Centers – National Tsunami Warning Center in Palmer, Alaska, and PTWC in Honolulu, Hawaiʻi. The information from the DART systems are processed at the warning centers to produce a new and more refined estimated of the tsunami source. The result is an increasingly accurate forecast of the tsunami that can be used to issue refine watches and warnings (National Oceanic and Atmospheric Administartion n.d.).

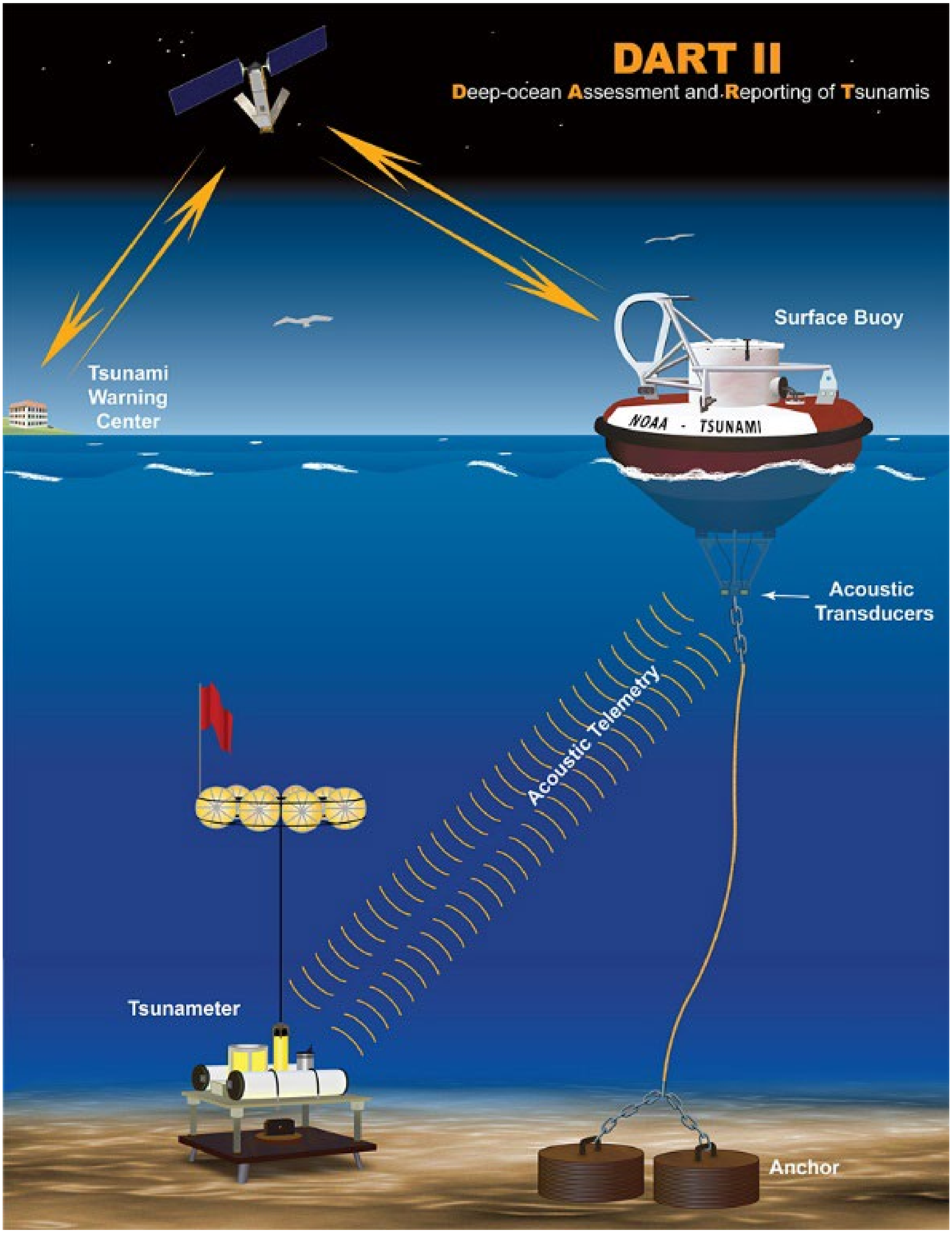
Tsunami Warning Sirens

Each county in Hawaiʻi is responsible for tsunami evacuations and issuing the all-clear. For distant-source tsunamis, the HI-EMA coordinates the statewide sounding of the first tsunami warning siren. Subsequent siren soundings are the responsibility of each county. If evacuation is necessary, the sirens will be activated. The sirens exist on the most densely populated coastal areas of all Hawaiian Islands. They are tested monthly. When the PTWC issues a warning, a steady three-minute siren tone is the attention alert signal (International Strategy for Disaster Reduction n.d., International Strategy for Disaster Reduction n.d.).

Runup Detector System

PTWC measures tsunamis within Hawaiʻi at 12 tide gauges throughout the state as well as at the DART off Kailua-Kona (National Centers for Environmental Information 2022). For a local-source tsunami, these data are not available fast enough to issue a useful warning, so in the early 2000s, a new runup detector system was installed close to potential sources on the Island of Hawaiʻi. Each sensor is a device on land, within 50 yards of the ocean, which sounds an alarm at PTWC if it gets wet. Six of these sensors are distributed along the southwest and southeast shorelines of Hawaiʻi Island. If two adjacent sensors are flooded within a few minutes of each other, regardless of whether or not there is an earthquake, PTWC will issue the appropriate local tsunami warning. In the event of an earthquake, PTWC will issue a warning within three minutes, several minutes before the tsunami reaches land. The runup detectors then serve simply to corroborate the warning since the warning will already have been issued. But if there is no earthquake, as in the case of a tsunami generated by a spontaneous landslide, the runup sensors allow a warning to be issued for the adjacent coast. The runup sensors therefore serve as a failsafe system.

Figure 4.13-10. DART II System



Source: National Weather Service n.d.

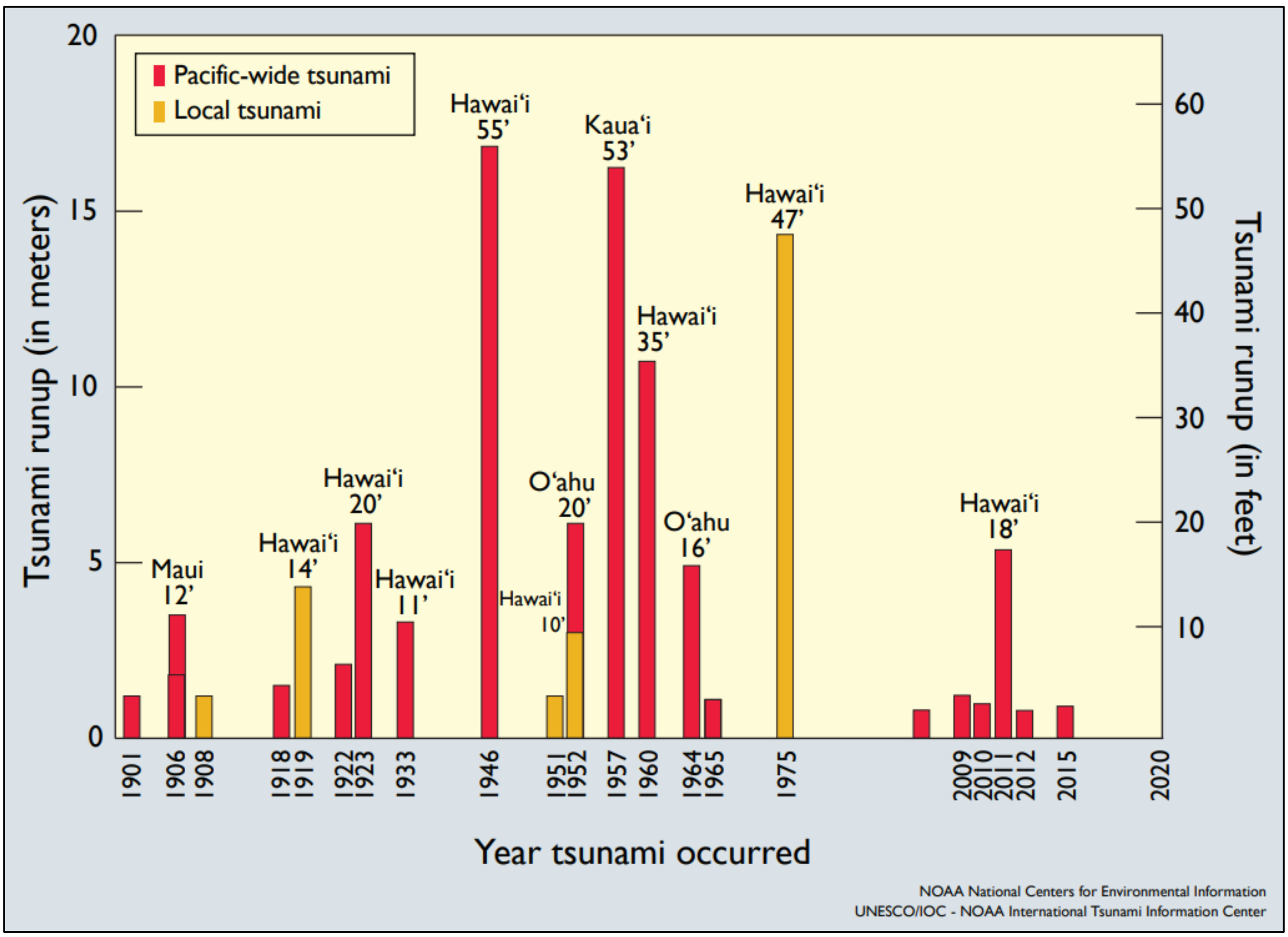
Previous Occurrences and Losses

The earliest historical account of a Hawaiʻi tsunami was from a 16th century Hawaiian chant that described a huge wave that struck the coast of Molokaʻi. The earliest written record of a tsunami in the state was on December 21, 1812, when a wave from southern California was observed at Hoʻokena on the west coast of the Island of Hawaiʻi. Since 1812, there have been more than 160 confirmed tsunamis in the state, resulting in over 2,000 runup observations. Nine of the confirmed tsunamis caused 293 deaths and damages, totaling over $625 million (International Tsunami Information Center 2023).

From 1812 to December 2022, eight tsunamis had significant damaging effects in the state, based on number of deaths, injuries, and damages (National Centers for Environmental Information 2022).

In the 120 years between 1900 and 2020, 12 tsunamis in Hawaiʻi have had runups of 10 feet or more (Figure 4.13-11).

Figure 4.13-11. Hawaiʻi Tsunami Runups, 1900-2020



Source: International Tsunami Information Center 2023

Many sources provided tsunami information regarding previous occurrences and losses associated with these events throughout the State of Hawaiʻi. The 2018 Plan discussed specific tsunami events that impacted Hawaiʻi through 2017. For this 2023 SHMP Update, tsunami events and associated runups were summarized between January 1, 2018, and December 31, 2022. According to the NOAA National Centers for Environmental Information database, between 2018 and 2022, there have been no recorded tsunamis that originated in Hawaiʻi. However, Hawaiʻi has experienced impacts of recent tsunami events in the form of runups.

Disaster and Emergency Declarations

The following disaster declarations or emergency proclamations related to the tsunami hazard have been issued for Hawaiʻi:

- **Federal disaster (DR) or emergency (EM) declarations, 1955 – 2022**: 1 event, classified as tsunami
- **Hawaiʻi state emergency proclamations, 2018 – 2022**: none
- **USDA agricultural disaster declarations, 2012 – 2022**: none

Table 4.13-2 includes details of tsunami and runup events that occurred in the state between 2018 and 2022. For events prior to 2018, please refer to Appendix E (Hazard Profile Supplement). Based on all sources researched, the State of Hawaiʻi was not included in any FEMA tsunami-related declarations between 2018 and 2022. For details regarding all declared disasters, refer to Section 4.1 (Overview) and Appendix D (Map Atlas).

Table 4.13-2. Tsunami Events in Hawaiʻi, 2018 to 2022

Date(s) of Event	Event Type	Counties Affected	Description
January 23, 2018	Tsunami Runup	Kauaʻi, Honolulu, Maui, Hawaiʻi	The source of the tsunami was in Kodiak Island, Alaska. The maximum runup (elevation water reached onshore) of this tsunami near the source was 0.25 meters. Runup was measured in all counties: • Honolulu (Honolulu) had a maximum water height of 0.03 meters • Kahului (Maui) had a maximum water height of 0.12 meters • Hanalei (Kauaʻi) had a maximum water height of 0.13 meters • Nāwiliwili (Kauaʻi) had a maximum water height of 0.03 meters • Mokuoloʻe-Coconut Island (Honolulu) had a maximum water height of 0.03 meters • Makapuʻu Point (Honolulu) had a maximum water height of 0.14 meters • Kawaihae (Hawaiʻi) had a maximum water height of 0.07 meters • Honokōhau (Hawaiʻi) had a maximum water height of 0.04 meters • Hilo (Hawaiʻi) had a maximum water height of 0.18 meters
May 4, 2018	Tsunami Runup	Kauaʻi, Honolulu, Maui, Hawaiʻi	The source of the tsunami was in Hawaiʻi from the magnitude 6.9 earthquake, part of the Kīlauea volcanic eruption sequence. The maximum near-source runup of this tsunami was 0.4 meters. Runup was measured in all counties: • Kawaihae (Hawaiʻi) had a maximum water height of 0.16 meters • Honuʻapo (Hawaiʻi) had a maximum water height of 0.15 meters • Kahului (Maui) had a maximum water height of 0.15 meters • Hilo (Hawaiʻi) had a maximum water height of 0.2 meters • Kapoho (Hawaiʻi) had a maximum water height of 0.4 meters • Honolulu (Honolulu) had a maximum water height of 0.03 meters • Nāwiliwili (Kauaʻi) had a maximum water height of 0.04 meters

Date(s) of Event	Event Type	Counties Affected	Description
December 5, 2018	Tsunami Runup	Honolulu, Hawaiʻi	The source of the tsunami was in the Loyalty Islands, New Caledonia. The maximum runup of this tsunami near the source was 2.0 meters. Runup was measured in Honolulu and Hawaiʻi counties: • Kawaihae (Hawaiʻi) had a maximum water height of 0.05 meters • Honolulu (Honolulu) had a maximum water height of 0.03 meters
March 25, 2020	Tsunami Runup	Honolulu, Maui, Hawaiʻi	The source of the tsunami was in the North Kuril Islands, Russia. The maximum runup of this tsunami near the source was 0.5 meters. Runup was measured in Honolulu, Maui, and Hawaiʻi counties: • Hilo (Hawaiʻi) had a maximum water height of 0.07 meters • Kahului (Maui) had a maximum water height of 0.08 meters • Haleʻiwa (Honolulu) had a maximum water height of 0.05 meters
October 19, 2020	Tsunami Runup	Kauaʻi, Honolulu, Maui, Hawaiʻi	The source of the tsunami was in the Shumagin Islands, Alaska. The maximum runup of this tsunami near the source was 0.76 meters. Runup was measured in all counties: • Kahului (Maui) had a maximum water height of 0.13 meters • Hanalei (Kauaʻi) had a maximum water height of 0.26 meters • Haleʻiwa (Honolulu) had a maximum water height of 0.19 meters • Kawaihae (Hawaiʻi) had a maximum water height of 0.05 meters • Hilo (Hawaiʻi) had a maximum water height of 0.28 meters • Mokuoloʻe-Coconut Island (Honolulu) had a maximum water height of 0.02 meters • Nāwiliwili (Kauaʻi) had a maximum water height of 0.09 meters
March 4, 2021	Tsunami Runup	Kauaʻi, Honolulu, Maui, Hawaiʻi	The source of the tsunami was in the Kermadec Islands, New Zealand. The maximum runup of the tsunami near the source was not recorded due to power and communication outages. Runup was measured in all counties: • Nāwiliwili (Kauaʻi) had a maximum water height of 0.06 meters • Honolulu (Honolulu) had a maximum water height of 0.08 meters • Waimānalo (Honolulu) had a maximum water height of 0.1 meters • Kahului (Maui) had a maximum water height of 0.18 meters • Kawaihae (Hawaiʻi) had a maximum water height of 0.07 meters • Barbers Point (Honolulu) had a maximum water height of 0.01 meters • Haleʻiwa (Honolulu) had a maximum water height of 0.05 meters • Hilo (Hawaiʻi) had a maximum water height of 0.09 meters
July 29, 2021	Tsunami Runup	Maui, Hawaiʻi	The source of the tsunami was in Kodiak Island, Alaska. The maximum runup of this tsunami near the source was 0.42 meters. Runup was measured in Maui and Hawaiʻi Counties: • Hilo (Hawaiʻi) had a maximum water height of 0.12 meters • Kahului (Maui) had a maximum water height of 0.13 meters
August 12, 2021	Tsunami Runup	Kauaʻi, Honolulu, Maui, Hawaiʻi	The source of the tsunami was in the Southern Atlantic Ocean. Runup was measured in all counties: • Honokōhau (Hawaiʻi) had a maximum water height of 0.06 meters • Honuʻapo (Hawaiʻi) had a maximum water height of 0.02 meters • Honolulu (Honolulu) had a maximum water height of 0.04 meters • Hilo (Hawaiʻi) had a maximum water height of 0.17 meters • Kahului (Maui) had a maximum water height of 0.17 meters • Kawaihae (Hawaiʻi) had a maximum water height of 0.09 meters • Haleʻiwa (Honolulu) had a maximum water height of 0.04 meters • Nāwiliwili (Kauaʻi) had a maximum water height of 0.06 meters

Date(s) of Event	Event Type	Counties Affected	Description
January 15, 2022	Tsunami Runup	Kauaʻi, Honolulu, Maui, Hawaiʻi	The source of the tsunami was the volcanic eruption of Hunga Tonga-Hunga Haʻapai Volcano in Tonga. The maximum runup of this tsunami near the source was 22.0 meters. Honolulu County sustained $3.32 million in damages and Hawaiʻi County had $75,000 in damages. Runup was measured in all counties: • Haleʻiwa (Honolulu) had a maximum water height of 0.69 meters • D51407 BPR (Honolulu) had a maximum water height of 0.05 meters • Makapuʻu Point (Honolulu) had a maximum water height of 0.86 meters • Honokōhau (Hawaiʻi) had a maximum water height of 0.34 meters • Honolulu (Honolulu) had a maximum water height of 0.12 meters • Kahului (Maui) had a maximum water height of 0.83 meters • Barbers Point (Honolulu) had a maximum water height of 0.19 meters • Kawaihae (Hawaiʻi) had a maximum water height of 0.37 meters • Hawaiʻi County (all) had a maximum water height of 1.0 meters • Nāwiliwili (Kauaʻi) had a maximum water height of 0.31 meters • Waimānalo (Honolulu) had a maximum water height of 0.28 meters • Hanalei (Kauaʻi) had a maximum water height of 0.82 meters

Source: (National Centers for Environmental Information 2022)
Note:
Not all sources may have been identified in order to be researched for this 2023 SHMP Update. Additionally, loss and impact information for many events could vary depending on the source. Therefore, Table 4.13-2 may not include all events that have occurred in or impacted the state and the accuracy of monetary figures discussed is based only on the available information identified during research for this 2023 SHMP Update.

Probability of Future Hazard Events

Overall Probability

Tsunamis are caused by earthquakes, landslides, and volcanic eruptions, so the frequency of tsunamis depends on these other geological events. Generally, four to five tsunamis occur every year in the Pacific Basin, though these are usually hazardous only close to the source. Every five years or so, a tsunami is generated which is large enough to threaten coastlines on the far side of the ocean from its source. Based on information from the National Centers for Environmental Information, since 1812, 61 tsunamis have produced a runup of greater than 0.3 meters (the threshold for issuing a tsunami advisory) somewhere in the State of Hawaiʻi. Of these, 35 produced a runup greater than one meter (the threshold for coastal flooding and, therefore, the threshold for issuing a tsunami warning). Based on these data, the State of Hawaiʻi should expect a potentially damaging tsunami, one requiring coastal evacuation, approximately once every six years. The State of Hawaiʻi has roughly a 17 percent chance of a damaging tsunami occurring in any given year.

The probability of advisory-level tsunamis, those for which evacuation is unnecessary but which may create dangerous coastal currents, is at least double that of the larger, warning-level tsunamis; the historical record for these smaller events is likely incomplete before about 1910. Very roughly, the State of Hawaiʻi should expect a tsunami advisory once every three years, or about a 34% chance in any year.

Climate Change Impacts

The warming of the atmosphere and the oceans and melting of ice sheets and glaciers is causing the global mean sea level to rise. Higher sea levels will exacerbate the extent of coastal inundation from a tsunami. The Intergovernmental Panel on Climate Change 6th Assessment Report predicts up to 7.89 feet of sea level rise for the Pacific Islands by 2100 (NASA 2022). This would have devastating impacts on the State of Hawaiʻi. Rising sea levels will increase the extent of coastal flooding from tsunamis as they create waves that flood low-lying coastal areas (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017). What rising sea level means for tsunami preparedness is that the evacuation maps should be reassessed periodically, probably once a decade.

The earthquakes and landslides that create tsunamis could be impacted by climate change. Some scientists say that melting glaciers could induce tectonic activity. Heavy rainfall from storm events could cause soil instability that may increase the likelihood of landslides into water bodies, which can generate tsunamis. Rising seas could result in an increase in wave runup when tsunamis occur. Even modest rises in sea level will dramatically increase the frequency and intensity of flooding when a tsunami occurs, as the tsunami can travel further inland, especially in low-lying coastal plains. Future smaller tsunamis could have the same impact as larger tsunamis today. A warming climate can increase the risk of landslides, thereby increasing the risk of local tsunamis.

4.13.2 VULNERABILITY ASSESSMENT

Tsunami Hazard Area Scenarios

Spatial data, provided by the Pacific Disaster Center, were used to assess exposure and potential loss to the tsunami hazard using the following three scenarios:

- Great Aleutian Tsunami (GAT) (1,500-year)
- School of Ocean & Earth Science & Technology (SOEST) Historic (200-year)
- American Society of Civil Engineers (ASCE) Design Inundation Mapping (3,500-year probabilistic event based on aggregated sources)

A statewide tsunami analysis was conducted based on best available data for the State of Hawaiʻi. The GAT, SOEST, and ASCE inundation areas and Hazus reports were provided by the PDC including building damage and loss, displaced population and potential casualties for each county, for use in the 2023 SHMP Update.

ASSESSMENT OF STATE VULNERABILITY AND POTENTIAL LOSSES

This section discusses statewide vulnerability of areas susceptible to the tsunami hazard and potential losses to state assets (state-owned or state-leased buildings), state roads and critical facilities.

State Assets

The spatial analysis identified 1,204 state buildings in the GAT inundation area. Of these buildings, the greatest number are located in the City and County of Honolulu (801 buildings with a replacement cost value of $3.384 billion); the majority of these buildings are occupied by the Department of Education and University of Hawaiʻi.

Table 4.13-3 and Table 4.13-6 summarize the state buildings located in the GAT inundation area by county and state agency, respectively.

The spatial analysis determined there are 420 state buildings located in the SOEST inundation area. Of these buildings, the greatest number are located in the City and County of Honolulu (231 buildings with a replacement cost value of $994 million); the majority of these buildings are occupied by the Department of Education and University of Hawaiʻi. Table 4.13-4 and Table 4.13-7 summarize the state buildings located in the SOEST inundation area by county and state agency, respectively.

The spatial analysis determined there are 1,474 state buildings located in the ASCE inundation area. Of these buildings, the greatest number are located in the City and County of Honolulu (989 buildings with a replacement cost value of $4.683 billion); the majority of these buildings are occupied by the Department of Education and University of Hawaiʻi. Table 4.13-5 and Table 4.13-8 summarize the state buildings located in the ASCE inundation area by county and state agency, respectively.

State roads are vulnerable to tsunami inundation. Not only will these roads become flooded and may experience extensive damage, but the debris carried by the tsunami may be deposited on the roadway surfaces. Roads may take months to repair and reopen, causing communities to become isolated. Table 4.13-9 shows the length of state roads in the GAT inundation area by county. The City and County of Honolulu has the greatest number of miles exposed (86 miles), followed by the County of Maui (28.5 miles). Table 4.13-10 shows the length of state roads in the SOEST inundation area by county. The City and County of Honolulu has the greatest number of miles exposed (46.2 miles), followed by the County of Maui (20.8 miles). Table 4.13-11 shows the length of state roads in the ASCE inundation area by county. The City and County of Honolulu has the greatest number of miles exposed (103.2 miles), followed by the County of Maui (38.8 miles). A complete list of state roads located in the GAT, SOEST, and ASCE inundation areas is included in Appendix F (State Profile and Risk Assessment Supplement).

Community Lifelines and Critical Facilities

Table 4.13-12 summarizes the number of community lifelines and critical facilities located in the GAT inundation area by county and core category. The City and County of Honolulu has the greatest number of critical facilities (194) exposed, followed by the County of Maui (98 critical facilities). Table 4.13-15 summarizes the number of facilities and replacement cost exposed by core category. The Energy core category has 49.44% of its facilities located in the tsunami hazard area, followed by Transportation (42.86%) and Food, Water, Shelter (35.36%).

Table 4.13-13 summarizes the number of community lifelines and critical facilities located in the SOEST inundation area by county and core category. The County of Maui has the greatest number of critical facilities (71) exposed, followed by the City and County of Honolulu (60 critical facilities). Table 4.13-16 summarizes the number of facilities and replacement cost exposed by core category. The Energy core category has 30.34% of its facilities located in the tsunami hazard area, followed by Transportation (28.57%) and Food, Water, Shelter (21.45%).

Table 4.13-14 summarizes the number of community lifelines and critical facilities located in the ASCE inundation area by county and core category. The City and County of Honolulu has the greatest number of critical facilities (242) exposed, followed by the County of Maui (107 critical facilities). Table 4.13-17 summarizes the number of facilities and replacement cost exposed by core category. The Energy core category has 56.18% of its facilities located in the tsunami hazard area, followed by Transportation (41.07%) and Food, Water, Shelter (38.55%).

Table 4.13-3. State Buildings Exposure to the GAT Inundation Area by County

County	Total Number of State Buildings	Total Replacement Cost Value	State Buildings in the Tsunami Hazard Area			
			Number	Percent (%) of Total	Total Replacement Cost Value	Percent (%) of Total
County of Kaua'i	531	$990,850,824	110	20.72%	$243,280,131	24.55%
City and County of Honolulu	3,472	$17,393,945,915	801	23.07%	$3,384,627,763	19.46%
County of Maui	831	$3,097,491,689	161	19.37%	$595,279,795	19.22%
Count of Hawai'i	1,261	$4,638,567,141	132	10.47%	$576,473,135	12.43%
Total	**6,095**	**$26,120,855,568**	**1,204**	**19.75%**	**$4,799,660,824**	**18.37%**

Source: Tetra Tech Requested Data from Doug Bausch 2022; State of Hawai'i Risk Management Office 2017

Table 4.13-4. State Buildings Exposure to the SOEST Inundation Area by County

County	Total Number of State Buildings	Total Replacement Cost Value	State Buildings in the Tsunami Hazard Area			
			Number	Percent (%) of Total	Total Replacement Cost Value	Percent (%) of Total
County of Kaua'i	531	$990,850,824	48	9.04%	$157,173,901	15.86%
City and County of Honolulu	3,472	$17,393,945,915	231	6.65%	$994,231,118	5.72%
County of Maui	831	$3,097,491,689	66	7.94%	$258,541,414	8.35%
Count of Hawai'i	1,261	$4,638,567,141	75	5.95%	$127,144,842	2.74%
Total	**6,095**	**$26,120,855,568**	**420**	**6.89%**	**$1,537,091,275**	**5.88%**

Source: Tetra Tech Requested Data from Doug Bausch 2022; State of Hawai'i Risk Management Office 2017

Table 4.13-5. State Buildings Exposure to the ASCE Inundation Area by County

County	Total Number of State Buildings	Total Replacement Cost Value	State Buildings in the Tsunami Hazard Area			
			Number	Percent (%) of Total	Total Replacement Cost Value	Percent (%) of Total
County of Kaua'i	531	$990,850,824	89	16.76%	$186,412,528	18.81%
City and County of Honolulu	3,472	$17,393,945,915	989	28.49%	$4,683,551,419	26.93%
County of Maui	831	$3,097,491,689	254	30.57%	$640,976,500	20.69%
Count of Hawai'i	1,261	$4,638,567,141	142	11.26%	$499,902,903	10.78%
Total	**6,095**	**$26,120,855,568**	**1,474**	**24.18%**	**$6,010,843,350**	**23.01%**

Source: Tetra Tech Requested Data from Doug Bausch 2022; State of Hawai'i Risk Management Office 2017

Table 4.13-6. State Buildings Exposure to the GAT Inundation Area by State Agency

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Hazard Area	Percent (%) of Total Buildings	Replacement Cost Value in the Hazard Area	Percent (%) of Total Value
Dept of Accounting & General Services	66	$953,963,738	17	25.76%	$225,705,367	23.66%
Dept of Agriculture	70	$147,607,399	25	35.71%	$47,526,939	32.20%
Dept of Attorney General	15	$108,425,480	6	40.00%	$34,366,693	31.70%
Dept of Budget & Finance	16	$28,968,679	6	37.50%	$22,172,194	76.54%
Dept of Business, Economic Development and Tourism	25	$645,480,379	6	24.00%	$560,518,082	86.84%
Dept of Commerce & Consumer Affairs	2	$40,197,360	1	50.00%	$35,605,036	88.58%
Dept of Defense	69	$267,352,836	12	17.39%	$38,237,951	14.30%
Dept of Education	4,090	$10,598,205,739	774	18.92%	$1,738,645,173	16.41%
Dept of Hawaiian Home Lands	12	$110,427,352	2	16.67%	$7,414,080	6.71%
Dept of Health	44	$387,068,440	7	15.91%	$11,154,835	2.88%
Dept of Human Resources Development	1	$5,973,872	0	0.00%	$0	0.00%
Dept of Human Services	130	$480,212,294	46	35.38%	$274,328,048	57.13%
Dept of Labor and Industrial Relations	22	$90,076,209	6	27.27%	$62,294,284	69.16%
Dept of Land and Natural Resources	90	$101,441,821	36	40.00%	$21,054,311	20.76%
Dept of Public Safety	154	$440,774,415	27	17.53%	$66,868,409	15.17%
Dept of Taxation	1	$7,174,162	1	100.00%	$7,174,162	100.00%
Dept of Transportation	68	$2,935,208,214	42	61.76%	$478,935,460	16.32%
Hawaiʻi State Ethics Commission	1	$984,533	0	0.00%	$0	0.00%
Hawaiʻi Health Systems Corporation	106	$1,230,852,871	1	0.94%	$936,734	0.08%
Hawaiʻi Housing Finance & Development Corporation	86	$360,851,671	16	18.60%	$156,215,306	43.29%
Hawaiʻi Public Housing Authority	273	$982,981,701	44	16.12%	$107,913,043	10.98%
Hawaiʻi State Legislature	2	$48,555,381	0	0.00%	$0	0.00%
Hawaiʻi State Public Library System	53	$525,584,082	17	32.08%	$49,960,772	9.51%
Judiciary	41	$534,877,354	12	29.27%	$165,922,633	31.02%
Legislative Reference Bureau	1	$2,996,162	0	0.00%	$0	0.00%
Office of Hawaiian Affairs	11	$54,125,645	7	63.64%	$43,813,415	80.95%
Office of the Auditor	2	$1,921,180	0	0.00%	$0	0.00%
Office of the Governor	1	$2,996,162	0	0.00%	$0	0.00%
Office of the Lieutenant Governor	2	$4,588,849	0	0.00%	$0	0.00%
Office of the Ombudsman	1	$1,818,060	0	0.00%	$0	0.00%
Research Corporation of the University of Hawaiʻi	3	$4,189,026	0	0.00%	$0	0.00%
University of Hawaiʻi	637	$5,014,974,503	92	14.44%	$641,913,366	12.80%
Total	**6,095**	**$26,120,855,568**	**1,203**	**19.74%**	**$4,798,676,291**	**18.37%**

Source: Tetra Tech Requested Data from Doug Bausch 2022; State of Hawai'i Risk Management Office 2017

Table 4.13-7. State Buildings Exposure to the SOEST Inundation Area by State Agency

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Hazard Area	Percent (%) of Total Buildings	Replacement Cost Value in the Hazard Area	Percent (%) of Total Value
Dept of Accounting & General Services	66	$953,963,738	5	7.58%	$34,904,592	3.66%
Dept of Agriculture	70	$147,607,399	7	10.00%	$17,187,559	11.64%
Dept of Attorney General	15	$108,425,480	2	13.33%	$17,236,498	15.90%
Dept of Budget & Finance	16	$28,968,679	1	6.25%	$4,806,631	16.59%
Dept of Business, Economic Development and Tourism	25	$645,480,379	3	12.00%	$546,896,699	84.73%
Dept of Commerce & Consumer Affairs	2	$40,197,360	0	0.00%	$0	0.00%
Dept of Defense	69	$267,352,836	9	13.04%	$29,801,107	11.15%
Dept of Education	4,090	$10,598,205,739	255	6.23%	$390,999,952	3.69%
Dept of Hawaiian Home Lands	12	$110,427,352	1	8.33%	$1,925,000	1.74%
Dept of Health	44	$387,068,440	5	11.36%	$9,934,532	2.57%
Dept of Human Resources Development	1	$5,973,872	0	0.00%	$0	0.00%
Dept of Human Services	130	$480,212,294	18	13.85%	$28,959,968	6.03%
Dept of Labor and Industrial Relations	22	$90,076,209	2	9.09%	$2,790,797	3.10%
Dept of Land and Natural Resources	90	$101,441,821	22	24.44%	$12,073,274	11.90%
Dept of Public Safety	154	$440,774,415	3	1.95%	$27,866,012	6.32%
Dept of Taxation	1	$7,174,162	0	0.00%	$0	0.00%
Dept of Transportation	68	$2,935,208,214	25	36.76%	$205,120,358	6.99%
Hawai'i State Ethics Commission	1	$984,533	0	0.00%	$0	0.00%
Hawaiʻi Health Systems Corporation	106	$1,230,852,871	1	0.94%	$936,734	0.08%
Hawaiʻi Housing Finance & Development Corporation	86	$360,851,671	1	1.16%	$222,080	0.06%
Hawaiʻi Public Housing Authority	273	$982,981,701	7	2.56%	$23,967,254	2.44%
Hawaiʻi State Legislature	2	$48,555,381	0	0.00%	$0	0.00%
Hawaiʻi State Public Library System	53	$525,584,082	9	16.98%	$24,625,219	4.69%
Judiciary	41	$534,877,354	5	12.20%	$71,403,089	13.35%
Legislative Reference Bureau	1	$2,996,162	0	0.00%	$0	0.00%
Office of Hawaiian Affairs	11	$54,125,645	6	54.55%	$18,013,415	33.28%
Office of the Auditor	2	$1,921,180	0	0.00%	$0	0.00%
Office of the Governor	1	$2,996,162	0	0.00%	$0	0.00%
Office of the Lieutenant Governor	2	$4,588,849	0	0.00%	$0	0.00%
Office of the Ombudsman	1	$1,818,060	0	0.00%	$0	0.00%
Research Corporation of the University of Hawai'i	3	$4,189,026	0	0.00%	$0	0.00%
University of Hawai'i	637	$5,014,974,503	33	5.18%	$67,420,505	1.34%
Total	**6,095**	**$26,120,855,568**	**420**	**6.89%**	**$1,537,091,275**	**5.88%**

Source: Tetra Tech Requested Data from Doug Bausch 2022; State of Hawaiʻi Risk Management Office 2017

Table 4.13-8. State Buildings Exposure to the ASCE Inundation Area by State Agency

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Hazard Area	Percent (%) of Total Buildings	Replacement Cost Value in the Hazard Area	Percent (%) of Total Value
Dept of Accounting & General Services	66	$953,963,738	21	31.82%	$343,977,572	36.06%
Dept of Agriculture	70	$147,607,399	26	37.14%	$49,845,241	33.77%
Dept of Attorney General	15	$108,425,480	7	46.67%	$48,759,711	44.97%
Dept of Budget & Finance	16	$28,968,679	6	37.50%	$22,172,194	76.54%
Dept of Business, Economic Development and Tourism	25	$645,480,379	6	24.00%	$560,518,082	86.84%
Dept of Commerce & Consumer Affairs	2	$40,197,360	1	50.00%	$35,605,036	88.58%
Dept of Defense	69	$267,352,836	12	17.39%	$38,237,951	14.30%
Dept of Education	4,090	$10,598,205,739	1004	24.55%	$2,244,599,445	21.18%
Dept of Hawaiian Home Lands	12	$110,427,352	3	25.00%	$7,618,080	6.90%
Dept of Health	44	$387,068,440	8	18.18%	$13,080,541	3.38%
Dept of Human Resources Development	1	$5,973,872	0	0.00%	$0	0.00%
Dept of Human Services	130	$480,212,294	48	36.92%	$274,603,030	57.18%
Dept of Labor and Industrial Relations	22	$90,076,209	4	18.18%	$59,503,487	66.06%
Dept of Land and Natural Resources	90	$101,441,821	42	46.67%	$77,543,352	76.44%
Dept of Public Safety	154	$440,774,415	27	17.53%	$66,868,409	15.17%
Dept of Taxation	1	$7,174,162	1	100.00%	$7,174,162	100.00%
Dept of Transportation	68	$2,935,208,214	36	52.94%	$513,831,729	17.51%
Hawai'i State Ethics Commission	1	$984,533	1	100.00%	$984,533	100.00%
Hawaiʻi Health Systems Corporation	106	$1,230,852,871	2	1.89%	$2,181,734	0.18%
Hawaiʻi Housing Finance & Development Corporation	86	$360,851,671	16	18.60%	$156,215,306	43.29%
Hawaiʻi Public Housing Authority	273	$982,981,701	66	24.18%	$218,620,456	22.24%
Hawaiʻi State Legislature	2	$48,555,381	0	0.00%	$0	0.00%
Hawaiʻi State Public Library System	53	$525,584,082	18	33.96%	$370,197,121	70.44%
Judiciary	41	$534,877,354	13	31.71%	$191,779,359	35.85%
Legislative Reference Bureau	1	$2,996,162	0	0.00%	$0	0.00%
Office of Hawaiian Affairs	11	$54,125,645	10	90.91%	$54,019,183	99.80%
Office of the Auditor	2	$1,921,180	2	100.00%	$1,921,180	100.00%
Office of the Governor	1	$2,996,162	0	0.00%	$0	0.00%
Office of the Lieutenant Governor	2	$4,588,849	0	0.00%	$0	0.00%
Office of the Ombudsman	1	$1,818,060	1	100.00%	$1,818,060	100.00%
Research Corporation of the University of Hawai'i	3	$4,189,026	0	0.00%	$0	0.00%
University of Hawai'i	637	$5,014,974,503	93	14.60%	$649,168,397	12.94%
Total	**6,095**	**$26,120,855,568**	**1,474**	**24.18%**	**$6,010,843,350**	**23.01%**

Source: Tetra Tech Requested Data from Doug Bausch 2022; State of Hawaiʻi Risk Management Office 2017

Table 4.13-9. State Road Exposure to the GAT Inundation Area by County

County	Length (in miles)		
	Total Length	Length of State Road in the GAT Inundation Area	Length as Percent (%) of Total Length
County of Kaua'i	103.7	25.2	24.30%
City and County of Honolulu	374.9	86.0	22.94%
County of Maui	245.9	28.5	11.59%
County of Hawai'i	379.2	6.0	1.58%
Total	**1,103.70**	**145.7**	**13.20%**

Source: Tetra Tech Requested Data from Doug Bausch 2022; State of Hawai'i Department of Transportation 2022

Table 4.13-10. State Road Exposure to the SOEST Inundation Area by County

County	Length (in miles)		
	Total Length	Length of State Road in the SOEST Inundation Area	Length as Percent (%) of Total Length
County of Kaua'i	103.7	18.4	17.74%
City and County of Honolulu	374.9	46.2	12.32%
County of Maui	245.9	20.8	8.46%
County of Hawai'i	379.2	3.32	0.88%
Total	**1,103.70**	**88.72**	**8.04%**

Source: Tetra Tech Requested Data from Doug Bausch 2022; State of Hawai'i Department of Transportation 2022

Table 4.13-11. State Road Exposure to the ASCE Inundation Area by County

County	Length (in miles)		
	Total Length	Length of State Road in the ASCE Inundation Area	Length as Percent (%) of Total Length
County of Kaua'i	103.7	27.2	26.23%
City and County of Honolulu	374.9	103.2	27.53%
County of Maui	245.9	38.8	15.78%
County of Hawai'i	379.2	8.0	2.11%
Total	**1,103.70**	**177.2**	**16.06%**

Source: Tetra Tech Requested Data from Doug Bausch 2022; State of Hawai'i Department of Transportation 2022

Table 4.13-12. Community Lifelines and Critical Facilities in the GAT Inundation Area, by County

County	Community Lifeline Categories								Additional Critical Facilities
	Communications	Energy	Food, Water, Shelter	Hazardous Material	Health & Medial	Safety & Security	Transportation	Total in the GAT Hazard Area	
County of Kaua'i	2	3	12	0	1	13	2	33	4
City and County of Honolulu	31	33	52	1	9	56	3	185	9
County of Maui	8	2	36	0	10	19	14	89	9
County of Hawai'i	11	6	22	1	4	4	5	53	4
Total	**52**	**44**	**122**	**2**	**24**	**92**	**24**	**360**	**26**

Source: Tetra Tech Requested Data from Doug Bausch 2022; Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020

Table 4.13-13. Community Lifelines and Critical Facilities in the SOEST Inundation Area, by County

County	Community Lifeline Categories								Additional Critical Facilities
	Communications	Energy	Food, Water, Shelter	Hazardous Material	Health & Medial	Safety & Security	Transportation	Total in the SOEST Hazard Area	
County of Kaua'i	1	3	10	0	0	8	2	24	3
City and County of Honolulu	9	17	20	0	1	12	0	59	1
County of Maui	5	2	25	0	9	14	9	64	7
County of Hawai'i	0	5	19	1	0	1	5	31	4
Total	**15**	**27**	**74**	**1**	**10**	**35**	**16**	**178**	**15**

Source: *Tetra Tech Requested Data from Doug Bausch 2022; Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020*

Table 4.13-14. Community Lifelines and Critical Facilities in the ASCE Inundation Area, by County

County	Community Lifeline Categories								Additional Critical Facilities
	Communications	Energy	Food, Water, Shelter	Hazardous Material	Health & Medial	Safety & Security	Transportation	Total in the ASCE Hazard Area	
County of Kaua'i	2	4	9	1	1	10	2	29	4
City and County of Honolulu	42	37	59	2	12	77	3	232	10
County of Maui	9	3	40	0	12	21	12	97	10
County of Hawai'i	11	6	25	1	4	6	6	59	7
Total	**64**	**50**	**133**	**4**	**29**	**114**	**23**	**417**	**31**

Source: *Tetra Tech Requested Data from Doug Bausch 2022; Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020*

Table 4.13-15. Community Lifelines and Critical Facilities in the GAT Inundation Area, by Category

Category	Total Number of Facilities	Total Replacement Cost Value	Number of Facilities in Hazard Area	Percent (%) of Total Facilities	Replacement Cost Value in the Hazard Area	Percent (%) of Total Value
Communications	188	$776,797,683	52	27.66%	$185,980,872	23.94%
Energy	89	$3,093,949,530	44	49.44%	$1,453,398,520	46.98%
Food, Water, Shelter	345	$11,847,189,588	122	35.36%	$4,212,175,248	35.55%
Hazardous Material	12	$436,474,800	2	16.67%	$72,588,000	16.63%
Health and Medical	193	$4,606,713,364	24	12.44%	$187,830,564	4.08%
Safety and Security	486	$38,164,188,232	92	18.93%	$9,323,330,742	24.43%
Transportation	56	$2,039,091,600	24	42.86%	$872,949,600	42.81%
Additional Critical Facilities	106	$447,698,794	26	24.53%	$163,837,374	36.60%
Total	**1,475**	**$61,412,103,591**	**386**	**26.17%**	**$16,472,090,919**	**26.82%**

Source: *Tetra Tech Requested Data from Doug Bausch 2022; Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020*

Table 4.13-16. Community Lifelines and Critical Facilities in the SOEST Inundation Area, by Category

Category	Total Number of Facilities	Total Replacement Cost Value	Number of Facilities in Hazard Area	Percent (%) of Total Facilities	Replacement Cost Value in the Hazard Area	Percent (%) of Total Value
Communications	188	$776,797,683	15	7.98%	$61,615,375	7.93%
Energy	89	$3,093,949,530	27	30.34%	$852,194,460	27.54%
Food, Water, Shelter	345	$11,847,189,588	74	21.45%	$2,498,503,589	21.09%
Hazardous Material	12	$436,474,800	1	8.33%	$36,294,000	8.32%
Health and Medical	193	$4,606,713,364	10	5.18%	$111,959,314	2.43%
Safety and Security	486	$38,164,188,232	35	7.20%	$5,987,194,407	15.69%
Transportation	56	$2,039,091,600	16	28.57%	$580,704,000	28.48%
Additional Critical Facilities	106	$447,698,794	15	14.15%	$88,799,320	19.83%
Total	**1,475**	**$61,412,103,591**	**193**	**13.08%**	**$10,217,264,464**	**16.64%**

Source: *Tetra Tech Requested Data from Doug Bausch 2022; Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020*

Table 4.13-17. Community Lifelines and Critical Facilities in the ASCE Inundation Area, by Category

Category	Total Number of Facilities	Total Replacement Cost Value	Number of Facilities in Hazard Area	Percent (%) of Total Facilities	Replacement Cost Value in the Hazard Area	Percent (%) of Total Value
Communications	188	$776,797,683	64	34.04%	$227,259,427	29.26%
Energy	89	$3,093,949,530	50	56.18%	$1,679,393,240	54.28%
Food, Water, Shelter	345	$11,847,189,588	133	38.55%	$4,625,745,853	39.05%
Hazardous Material	12	$436,474,800	4	33.33%	$145,176,000	33.26%
Health and Medical	193	$4,606,713,364	29	15.03%	$274,599,521	5.96%
Safety and Security	486	$38,164,188,232	114	23.46%	$10,122,891,310	26.52%
Transportation	56	$2,039,091,600	23	41.07%	$836,655,600	41.03%
Additional Critical Facilities	106	$447,698,794	31	29.25%	$178,253,774	39.82%
Total	**1,475**	**$61,412,103,591**	**448**	**30.37%**	**$18,089,974,724**	**29.46%**

Source: *Tetra Tech Requested Data from Doug Bausch 2022; Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020*

As summarized in Section 4.2 (Climate Change and Sea Level Rise), the primary transportation arteries for the entry of people and goods to the state are the Daniel K. Inouye International Airport and Honolulu Harbor. Each island also has critical points of entry along the coast. Because of their geographic location, ports and harbors as well as airports located on the coast are especially vulnerable to the tsunami hazard. Damages and closures to these critical facilities will likely be long-term, causing cascading economic impacts statewide.

The March 2011 tsunami that impacted Japan serves as a point of reference for potential losses to critical assets in the State of Hawaiʻi. As a result of the tsunami, cargo containers were floating in the flood waters; there is a similar concern that containers may fall into Honolulu Harbor not only losing the cargo itself but blocking ships from accessing the piers and the containers themselves becoming projectiles which can cause more damage. The Oʻahu Metropolitan Planning Organization 2011 *Transportation Asset Climate Change Risk Assessment* estimates the Daniel K. Inouye International Airport will experience one-to-three days of downtime for emergency response, and one-to-two weeks of downtime for commercial flights after a tsunami event (SSFM International 2011).

Assessment of Local Vulnerability and Potential Losses

This section provides a summary of vulnerability and potential losses to population, general building stock, and environmental resources and cultural assets by county.

The local HMPs were reviewed to integrate risk assessment results into the 2023 SHMP Update; a summary of information available is below.

- **County of Kauaʻi** – The Kauaʻi County HMP includes a qualitative overview of risk posed by tsunamis as well as a discussion of precipitating events. 10,411 County residents live within the Tsunami Inundation Zone, with 5,139 buildings exposed (County of Kauaʻi 2020).
- **City and County of Honolulu** – The City and County of Honolulu HMP includes a qualitative overview of risk posed by tsunamis as well as a discussion of precipitating events. The City and County also discussed tsunami warning systems and plans in place (City and County of Honolulu 2020).
- **County of Maui** – The Maui County HMP includes a qualitative overview of risk posed by tsunamis as well as a discussion of precipitating events. The County included Tsunami Evacuation Zone maps overlaid with buildings, critical facilities, and major roads. 5,190 County residents live within the Tsunami Inundation Zone, with 2,562 buildings exposed. Additionally, the HMP lists residents who are most vulnerable to flood risk, including single parent and dependent households, residents living below the poverty line, residents without adequate communication infrastructure and/or limited English proficiency, residents living in properties built prior to the 1950s, and residents with limited mobility (County of Maui 2020).
- **County of Hawaiʻi** – The Hawaiʻi County HMP includes a qualitative overview of risk posed by tsunamis as well as a discussion of precipitating events. The County included a Tsunami Inundation Area map based on FEMA flood studies demonstrating areas at high risk. 5,190 County residents live within the Tsunami Inundation Zone, with 2,562 buildings exposed (County of Hawaiʻi 2020).

Socially Vulnerable and Total Population

Table 4.13-18 displays the estimated population living in or near the GAT inundation area that could be impacted should a tsunami event occur (see Table 4.13-19 for the SOEST inundation area and Table 4.13-20 for the ASCE inundation area). For the purposes of the 2023 SHMP Update, the population vulnerable to possible tsunami inundation is considered the same as the exposed population. The degree of vulnerability of the population exposed is based on several factors:

- Is there a warning system?
- What is the lead time of the warning?
- What is the method of warning dissemination?
- Will the people evacuate when warned?

Table 4.13-18. 2020 U.S. Census Population Located in the GAT Inundation Area by County

County	Population				
	Total Population	Population in the GAT Hazard Area	Population Exposed as % of Total Population	Socially Vulnerable Population in the GAT Hazard Area	Socially Vulnerable Population Exposed as % of Total Population
County of Kauaʻi	71,949	4,490	6.24%	532	0.74%

County	Population				
	Total Population	Population in the GAT Hazard Area	Population Exposed as % of Total Population	Socially Vulnerable Population in the GAT Hazard Area	Socially Vulnerable Population Exposed as % of Total Population
City and County of Honolulu	979,682	126,570	12.92%	27,767	2.83%
County of Maui	167,093	21,784	13.04%	4,077	2.44%
County of Hawaiʻi	201,350	9,098	4.52%	7,325	3.64%
Total	**1,420,074**	**161,942**	**11.40%**	**39,701**	**2.80%**

Source: Tetra Tech Requested Data from Doug Bausch 2022; U.S. Census Bureau 2020; Centers for Disease Control and Prevention 2018

Table 4.13-19. 2020 U.S. Census Population Located in the SOEST Inundation Area by County

County	Population				
	Total Population	Population in the SOEST Hazard Area	Population Exposed as % of Total Population	Socially Vulnerable Population in the SOEST Hazard Area	Socially Vulnerable Population Exposed as % of Total Population
County of Kauaʻi	71,949	2,583	3.59%	273	0.38%
City and County of Honolulu	979,682	34,999	3.57%	10,655	1.09%
County of Maui	167,093	14,239	8.52%	1,804	1.08%
County of Hawaiʻi	201,350	2,607	1.29%	710	0.35%
Total	**1,420,074**	**54,428**	**3.83%**	**13,442**	**0.95%**

Source: Tetra Tech Requested Data from Doug Bausch 2022; U.S. Census Bureau 2020; Centers for Disease Control and Prevention 2018

Table 4.13-20. 2020 U.S. Census Population Located in the ASCE Inundation Area by County

County	Population				
	Total Population	Population in the ASCE Hazard Area	Population Exposed as % of Total Population	Socially Vulnerable Population in the ASCE Hazard Area	Socially Vulnerable Population Exposed as % of Total Population
County of Kauaʻi	71,949	4,861	6.76%	645	0.90%
City and County of Honolulu	979,682	197,348	20.14%	51,346	5.24%
County of Maui	167,093	33,194	19.87%	8,520	5.10%
County of Hawaiʻi	201,350	12,145	6.03%	8,621	4.28%
Total	**1,420,074**	**247,548**	**17.43%**	**69,132**	**4.87%**

Source: Tetra Tech Requested Data from Doug Bausch 2022; U.S. Census Bureau 2020; Centers for Disease Control and Prevention 2018

The analysis indicates that the City and County of Honolulu has the greatest number of people (126,570) located in the GAT inundation area; the SOEST and ASCE indicate the same with populations of (34,999) and (197,348), respectively. This analysis does not include the number of tourists and visitors in the state; some may be located on the beach or in other recreational areas or in lodgings that are located in GAT, SOEST, and ASCE inundation areas. Therefore, this estimate may be underestimating exposure and vulnerability. Hazus estimates a higher day population exposed to the GAT, SOEST, and ASCE inundation areas compared to the night population exposed. Therefore, the exposed population depends on the time of day the tsunami occurs.

The populations considered most vulnerable include children, elderly (persons over the age of 65), and individuals with access and functional needs. Socially vulnerable populations are most susceptible based on many factors, including their physical and financial ability to react or respond during a hazard. The cost of interventions to protect properties from tsunami risk may financially stress lower- or middle-income residents. Relocating may be difficult because of the expenses and the availability of accessible housing or the time needed to make housing accessible. The high vulnerability population makes up about 27.92% of the total population residing in the hazard area. Visitors recreating in or around the inundation areas are also vulnerable because they may not be as familiar with appropriate response and the best way to reach higher ground.

Tsunami events can cause injuries and fatalities if timely evacuation does not occur. Further, tsunami waves can carry debris and people out to sea when they retreat. Hazus estimates the number of casualties based on three community tsunami preparedness scenarios ranging from good to poor. “Good” is intended for well-prepared communities such as Tsunami Ready communities. All counties and many communities throughout the state are Tsunami Ready. “Poor” is considered for a community with little to no experience or education programs available. The guidance from Hazus is that areas with large visitor populations, such as the state, may incorporate more than one preparedness level into their planning. Table 4.13-21 summarizes the estimated casualties (fatalities and injuries) Hazus estimates as a result of the GAT (see Table 4.13-22 for SOEST and Table 4.13-23 for ASCE).

According to the Centers for Disease Control and Prevention, the primary health concerns after a tsunami event include clean drinking water, food, shelter and medical care for injuries. Flood waters can pose health risks, such as contaminated water and food supplies. Most deaths from tsunamis are related to drowning; however, traumatic injuries are also a primary concern. Medical care is critical in areas impacted by a tsunami (CDC 2013).

Table 4.13-21. Estimated GAT Fatalities and Injuries by Community Preparedness Level

County	Community Preparedness Level								
	Good			Fair			Poor		
	Fatalities	Injuries	Total Casualties	Fatalities	Injuries	Total Casualties	Fatalities	Injuries	Total Casualties
County of Kaua‘i	0	0	0	2,260	81	2,341	6,953	102	7,056
City and County of Honolulu	0	0	0	39,802	2,118	41,921	126,964	2,604	129,567
County of Maui	0	0	0	8,225	245	8,471	25,396	325	25,722
County of Hawai‘i	0	0	0	4,187	149	4,336	12,862	191	13,052
Total	**0**	**0**	**0**	**54,474**	**2,594**	**57,068**	**172,175**	**3,222**	**175,397**

Source: Tetra Tech Requested Data from Doug Bausch 2022
The estimated number of injuries and fatalities is based on the daytime population which is higher than the night population to provide a worst-case scenario for planning purposes.

Table 4.13-22. Estimated SOEST Fatalities and Injuries by Community Preparedness Level

County	Community Preparedness Level								
	Good			Fair			Poor		
	Fatalities	Injuries	Total Casualties	Fatalities	Injuries	Total Casualties	Fatalities	Injuries	Total Casualties
County of Kaua‘i	0	0	0	1,299	33	1,332	4,165	48	4,213
City and County of Honolulu	0	0	0	13,610	68	13,678	44,279	222	44,501
County of Maui	0	0	0	5,630	134	5,764	18,047	200	18,247

County	Community Preparedness Level								
	Good			Fair			Poor		
	Fatalities	Injuries	Total Casualties	Fatalities	Injuries	Total Casualties	Fatalities	Injuries	Total Casualties
County of Hawai'i	0	0	0	1,185	26	1,211	3,843	40	3,883
Total	0	0	0	21,724	261	21,986	70,334	510	70,844

Source: Tetra Tech Requested Data from Doug Bausch 2022
The estimated number of injuries and fatalities is based on the daytime population which is higher than the night population to provide a worst-case scenario for planning purposes.

Table 4.13-23. Estimated ASCE Fatalities and Injuries by Community Preparedness Level

County	Community Preparedness Level								
	Good			Fair			Poor		
	Fatalities	Injuries	Total Casualties	Fatalities	Injuries	Total Casualties	Fatalities	Injuries	Total Casualties
County of Kaua'i	0	0	0	2,035	71	2,106	6,180	93	6,273
City and County of Honolulu	0	0	0	63,351	4,324	67,675	194,226	4,856	199,082
County of Maui	0	0	0	10,757	188	10,945	31,704	285	31,989
County of Hawai'i	0	0	0	5,111	248	5,359	14,987	266	15,253
Total	0	0	0	81,254	4,831	86,085	247,097	5,500	252,597

Source: Tetra Tech Requested Data from Doug Bausch 2022
The estimated number of injuries and fatalities is based on the daytime population which is higher than the night population to provide a worst-case scenario for planning purposes.

After a tsunami, residents should not return home until after local officials indicate it is safe. It cannot be assumed that after one wave the danger is over; a tsunami is a series of waves that may continue for hours. Debris in the water may be a safety hazard to both people and pets. Residents should not enter their homes or other buildings when they have water in and around the structure; the floors may be cracked, and the walls may collapse.

General Building Stock

All structures along the coast are vulnerable to a tsunami. Waves and scouring associated with debris that may be carried in the water could damage or destroy structures in the tsunami's path. Similar to the analyses presented earlier, the general building stock data was overlaid with the tsunami hazard area to assess exposure; or buildings located in the GAT, SOEST, and ASCE inundation areas. The City and County of Honolulu has the greatest replacement cost value of buildings located in the GAT, SOEST, and ASCE inundation areas. See Table 4.13-24 for the values by county for the GAT inundation area, Table 4.13-25 for the SOEST, and Table 4.13-26 for the ASCE.

Table 4.13-24. General Building Stock Exposure and Potential Losses to the GAT by County

County	Total Value	Replacement Cost Value in Hazard Area	Replacement Cost Value Exposed as % of Total	Estimated Economic Loss (Losses for Building, Content, Wage, Income, Relocation, and Lost Rent Payments)
County of Kaua'i	$24,246,497,228	$6,043,289,106	24.92%	$5,260,235,045
City and County of Honolulu	$239,152,051,766	$62,462,635,336	26.12%	$20,183,707,566
County of Maui	$50,796,693,140	$17,557,864,308	34.56%	$13,752,319,875

County	Total Value	Replacement Cost Value in Hazard Area	Replacement Cost Value Exposed as % of Total	Estimated Economic Loss (Losses for Building, Content, Wage, Income, Relocation, and Lost Rent Payments)
County of Hawaiʻi	$58,395,349,136	$7,721,540,430	13.22%	$8,029,150,184
Total	**$372,590,591,270**	**$93,785,329,180**	**25.17%**	**$47,225,412,670**

Source: Tetra Tech Requested Data from Doug Bausch 2022; NIYAM IT 2022; United States Army Corps of Engineers 2022

Table 4.13-25. General Building Stock Exposure and Potential Losses to the SOEST by County

County	Total Value	Replacement Cost Value in Hazard Area	Replacement Cost Value Exposed as % of Total	Estimated Economic Loss (Losses for Building, Content, Wage, Income, Relocation, and Lost Rent Payments)
County of Kauaʻi	$24,246,497,228	$3,710,486,185	15.30%	$2,972,790,392
City and County of Honolulu	$239,152,051,766	$18,035,989,197	7.54%	$16,352,343,198
County of Maui	$50,796,693,140	$10,881,098,937	21.42%	$7,798,734,287
County of Hawaiʻi	$58,395,349,136	$2,807,678,584	4.81%	$2,784,799,873
Total	**$372,590,591,270**	**$35,435,252,903**	**9.51%**	**$29,908,667,750**

Source: Tetra Tech Requested Data from Doug Bausch 2022; NIYAM IT 2022; United States Army Corps of Engineers 2022

Table 4.13-26. General Building Stock Exposure and Potential Losses to the ASCE by County

County	Total Value	Replacement Cost Value in Hazard Area	Replacement Cost Value Exposed as % of Total	Estimated Economic Loss (Losses for Building, Content, Wage, Income, Relocation, and Lost Rent Payments)
County of Kauaʻi	$24,246,497,228	$6,219,253,544	25.65%	$5,830,032,601
City and County of Honolulu	$239,152,051,766	$77,628,500,586	32.46%	$37,743,118,057
County of Maui	$50,796,693,140	$18,804,707,390	37.02%	$19,583,636,497
County of Hawaiʻi	$58,395,349,136	$10,192,980,322	17.46%	$10,824,663,660
Total	**$372,590,591,270**	**$112,845,441,842**	**30.29%**	**$73,981,450,814**

Source: Tetra Tech Requested Data from Doug Bausch 2022; NIYAM IT 2022; United States Army Corps of Engineers 2022

The PDC calculated estimated potential building damage as a result of the GAT, SOEST, and ASCE. Total building loss includes structural damage cost, non-structural damage cost and content damage cost. Greater than $47 billion in building damages, or 12.67% of the state's total inventory, is estimated in the GAT inundation area. Greater than $29 billion in building damages, or 8.02% of the state's total inventory, is estimated in the SOEST inundation area. Greater than $73 billion in building damages, or 19.85% of the state's total inventory, is estimated in the ASCE inundation area.

Hazus estimates business interruption losses as a result of a tsunami event. Business interruption losses are the losses associated with the inability to operate a business because of the damage sustained from the tsunami. These losses also include temporary living expenses for those people displaced from their homes (relocation loss). Business interruption losses are in addition to the direct building-related losses listed in the tables above. Table 4.13-27 summarizes the business interruption losses that the state may incur for the GAT inundation area. Table 4.13-28 and Table 4.13-29 summarize the business interruption losses that the state may incur for the SOEST and ASCE inundation area.

Table 4.13-27. Business Interruption Losses as a result of the GAT by County

County	Total Economic Loss	Relocation Loss	Capital-Related Loss	Wages Loss	Rental Income Loss
County of Kaua'i	$1,398,000,000	$181,000,000	$206,000,000	$810,000,000	$201,000,000
City and County of Honolulu	$3,191,000,000	$716,000,000	$725,000,000	$1,244,000,000	$506,000,000
County of Maui	$2,542,000,000	$321,000,000	$613,000,000	$1,122,000,000	$485,000,000
County of Hawai'i	$1,629,000,000	$190,000,000	$360,000,000	$905,000,000	$174,000,000
Total	**$8,760,000,000**	**$1,408,000,000**	**$1,904,000,000**	**$4,081,000,000**	**$1,366,000,000**

Source: Tetra Tech Requested Data from Doug Bausch 2022; Hazus 5.1

Table 4.13-28. Business Interruption Losses as a result of the SOEST by County

County	Total Economic Loss	Relocation Loss	Capital-Related Loss	Wages Loss	Rental Income Loss
County of Kaua'i	$536,000,000	$85,000,000	$102,000,000	$260,000,000	$90,000,000
City and County of Honolulu	$515,000,000	$135,000,000	$106,000,000	$159,000,000	$114,000,000
County of Maui	$1,418,000,000	$196,000,000	$384,000,000	$594,000,000	$243,000,000
County of Hawai'i	$541,000,000	$60,000,000	$132,000,000	$243,000,000	$107,000,000
Total	**$3,010,000,000**	**$476,000,000**	**$724,000,000**	**$1,256,000,000**	**$554,000,000**

Source: Tetra Tech Requested Data from Doug Bausch 2022; Hazus 5.1

Table 4.13-29. Business Interruption Losses as a result of the ASCE by County

County	Total Economic Loss	Relocation Loss	Capital-Related Loss	Wages Loss	Rental Income Loss
County of Kaua'i	$1,103,000,000	$151,000,000	$191,000,000	$574,000,000	$187,000,000
City and County of Honolulu	$4,782,000,000	$1,118,000,000	$1,079,000,000	$1,744,000,000	$840,000,000
County of Maui	$3,355,000,000	$472,000,000	$805,000,000	$1,423,000,000	$655,000,000
County of Hawai'i	$2,398,000,000	$250,000,000	$435,000,000	$1,467,000,000	$247,000,000
Total	**$11,638,000,000**	**$1,991,000,000**	**$2,510,000,000**	**$5,208,000,000**	**$1,929,000,000**

Source: Tetra Tech Requested Data from Doug Bausch 2022; Hazus 5.1

Land Use Districts

Table 4.13-30 shows the square miles of the tsunami hazard area in each state land use district statewide for the GAT inundation area (see Table 4.13-31 for the SOEST and Table 4.13-32 for the ASCE); refer to Appendix F (State Profile and Risk Assessment Supplement) for results for each county. In the GAT inundation area, more than 16% of Urban District lands statewide are exposed to the tsunami hazard (7.40% in the SOEST and 24.6% in the ASCE), which is concerning due to the concentration of development in these areas. Although tsunami risk is considered to some extent in the delineation of special flood hazard areas (SFHA) in the state (areas where flood resistant construction standards apply), the inundation area from the GAT and ASCE events includes more than double the amount of Urban District lands than are located in the SFHA.

Table 4.13-30. State Land Use Districts Located in the GAT Inundation Area

Land Use District	Total (square miles)	Square Miles in Tsunami Hazard Area	Percent (%) of Total Area
Agricultural	2,973.6	42.2	1.4%
Conservation	3,202.9	18.4	0.6%
Rural	16.3	0.6	3.7%
Urban	319.1	53.7	16.8%
Total	**6,511.9**	**114.9**	**1.8%**

Source: *Tetra Tech Requested Data from Doug Bausch 2022; State Land Use Commission, Hawai'i Statewide GIS Program 2021; Honolulu County GIS 2022*

Table 4.13-31. State Land Use Districts Located in the SOEST Inundation Area

Land Use District	Total (square miles)	Square Miles in Tsunami Hazard Area	Percent (%) of Total Area
Agricultural	2,973.6	19.8	0.67%
Conservation	3,202.9	10.7	0.33%
Rural	16.3	0.4	2.45%
Urban	319.1	23.6	7.40%
Total	**6,511.9**	**54.5**	**0.84%**

Source: *Tetra Tech Requested Data from Doug Bausch 2022; State Land Use Commission, Hawai'i Statewide GIS Program 2021; Honolulu County GIS 2022*

Table 4.13-32. State Land Use Districts Located in the ASCE Inundation Area

Land Use District	Total (square miles)	Square Miles in Tsunami Hazard Area	Percent (%) of Total Area
Agricultural	2,973.6	58.8	2.0%
Conservation	3,202.9	27.3	0.9%
Rural	16.3	0.7	4.3%
Urban	319.1	78.4	24.6%
Total	**6,511.9**	**165.2**	**2.5%**

Source: *Tetra Tech Requested Data from Doug Bausch 2022; State Land Use Commission, Hawai'i Statewide GIS Program 2021; Honolulu County GIS 2022*

This means that development in these areas is unlikely to have been constructed within any considerations for flood damage reduction and that many of these structures will not be insured against flood losses. Although only less than 1% of the Conservation District lands are exposed to the tsunami hazard for each of the inundation areas, there may be significant ecological consequences in these areas, particularly in the nearshore environment. Conservation District lands contain valuable environmental resources. Additional discussion of exposure and vulnerability of these resource areas can be found in the discussion on environmental resources below.

Environmental Resources

The loss of natural resources across the state is difficult to quantify. Not only do coral reefs benefit the environment, but they also provide protection from tsunamis. Coasts with offshore reefs receive less wave energy than unprotected coastlines lying in the path of an approaching tsunami. Small islands may experience reduced runup as the tsunami waves may refract around them. Fringing and barrier reefs appear to have a mitigating influence on tsunamis by dispersing the wave energy (State of Hawaiʻi 2018).

Tsunami impacts range from loss of livelihood for fishermen to damages to coral reefs, flora and fauna, and beach loss, all of which have cascading economic impacts statewide. An economic impact analysis was conducted for Waikīkī Beach to estimate the potential economic impact if the beach was completely eroded, whether the cause be a tsunami, flood event or climate change. The economic impact on total hotel revenues could be as much as $661.2 million annually, with 6,352 lost jobs in the hotel industry. This is just one example of the potential economic impact to one sector due to the loss of one environmental resource (University of Hawaiʻi 2018).

As discussed above, there are 42.2 square miles of agricultural land located in the GAT inundation area, 19.8 in the SOEST, and 58.8 in the ASCE. As a result of tsunami waves traveling potentially miles inland, salinization of the land may cause soil to be less fertile and increase vulnerability to erosion (World Ecology Foundation 2022).

Septic tanks, cesspools, and other on-site sewage disposal systems are located along the coast. There is a concern that chronic flooding will impact these systems and release wastewater and hazardous materials and waste into nearshore waters and coastal habitats as discussed in the 2017 *Hawaiʻi Sea Level Rise and Vulnerability Assessment Report*. A tsunami may lead to the failure of these systems diminishing water quality, impacting natural aquatic systems and leading to human health exposure to these hazardous wastes.

Due to its geographic location and isolation, the state faces unique challenges in addressing disaster debris. With limited landfill capacity, advanced planning for large amounts of debris generated by a tsunami is critical. Hazardous materials may be mixed with the debris and need to be considered during staging and disposal.

A spatial analysis was conducted to estimate the square miles of environmental resources, including critical habitat (or habitats that are known to be essential for an endangered or threatened species), wetlands, and parks and reserves located in the GAT, SOEST, and ASCE inundation areas. These results are summarized in Table 4.13-33, Table 4.13-34, and Table 4.13-35, respectively.

Table 4.13-33. Environmental Resource Areas Located in the GAT Inundation Area

Environmental Resource	Statewide		
	Total Square Miles of Resources	Square Miles in the GAT Inundation Area	Percent (%) of Total Resource Area
Critical Habitat [a]	951	2	0.3%
Wetlands	3,637	22	0.6%
Parks and Reserves	2,778	16	0.6%
Reefs [b]	55	1	1.4%
Total [c]	**7,420**	**42**	**0.6%**

Source: *Tetra Tech Requested Data from Doug Bausch 2022; U.S. Fish and Wildlife Service, Pacific Islands Office, 2022a, U.S. Fish and Wildlife Service 2021e; 2017b, Hawai'i State Department of Land and Natural Resources, Division of Forestry and Wildlife 2022, NOAA raster nautical charts 2020b, State of Hawai'i Department of Land and Natural Resources, Division of State Parks 2021*

Notes:
a. *Critical area mileage includes the combined area of coverage of individual critical habitat areas.*
b. *Reefs include artificial and coral reefs.*
c. *Total square miles includes environmental assets within 3 nautical miles of each county and may be over-reported as some environmental asset areas may overlap.*

Table 4.13-34. Environmental Resource Areas Located in the SOEST Inundation Area

Environmental Resource	Statewide		
	Total Square Miles of Resources	Square Miles in the SOEST Inundation Area	Percent (%) of Total Resource Area
Critical Habitat [a]	951	1	0.1%
Wetlands	3,637	18	0.5%
Parks and Reserves	2,778	9	0.3%
Reefs [b]	55	1	1.9%
Total [c]	**7,420**	**29**	**0.4%**

Source: *Tetra Tech Requested Data from Doug Bausch 2022; U.S. Fish and Wildlife Service, Pacific Islands Office, 2022a, U.S. Fish and Wildlife Service 2021e; 2017b, Hawai'i State Department of Land and Natural Resources, Division of Forestry and Wildlife 2022, NOAA raster nautical charts 2020b, State of Hawai'i Department of Land and Natural Resources, Division of State Parks 2021*

Notes:
a. *Critical area mileage includes the combined area of coverage of individual critical habitat areas.*
b. *Reefs include artificial and coral reefs.*
c. *Total square miles includes environmental assets within 3 nautical miles of each county and may be over-reported as some environmental asset areas may overlap.*

Table 4.13-35. Environmental Resource Areas Located in the ASCE Inundation Area

Environmental Resource	Statewide		
	Total Square Miles of Resources	Square Miles in the ASCE Inundation Area	Percent (%) of Total Resource Area
Critical Habitat [a]	951	3	0.3%
Wetlands	3,637	26	0.7%
Parks and Reserves	2,778	22	0.8%
Reefs [b]	55	1	1.4%
Total [c]	**7,420**	**52**	**0.7%**

Source: *Tetra Tech Requested Data from Doug Bausch 2022; U.S. Fish and Wildlife Service, Pacific Islands Office, 2022a, U.S. Fish and Wildlife Service 2021e; 2017b, Hawai'i State Department of Land and Natural Resources, Division of Forestry and Wildlife 2022, NOAA raster nautical charts 2020b, State of Hawai'i Department of Land and Natural Resources, Division of State Parks 2021*

Notes:
a. *Critical area mileage includes the combined area of coverage of individual critical habitat areas.*
b. *Reefs include artificial and coral reefs.*
c. *Total square miles includes environmental assets within 3 nautical miles of each county and may be over-reported as some environmental asset areas may overlap.*

Cultural Assets

Many Native Hawaiian cultural and historical resources are located near the shore and are threatened by a tsunami event, including fishing and cultural practices. The population, built and natural environment, and cultural sites located on Hawaiian Home Lands are vulnerable to the tsunami hazard (see Table 4.13-36 through Table 4.13-38). The County of Hawai'i has the greatest number of square miles (2.1 square miles) located in the GAT inundation area; followed by the City and County of Honolulu (1.4 square miles). The County of Hawai'i and the County of Kaua'i both have the greatest number of square miles (0.3 square miles) located in the SOEST inundation area, followed by the City and County of Honolulu (0.2 square miles). The County of Hawai'i has the greatest number of square miles (3.2 square miles) located in the ASCE inundation area, followed by the City and County of Honolulu (1.6 square miles).

Table 4.13-36. Hawaiian Home Lands Located in the GAT Inundation Area

County	Area (in square miles)		
	Total Area	Hawaiian Home Land in the GAT Inundation Area	Percent (%) of Total Area
County of Kaua'i	32.1	0.8	2.5%
City and County of Honolulu	10.6	1.4	12.9%
County of Maui	102.6	0.1	0.1%
County of Hawai'i	191.5	2.1	1.1%
Total	**336.7**	**4.4**	**1.3%**

Source: Tetra Tech Requested Data from Doug Bausch 2022; Hawai'i State Department of Hawaiian Homelands 2021

Table 4.13-37. Hawaiian Home Lands Located in the SOEST Inundation Area

County	Area (in square miles)		
	Total Area	Hawaiian Home Land in the SOEST Inundation Area	Percent (%) of Total Area
County of Kaua'i	32.1	0.3	0.9%
City and County of Honolulu	10.6	0.2	1.8%
County of Maui	102.6	0.0	0.0%
County of Hawai'i	191.5	0.3	0.2%
Total	**336.7**	**0.8**	**0.3%**

Source: Tetra Tech Requested Data from Doug Bausch 2022; Hawai'i State Department of Hawaiian Homelands 2021

Table 4.13-38. Hawaiian Home Lands Located in the ASCE Inundation Area

County	Area (in square miles)		
	Total Area	Hawaiian Home Land in the ASCE Inundation Area	Percent (%) of Total Area
County of Kaua'i	32.1	0.8	2.3%
City and County of Honolulu	10.6	1.6	15.2%
County of Maui	102.6	0.5	0.4%
County of Hawai'i	191.5	3.2	1.7%
Total	**336.7**	**6.1**	**1.8%**

Source: Tetra Tech Requested Data from Doug Bausch 2022; Hawai'i State Department of Hawaiian Homelands 2021

Table 4.13-39, Table 4.13-40, and Table 4.13-41 summarize the cultural resources located in the GAT, SOEST, and ASCE inundation areas, respectively. The cultural resource type with the largest total area and largest area in each of the inundation areas is the Historic District, followed by Archaeological Sites.

Table 4.13-39. Cultural Resources Located in the GAT Inundation Area

Cultural Resource Site Type	Area (in square miles)		
	Total Square Miles of Asset	Total Square Miles in GAT Inundation Area	Percent (%) of Total Asset Area
Archaeology	90.892401	6.314457	6.95%
Burial Sensitivity Area	2.074551	0.88416	42.62%
Historic Building	2.680785	0.469084	17.50%
Historic District	849.360596	12.324423	1.45%
Historic Object	9.6143	0.000252	0.00%
Historic Structure	20.739072	0.532644	2.57%
Total	**975.361705**	**20.52502**	**2.10%**

Source: *Tetra Tech Requested Data from Doug Bausch 2022; Department of Land and Natural Resources, Hawai'i State Historic Preservation Division 2022*

Table 4.13-40. Cultural Resources Located in the SOEST Inundation Area

Cultural Resource Site Type	Area (in square miles)		
	Total Square Miles of Asset	Total Square Miles in SOEST Inundation Area	Percent (%) of Total Asset Area
Archaeology	90.892401	2.633448	2.90%
Burial Sensitivity Area	2.074551	0.605631	29.19%
Historic Building	2.680785	0.313276	11.69%
Historic District	849.360596	6.893097	0.81%
Historic Object	9.6143	0.000122	0.00%
Historic Structure	20.739072	0.373213	1.80%
Total	**975.361705**	**10.818787**	**1.11%**

Source: *Tetra Tech Requested Data from Doug Bausch 2022; Department of Land and Natural Resources, Hawai'i State Historic Preservation Division 2022*

Table 4.13-41. Cultural Resources Located in the ASCE Inundation Area

Cultural Resource Site Type	Area (in square miles)		
	Total Square Miles of Asset	Total Square Miles in ASCE Inundation Area	Percent (%) of Total Asset Area
Archaeology	90.892401	9.997949	11.00%
Burial Sensitivity Area	2.074551	0.888939	42.85%
Historic Building	2.680785	0.621512	23.18%
Historic District	849.360596	21.163075	2.49%
Historic Object	9.6143	0.000484	0.01%
Historic Structure	20.739072	0.803514	3.87%

Cultural Resource Site Type	Area (in square miles)		
	Total Square Miles of Asset	Total Square Miles in ASCE Inundation Area	Percent (%) of Total Asset Area
Total	**975.361705**	**33.475473**	**3.43%**

Source: *Tetra Tech Requested Data from Doug Bausch 2022; Department of Land and Natural Resources, Hawai'i State Historic Preservation Division 2022*

Future Changes that May Impact State Vulnerability

Understanding future changes that impact vulnerability in the state can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The state considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

Potential or Projected Development

The tsunami hazard area was overlain on areas that may experience significant changes in development or redevelopment in future years (see Table 4.13-42, Table 4.13-43, and Table 4.13-44 below and refer to Section 3 [State Profile] for more information on projected development areas). The results of this assessment indicate almost half (48%) of the Hawaiʻi Community Development Authority (HCDA) Community Development Districts are located in tsunami hazard areas in the GAT and ASCE inundation areas.

Table 4.13-42. HCDA Community Development Districts, Maui Development Projects, and Enterprise Zones Located in the GAT Inundation Area

County	Area (in square miles)								
	HCDA Community Development Districts (Total Area)	Total Area Exposed to Hazard	Hazard Area as Percent (%) of Total Area	Maui Development Projects (Total Area)	Total Area Exposed to Hazard	Hazard Area as Percent (%) of Total Area	Enterprise Zones (Total Area)	Total Area Exposed to Hazard	Hazard Area as Percent (%) of Total Area
County of Kauaʻi	0	0	0	0	0	0	251	21.4	8.53%
City and County of Honolulu	7.4	3.05	41.22%	0	0	0	297.3	29.9	10.06%
County of Maui	0	0	0	27.6	0.5	1.81%	1,059.80	14.4	1.36%
County of Hawaiʻi	0	0	0.00%	0	0	0	1,274.90	14.1	1.11%
Total	**7.4**	**3.05**	**41.22%**	**27.6**	**0.5**	**1.81%**	**2,883.00**	**79.8**	**2.77%**

Source: *Maui County Planning Department 2016; Hawai'i Community Development Authority 2021; Community Economic Development Program, Department of Business, Economic Development & Tourism, County Planning Departments 2021; Tetra Tech Requested Data from Doug Bausch 2022*

Table 4.13-43. HCDA Community Development Districts, Maui Development Projects, and Enterprise Zones Located in the SOEST Inundation Area

County	Area (in square miles)								
	HCDA Community Development Districts (Total Area)	Total Area Exposed to Hazard	Hazard Area as Percent (%) of Total Area	Maui Development Projects (Total Area)	Total Area Exposed to Hazard	Hazard Area as Percent (%) of Total Area	Enterprise Zones (Total Area)	Total Area Exposed to Hazard	Hazard Area as Percent (%) of Total Area
County of Kaua'i	0	0	0.0%	0	0	0.0%	251	15.4	6.1%
City and County of Honolulu	7.4	0.7	9.5%	0	0	0.0%	297.3	12.2	4.1%
County of Maui	0	0	0.0%	27.6	0.28	1.0%	1,059.80	9.3	0.9%
County of Hawai'i	0	0	0.0%	0	0	0.0%	1,274.90	3.5	0.3%
Total	**7.4**	**0.7**	**9.5%**	**27.6**	**0.28**	**1.0%**	**2,883.00**	**40.4**	**1.4%**

Source: Maui County Planning Department 2016; Hawai'i Community Development Authority 2021; Community Economic Development Program, Department of Business, Economic Development & Tourism, County Planning Departments 2021; Tetra Tech Requested Data from Doug Bausch 2022

Table 4.13-44. HCDA Community Development Districts, Maui Development Projects, and Enterprise Zones Located in the ASCE Inundation Area

County	Area (in square miles)								
	HCDA Community Development Districts (Total Area)	Total Area Exposed to Hazard	Hazard Area as Percent (%) of Total Area	Maui Development Projects (Total Area)	Total Area Exposed to Hazard	Hazard Area as Percent (%) of Total Area	Enterprise Zones (Total Area)	Total Area Exposed to Hazard	Hazard Area as Percent (%) of Total Area
County of Kaua'i	0	0	0.00%	0	0	0.00%	251	23.6	9.40%
City and County of Honolulu	7.4	3.7	50.00%	0	0	0.00%	297.3	38	12.78%
County of Maui	0	0	0.00%	27.6	1.04	3.77%	1,059.80	19.9	1.88%
County of Hawai'i	0	0	0.00%	0	0	0.00%	1,274.90	25.2	1.98%
Total	**7.4**	**3.7**	**50.00%**	**27.6**	**1.04**	**3.77%**	**2,883.00**	**106.7**	**3.70%**

Source: Maui County Planning Department 2016; Hawai'i Community Development Authority 2021; Community Economic Development Program, Department of Business, Economic Development & Tourism, County Planning Departments 2021; Tetra Tech Requested Data from Doug Bausch 2022

None of these areas are located in the special flood hazard area, so it is unlikely that construction is to standards that would be able to withstand impacts from a tsunami event. Relatively small amounts of the Maui Development Project and Enterprise Zone areas are exposed to the tsunami hazard in the GAT and ASCE inundation areas; however, the exposed area is also greater than the special flood hazard area in these areas.

Projected Changes in Population

As the population in the state ages, more of the state's residents may be unable to quickly evacuate in the event of a local-source tsunami, and additional resources may be needed to support evacuation efforts in the event of a distant-source tsunami.

Other Factors of Change

As sea levels rise, inundation from tsunamis will reach further inland putting more people and property at risk.

Section 4.14 Volcanic Hazards

Volcanic Hazards

Volcanic eruptions create local and regional hazards. Lava flows can destroy anything in their paths, and the gasses and ash expelled into the atmosphere can endanger plant, animal, and human life as far as the wind carries them. The statistics below represent lava flow hazard areas in Hawaiʻi and Maui Counties.

CHANGES SINCE 2018

+1 Declared Disaster

+4 Volcanic Events

COUNTIES MOST VULNERABLE

Kauaʻi Honolulu Maui **Hawaiʻi**

SOCIALLY VULNERABLE POPULATION

10% Of Total Population

36,475 Persons

CLIMATE PROJECTIONS

Projected changes in wind and rainfall frequency and intensity may alter the dispersion of volcanic gas emissions, adversely impacting human, animal, and plant health

Carbon Dioxide release from recent eruptions has *not* been shown to lead to a detectable increase in global warming

HAZARD RANKING

Low Medium High

COMMUNITY LIFELINES

239 Total

Food, Water, Shelter — Greatest

SQUARE MILES

1,115 State Buildings

1,938 Environmental Resources

71 Hawaiian Home Lands

404 Cultural Resources

241 Miles of State Road

CONTENTS

TABLES

FIGURES

[1] *Section Cover Photo: Ahuʻailaʻau (Fissure 8) eruption in 2018, Hawaiʻi Island. Photo by Bruce Houghton*

SECTION 4. RISK ASSESSMENT

4.14 VOLCANIC HAZARDS

2023 SHMP Update Changes

- Volcanic hazard events that occurred in the State of Hawaiʻi from January 1, 2018, through December 31, 2022, were researched for this 2023 SHMP Update.
- New and updated figures from federal and state agencies are incorporated.
- This section now includes a discussion of how floods impact socially vulnerable populations and community lifelines.
- Reefs (both artificial and coral) are now separated out for all hazards in the Environmental Resources analysis and listed along with critical habitat, wetlands, and parks and reserves.
- Six types of cultural resources (archaeology, burial sensitivity area, historic building, historic district, historic object, and historic structure) are added to the vulnerability assessment.

4.14.1 HAZARD PROFILE

The main Hawaiian Islands are at the tops of giant undersea shield volcanoes, located at the southeastern end of a chain of volcanoes that began to form over 70 million years ago. Each island is made up of one or more volcanoes that first erupted on the ocean floor and emerged above the ocean's surface after countless eruptions over hundreds of thousands of years. All of the volcanic activity in the last 200 years has occurred on the Island of Hawaiʻi. The Island of Hawaiʻi is known for frequent occurrence of lava flow eruptions on Kīlauea near its summit and along its east rift zone and, less frequently, its Southwest Rift Zone. Mauna Loa, the second most active volcano on the Island of Hawaiʻi, averaged one eruption every 5 years before 1950. However, it has erupted only three times since 1975, most recently in November 2022. The 38 years since the previous eruption marked the longest quiet period on record (U.S. Geological Survey 2022).

The likelihood that future lava flows from Kīlauea and Mauna Loa will interfere with human activity and infrastructure increases as communities and other development encroach on these active volcanoes (U.S. Geological Survey n.d.). Hualālai Volcano, although still considered active, has erupted most recently in 1801, whereas Mauna Kea is considered to be dormant, having erupted about 4,000 years ago. Both of these volcanoes are considered to pose comparatively minimal threats of eruptive impact to residents and infrastructure on the island. Haleakalā volcano on Maui last erupted about 500 years ago at its summit and southwest rift zone. It does not currently show signs of unrest and is unlikely to pose a threat in the immediate future.

Volcanic Terms Defined

- **ʻAʻā** – Lava with a rough, rubbly surface composed of broken lava blocks called clinkers
- **Lava** – Molten rock that has reached the surface of the Earth
- **Laze** – Lava haze gas plume created when molten lava flows into the ocean
- **Magma** – Molten rock beneath Earth's surface
- **Pāhoehoe** – Lava with a smooth or ropy surface
- **Vog** – Visible haze of gas, tiny particles, and acidic droplets emitted from a volcano

Kamaʻehuakanaloa (formerly Lōʻihi) is the youngest volcano associated with the Hawaiian chain and is located 15 miles (28 km) southeast of Kīlauea volcano underwater off the southern coast of the Island of Hawaiʻi. There are no estimated potential impacts to residents and infrastructure from Kamaʻehuakanaloa based on its size, location, depth in the ocean, and activity recorded since 1996.

Hazard Description

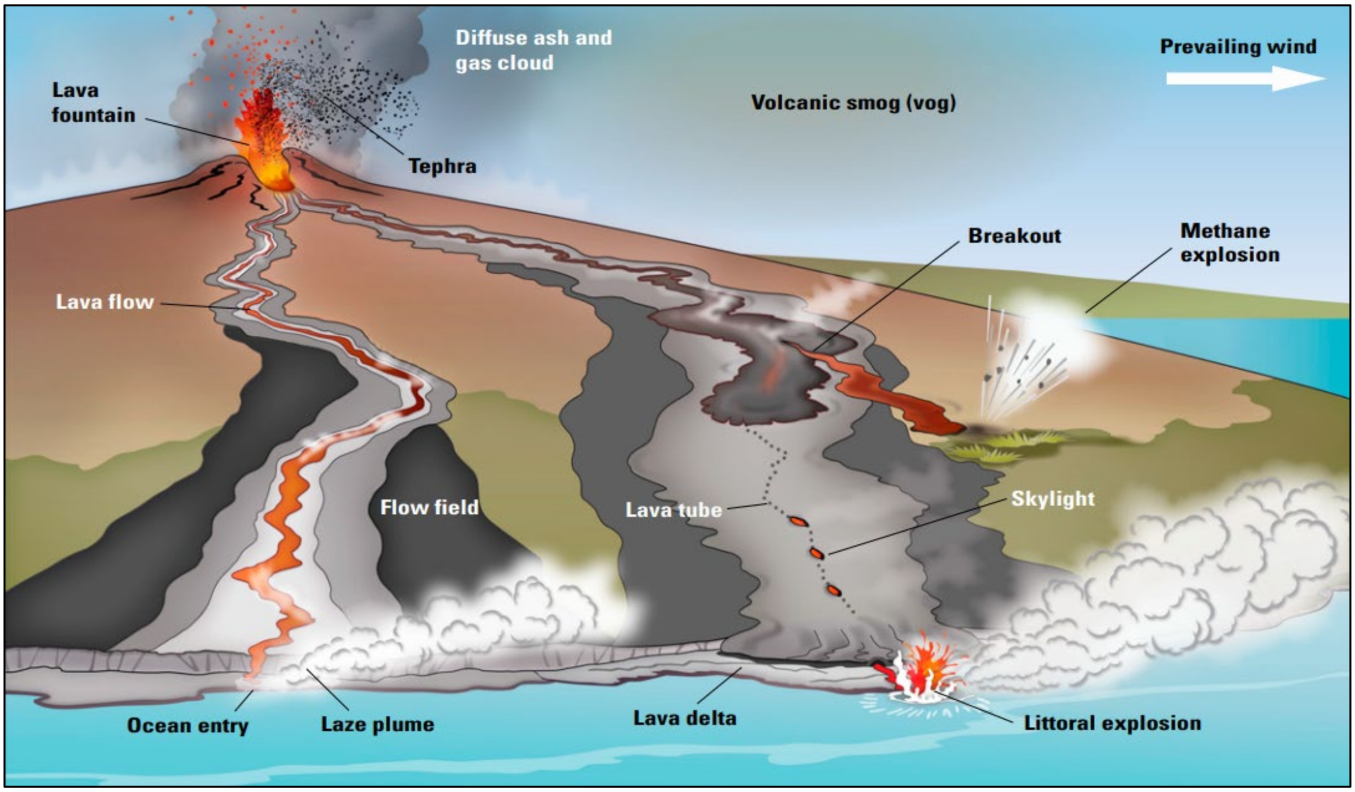
Hawaiian volcanoes are shield volcanoes. Because shield volcanoes dominantly erupt fluid, lava flows form gently sloping, shield-like mountains. Shield volcanoes are the largest volcanoes on Earth. Examples of shield volcanoes (see

Figure 4.14-1) are Mauna Loa and Kīlauea, which are located in the County of Hawaiʻi. Volcanic activity in Hawaiʻi is distinct from that occurring at continental margins (e.g., Mt. Shasta, Mt. Saint Helens, etc.) in that the state's volcanoes produce more fluid basalt magmas that are typically less explosive. Hawaiian volcanoes form at the southeast end of the chain and are sequentially transported as they age to the northwest by movement of the Pacific plate. Each volcano develops through a relatively consistent sequence of stages exemplified by Kamaʻehuakanaloa (the youngest), forming an intermittently active submarine volcano on the ocean floor; to Kīlauea, in near constant, vigorous activity producing fluid basalts that are expanding the boundaries of the island to the south and encroaching on the southern flank of its older sister volcano Mauna Loa. Mauna Loa, a less frequently active volcano, continues to discharge fluid basalts at much higher volume rates during its eruptive episodes, whereas Hualālai and Mauna Kea are less active but typically produce more viscous and more explosive lavas.

Mauna Loa last erupted in 2022, and Kīlauea continuously erupted from 1983 to 2018. Kīlauea erupted again from December 2020 to May 2021. A summit eruption occurred from September to early December 2022, and started again in early January 2023.

Lava that flows from shield volcanoes is almost entirely of basalt composition. The fluid, low viscosity of the basalt and the long duration of the flows create the gentle slopes of shield volcanoes. Basalt lava flows are characterized by two morphologies known around the world by their Hawaiian names: ʻaʻā and pāhoehoe. Eruptions from shield volcanoes are not typically explosive unless water has entered the vent (Oregon State University 2022).

Figure 4.14-1. Shield Volcano and Lava Field Components



Source: (U.S. Geological Survey 2019)

The understanding of the eruptive process is incomplete since subject matter experts have been able to observe and record only a small fraction of the life cycle of Hawaiian volcanoes; the frequency and intensity of the explosive events is not yet fully understood. Shield volcanoes erupt almost exclusively at their summits or along rift zones. For example, Puʻu ʻŌʻō, the vent associated with the current eruption from 1983 until 2018, is on the east rift zone of Kīlauea Volcano (Patrick, et al. 20220).

Young Hawaiian volcanoes, such as Kīlauea and Mauna Loa, have summit calderas. In Hawaii's shield volcanoes, calderas are depressions several miles in diameter that form as the result of a collapse when magma drains from beneath the summit. Summit eruptions of Kīlauea and Mauna Loa occur within or near their calderas. Flank eruptions usually take place along rift zones, which are highly fractured zones of weakness within the volcano that typically extend from the summit of a volcano toward the coastline and continue under the ocean (University of Hawaiʻi 2023).

Volcanic Phenomena

Volcanic phenomena appear to be individually isolated and diversified. Some phenomena can pose great risk to people and property near these volcanoes, while others pose no risk to people or property, such as Kamaʻehuakanaloa that produces submarine pillow lavas. Those phenomena that would pose the most risk to people and property include:

- Lava flows at the summits and along the rift zones
- Ground cracking, slumping, or deformation
- Earthquake activity associated with the intrusion of magma
- Possible displacement of volcanic flank (i.e., larger earthquakes) associated with the intrusion of magma into the flanks (e.g., the 2018 M6.9 on Kīlauea’s south flank or Mauna Loa’s 1868 M7.9 Ka’u event)
- The discharge of volcanic gases (sulfur dioxide and sulfuric acid)
- The potential for explosive eruptions at the summit accompanying drain-out of the summit magma column
- Pit crater formation on the rift zones, possibly accompanied by explosive interaction of groundwater with subsurface magma
- Volcanic weather phenomena such as “fire clouds” or “volcanic tornadoes”
- Bench collapse along newly formed shoreline
- Methane explosions from burning vegetation
- Falling ejecta (ash)
- Tsunamis induced by the earthquakes that trigger or are caused by volcanic activity

Volcanic hazards most prevalent in the State of Hawaiʻi are: lava flow, volcanic gases, bench collapse, and methane explosions. These hazards are further discussed throughout this section.

Lava Flows

Lava flows typically erupt from a volcano’s summit or along rift zones on its flanks. Lava flows present potential threats to homes, infrastructure, natural and historic resources and entire communities. The areas exposed to the highest risk from lava flows are those situated downslope and proximate to the active rift zones of the active Mauna Loa and Kīlauea volcanoes, as was seen with the 2018 eruption of Kīlauea. Lava flows travel downslope toward the ocean, burying everything along the way. Lava entering the ocean may build new land known as lava deltas, which are unstable and prone to sudden collapse. A collapsing lava delta can trigger explosive activity that hurls hot rocks hundreds of yards inland or seaward (U.S. Geological Survey n.d.). Steep slopes may allow lava flows to move quickly from the summit to the ocean in a matter of hours (Pappas 2022).

Explosive volcanic eruptions can produce a variety of pyroclastic material called tephra, including:

- Large fragments (angular blocks and rounded bombs) expelled with great force but deposited near the eruptive vent
- Smaller fragments (lapilli) of ash and thin glass fibers (Pele’s hair) carried upward within in a volcanic plume and downwind in a volcanic cloud
- Very fine-grained material volcanic ash carried upward within the plume and blown downwind for very long distances, which can affect communities and farmland across hundreds, or even thousands, of miles.

Volcanic Gas

Volcanic gas emissions are composed mainly of water vapor (H_2O), carbon dioxide (CO_2), and sulfur dioxide (SO_2), with trace amounts of several other gaseous compounds, including hydrogen sulfide (H_2S), hydrogen fluoride (HF), and carbon monoxide (CO). Vog is a hazy mixture of SO_2 gas and aerosols, primarily composed of sulfuric acid droplets and other sulfate (SO_4) compounds. Aerosols are created when SO_2 and other volcanic gases combine in the atmosphere and interact chemically with oxygen, moisture, dust, and sunlight over periods of minutes to days. Vog particles grow by absorbing water vapor and other gases, so they can increase in size in a moist environment such as the nose, mouth, and throat (U.S. Geological Survey n.d.).

When molten lava flows into the ocean, it creates localized air pollution known as laze (combination of the words lava and haze). This is a type of gas plume that results in hazy and noxious conditions downwind of an ocean entry. It forms through a series of chemical reactions as hot lava boils seawater to dryness. The plume is a mixture of hydrochloric acid gas (HCl), steam, and tiny volcanic gas particles. The entry point area and downwind should be avoided by humans, as laze can cause skin and eye irritation and breathing difficulties (U.S. Geological Survey n.d.).

Bench Collapse

Unstable lava deltas along a newly formed shoreline following volcanic activity can result in what is often referred to as a “bench collapse”. The collapses happen because the lava benches build up over unstable, underwater piles of rubble. Shifting or landslides in the rubble below erode the support for the surface outcropping, and finally, the lava deltas collapse. In April 1993, a local native of the Island of Hawaiʻi, a Kona photographer, died at Kīlauea's eruption site when a lava bench which appeared to be solid collapsed. He was attempting to photograph the entry site of lava into the ocean. He and several other onlookers had crossed a rope barrier set up by park rangers. When the bench collapsed, the others were able to scramble to safety, but the photographer was swept into the sea (Sprowl 2014).

Methane Explosions

Methane gas explosions are caused by lava igniting the pockets of vegetation rotting due to vog. Decomposing vegetation produces methane gas that can travel subsurface beyond the lava front in different directions, accumulating in pockets that can ignite. The methane can seep through cracks several feet away from the lava (see Figure 4.14-2). It can also cause explosions when it is ignited while trapped underground. These blasts can toss blocks several feet away. This methane gas can also be the source of the blue flame that is most recognizable at night during lava flow events.

LOCATION

This section discusses the best data available to define the locations of the four volcano hazards profiled above for the purpose of assessing the risk from these hazards. To measure risk, assessments need a defined location to measure the vulnerability assets and populations exposed to the hazard. In some cases, for a hazard like vog, may potentially impact the entire planning area. In other cases, such as lava flows, there may be clearly define mapping that allows an assessment to determine exposure and potential impacts from the hazard.

There are six active volcanoes in the State of Hawaiʻi: five located in the County of Hawaiʻi and one located in the County of Maui. Table 4.14-1 summarizes the location of these volcanoes and the associated potential threat/areas at risk.

Figure 4.14-2. Burning Methane Gas Erupting Through Cracks in a Leilani Estates Street, 2018

Source: U.S. Geological Survey/Associated Press

Table 4.14-1. Active Volcanoes in the State of Hawaiʻi

Name of Volcano	Location of Volcano	Date of Last Eruption	Threat Potential / Areas at Risk
Haleakalā	County of Maui	1600 A.D.	Moderate threat potential; areas at risk include Hana, Keokea, Kula, Pukalani, and Wailea-Makena
Mauna Loa	County of Hawaiʻi	November-December 2022 and lasted 15 days	Very high threat potential; areas at risk include the districts of South Hilo, Puna, Kaʻu, South Kona, North Kona and South Kohala
Kīlauea	County of Hawaiʻi	January 2023–ongoing	Very high threat potential; areas at risk include portions of the Puna district; eruptions on the southwest flank of Kīlauea are a threat to land within the Hawaiʻi Volcanoes National Park and the district of Kaʻu
Hualālai	County of Hawaiʻi	1801	High threat potential; areas at risk include the land within the North Kona district
Mauna Kea	County of Hawaiʻi	Between 6,000 and 4,000 years ago	Moderate threat potential
Kamaʻehuakanaloa (underwater volcano)	County of Hawaiʻi (located 22 miles southwest)	1996	Low to very low threat potential

Sources: (U.S. Geological Survey n.d., U.S. Geological Survey 2021)

Lava Flows Location

The USGS Hawaiian Volcano Observatory (HVO) monitors six active volcanoes with delineated lava flow hazard areas on the Islands of Hawaiʻi and Maui that may pose a hazard to communities (U.S. Geological Survey n.d.). The lava flow hazard areas are based on past eruption sites, the likely path of lava flows from those sites based on topography and historical flows, and the frequency of lava inundation over the past several thousand years. The lava flow zones are designed to show the relative lava flow hazard across each island and are suitable for general planning purposes. The lower the number zone, the greater severity of the hazard (U.S. Geological Survey n.d.). The lava flow zones in each county are classified differently, meaning Zone 1 in the County of Hawaiʻi is not the equivalent of Zone 1 in the County of Maui. HVO is currently developing standardized statewide maps that will allow for consistent lava hazard zone numbering. Those maps may be available for use in future planning efforts. For this SHMP update, Figure 4.14-3 and Figure 4.14-4 illustrate the lava flow hazard areas in the Counties of Hawaiʻi and Maui, based on existing data from HVO. Descriptions of the lava zones are as follows:

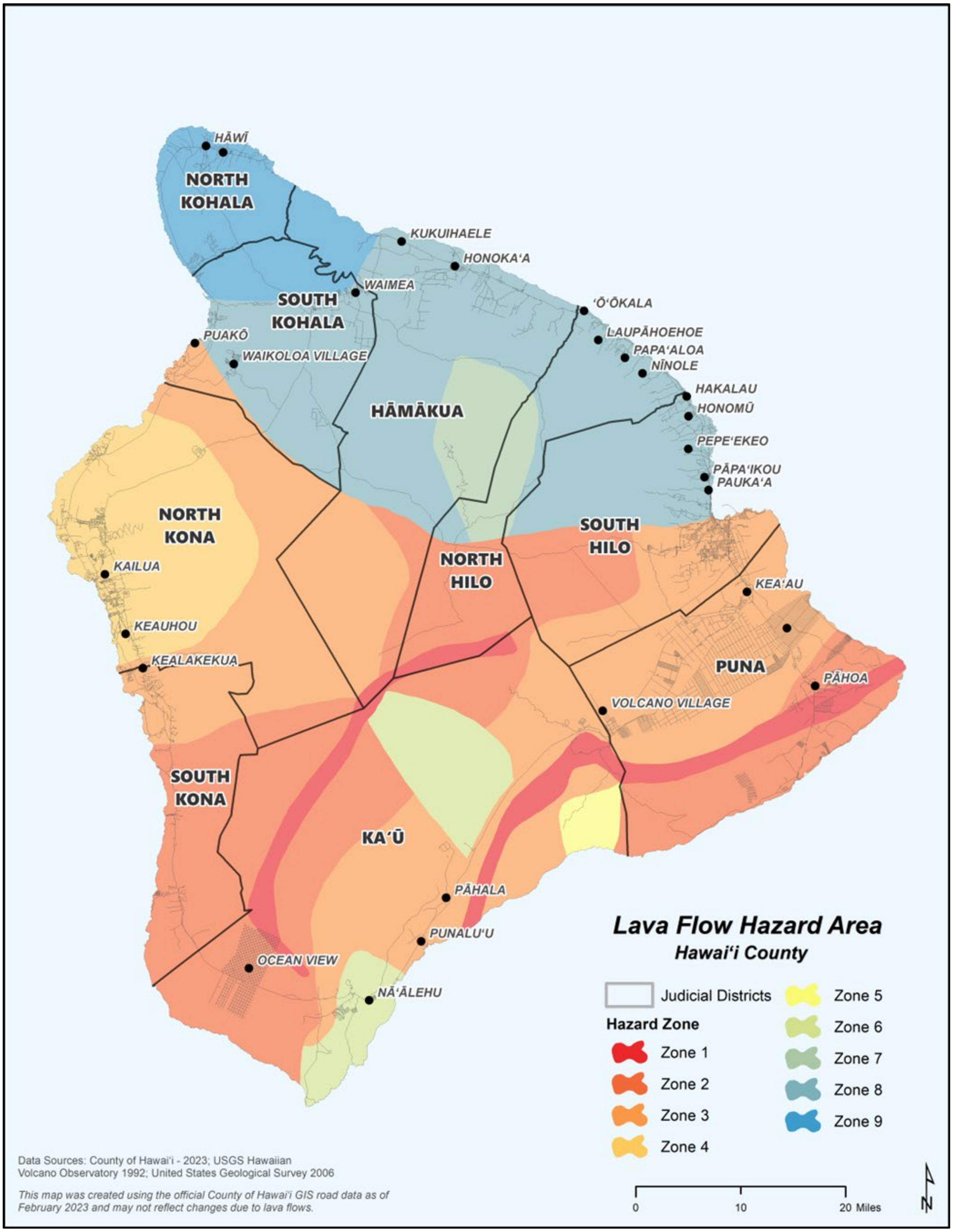
County of Hawaiʻi

- Zone 1 includes summits and rift zones of Kīlauea and Mauna Loa, where vents have been repeatedly active since written records have been kept (c.a. 1800 CE)
- Zone 2 includes areas adjacent to, and downslope of, Zone 1. Fifteen to 25 percent of Zone 2 has been covered by lava since 1800, and 25 to 75 percent has been covered within the past 750 years. Lava flow hazard within Zone 2 decreases gradually as one moves away from Zone 1.
- Zone 3 includes areas less hazardous than Zone 2 because of greater distance from recently active vents and (or) because of topography. 1 to 5 percent of Zone 3 has been covered since 1800, and 15 to 75 percent has been covered within the past 750 years.
- Zone 4 includes all of Hualālai, where the frequency of eruptions is lower than that for Kīlauea or Mauna Loa. Lava coverage is proportionally smaller, about 5 percent since 1800, and less than 15 percent within the past 750 years.
- Zone 5 includes the area on Kīlauea protected by topography (the north-facing Koaʻe fault system)
- Zone 6 includes two areas on Mauna Loa, both protected by topography
- Zone 7 includes the younger part of much-less-active volcano Mauna Kea; 20% of this area was covered by lava in the past 10,000 years
- Zone 8 is the remaining part of Mauna Kea; only a small percentage of this area has been covered by lava in the past 10,000 years.
- Zone 9 is Kohala Volcano, which last erupted over 60,000 years ago

County of Maui

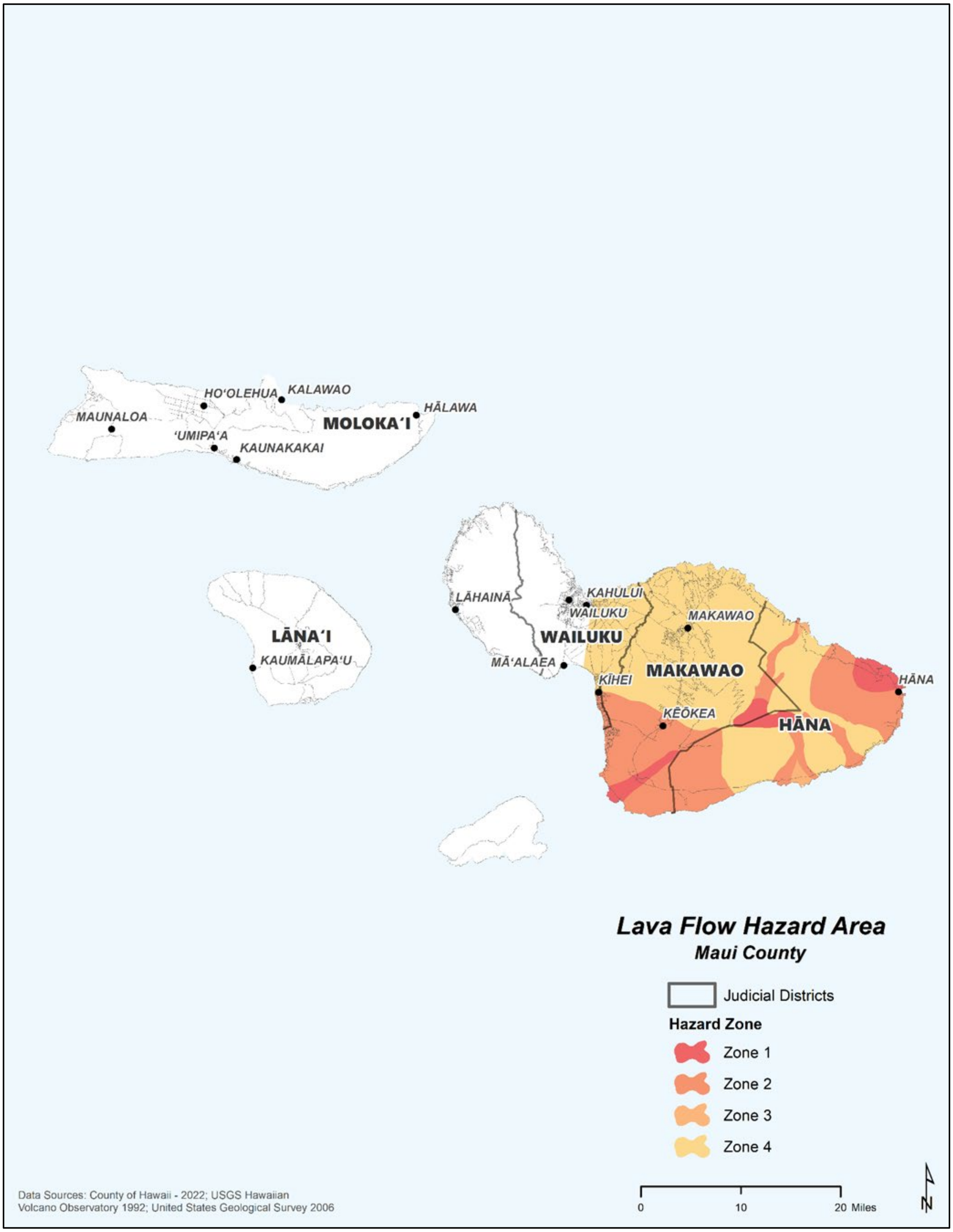
- Zone 1 - Encompasses the lower- and middle-altitude reaches of the southwest and east rift zones, Haleakalā Crater itself, and an area on the northern flank of the east rift zone; all areas where eruptions have occurred frequently in the past 1500 years.
- Zone 2 - Encompasses the volcano’s flanks downslope of the southwest and east rift zone axes, chiefly areas where lava has encroached at least once in the past 13,000 years.
- Zone 3 - Demarcates downslope reaches centered low on the Kaʻupo and Koʻolau lava fans. These areas, although within potentially active lava sheds, have become sheltered by buildup of lava upslope during the past 40,000 years that now would deflect new lava toward only the margins of the fans.
- Zone 4 - Encompasses those flanks shielded from lava during the past 100,000 years or for which the sparse eruptive products found are the consequence of off-rift cinder cones from random, infrequent eruptive events. Corresponds to essentially no hazard under most lava inundation conditions.

Figure 4.14-3. Lava Flow Hazard Areas in the County of Hawaiʻi



Source: USGS HVO 1992

Figure 4.14-4. Lava Flow Hazard Areas in the County of Maui



Source: USGS 2006

Table 4.14-2 lists the square miles of these lava flow high risk zones, called the lava flow hazard areas, in each county. These zones were used to assess vulnerability discussed later in this section. The County of Hawaiʻi has the largest percent (65.47%) of the volcano lava flow hazard area (Zones 1 through 4) in the state.

Table 4.14-2. Lava Flow Hazard Areas in the State of Hawaiʻi

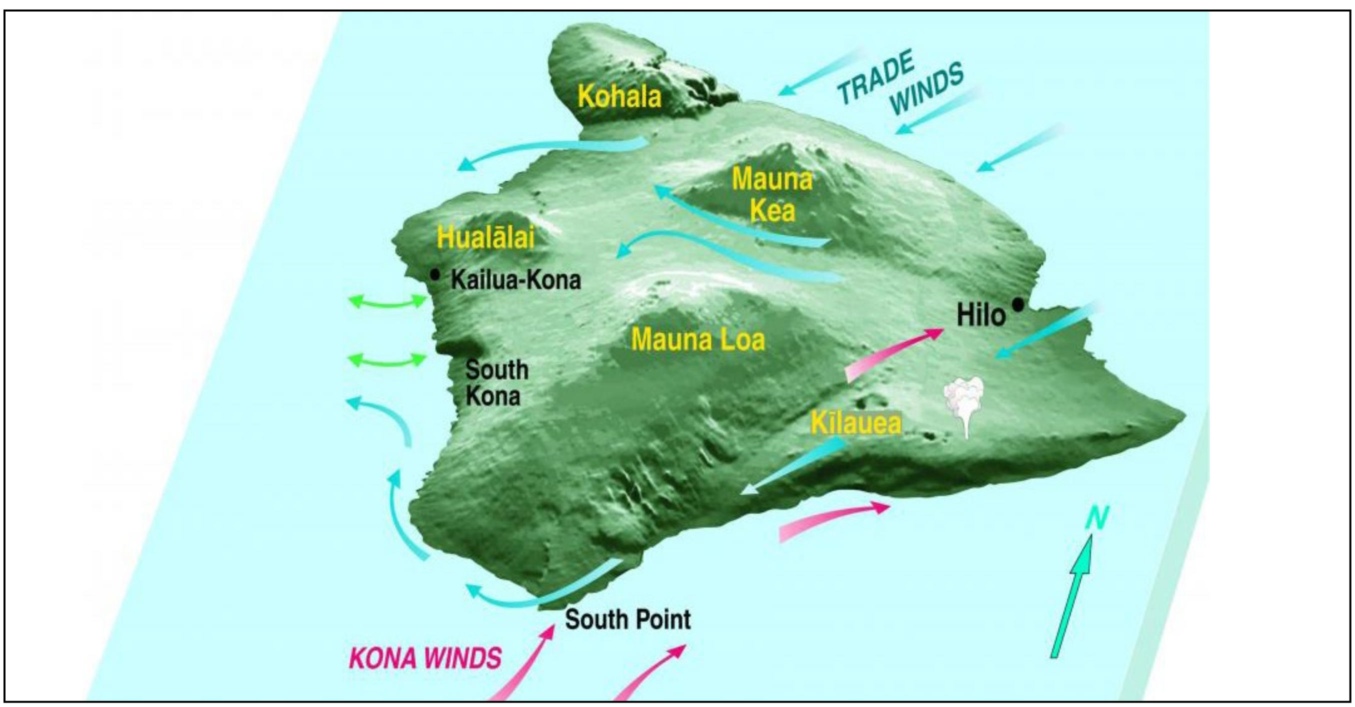
County	Area (in square miles)		
	Total Area of the County	Lava Flow Hazard Area	Hazard Area as Percent (%) of Total Area
County of Maui	1,176.28	216.5	18.4%
County of Hawaiʻi	4,039.64	2,644.80	65.47%
Total	**5,215.92**	**2,857**	**54.77%**

Source: USGS Hawaiian Volcano Observatory 1992; United States Geological Survey 2006

Volcanic Gases and Vog

While active volcanoes are only located on the Counties of Hawaiʻi and Maui, the entire state can be impacted by volcanic gases and vog. Vog conditions in the County of Hawaiʻi vary depending on wind direction (northeasterly trade winds, southerly Kona winds) and emission source. Looking at Figure 4.14-5, during prevailing trade winds, the nearly constant stream of vog produced by Kīlauea is blown to the southwest and west, where wind patterns send it up to the Kona coast. Once at the Kona coast, it becomes trapped by daytime and nighttime sea breezes (double-headed arrows on figure). However, when light Kona winds blow (red arrows on figure), much of the vog is concentrated on the eastern side of the island but can reach Honolulu County, which is more than 200 miles to the northwest of the County of Hawaiʻi (U.S. Geological Survey n.d.).

Figure 4.14-5. Wind Direction and Vog Conditions in the County of Hawaiʻi



Source: (U.S. Geological Survey n.d.)

Vog risk is both source (spatially) and time (weather) dependent. The Vog Measurement and Prediction Project (VMAP) provides real-time vog forecasts (may be accessed at http://weather.hawaii.edu/vmap/index.cgi). Vog impacts across the state are not expected to be as severe as those experienced in the County of Hawaiʻi. Though Kīlauea has a more frequent eruption history, Mauna Loa's magmatic gas discharge rate can be ten times that of Kīlauea.

Bench Collapse and Methane Gas Explosion

While no mapping has currently been produced specific to the bench collapse and methane case explosion hazards, their locations can be correlated to where there are likely to be lava flows since both hazards are directly associated with a lava flow. For the purposes of this assessment, the location of the bench collapse and methane gas explosion hazards is associated with the lava flow data, as discussed above.

EXTENT

The extent (the magnitude or severity) of volcanic hazards in the State of Hawaiʻi vary widely. Eruptions of volcanoes in the state range from almost imperceptible to major events that cover or create hundreds of acres of land, can destroy homes and businesses (see Figure 4.14-6), block or destroy roadways and other infrastructure, and can impact the quality of life, particularly due to vog and other gases.

Figure 4.14-6. Homes and Infrastructure in Hawaiʻi County Inundated by the 2018 Kīlauea Eruption

Source: Hawaiʻi Emergency Management Agency

Although explosive eruptions are rare for Hawaiʻi, the magnitude is determined by the degree of interaction between magma and water and ranges from harmless (such as steam blasts of pulverized rock when lava encounters the ocean) to catastrophic (such as those that produce pyroclastic surges that travel from the summit of a volcano several miles outward, killing people and destroying property).

In current times, most eruptions from Hawaiian volcanoes are forecasted due to weeks or months of precursory activity (e.g., seismicity, deformation, methane, littoral explosions, and laze). However, volcanic activity can also occur with little advanced warning. The 2018 eruption on the lower east rift zone was preceded by less than a day of warning. Officials were not seriously anticipating propagation of the 35-year long Puʻu ʻŌʻō rift eruption into lower Puna weeks or months prior to the event. Volcano-alert notifications are produced by volcano observatory scientists and are based on analysis of data from monitoring networks, direct observations, and satellite sensors. They are issued for both increasing and decreasing volcanic activity and include text about the nature of the unrest or eruption and about potential or current hazards and likely outcomes. The USGS employs a nationwide volcano alert-level system for characterizing conditions (Normal, Advisory, Watch, Warning) at U.S. volcanoes. Notifications about the status of activity at U.S. volcanoes are issued through the five regional U.S. volcano observatories. The USGS alert-level system for volcanic activity has two parts:

- Ranked terms to inform people on the ground about a volcano’s status (Table 4.14-3)
- Ranked colors to inform the aviation sector about airborne ash hazards (Table 4.14-4)

Table 4.14-3. USGS Volcano Alert-Level Terms

Alert Level	Details
Normal	Volcano is in typical background, non-eruptive state or, after a change from a higher level, volcanic activity has ceased, and volcano has returned to non-eruptive background state.
Advisory	Volcano is exhibiting signs of elevated unrest above known background level or, after a change from a higher level, volcanic activity has decreased significantly but continues to be closely monitored for possible renewed increase.
Watch	Volcano is exhibiting heightened or escalating unrest with increased potential of eruption, timeframe uncertain, or eruption is underway but poses limited hazards.
Warning	Hazardous eruption is underway, imminent, or suspected.

Source: U.S. Geological Survey n.d.

Table 4.14-4. USGS Volcano Aviation Color Codes

Alert Color	Details
Green	Volcano is in typical background, non-eruptive state or, after a change from a higher level, volcanic activity has ceased, and volcano has returned to non-eruptive background state.
Yellow	Volcano is exhibiting signs of elevated unrest above known background level or, after a change from a higher level, volcanic activity has decreased significantly but continues to be closely monitored for possible renewed increase.
Orange	Volcano is exhibiting heightened or escalating unrest with increased potential of eruption, timeframe uncertain, or eruption is underway with no or minor volcanic ash emissions (ash-plume height specified, if possible).
Red	Eruption is ongoing or imminent with significant emission of volcanic ash into the atmosphere likely or eruption is underway or suspected with significant emission of volcanic ash into the atmosphere (ash-plume height specified, if possible).

Source: U.S. Geological Survey n.d.

Lava Flows

The advance of lava flows depends on the type of lava and its viscosity; the terrain of the ground over which it travels; whether the lava flows as a broad sheet, through a confined channel, or down a lava tube; and the rate of lava produced at the vent (U.S. Geological Survey n.d.). Hawaiian lava flows generally advance slowly and can be easily avoided by people. But they can destroy or cover nearly everything in their paths (see Figure 4.14-7). Future lava flows are likely to interfere with human activity and infrastructure as communities and other development encroach on active volcanoes (U.S. Geological Survey n.d.).

Figure 4.14-7. Lava from the 2018 Kīlauea Eruption Covers a Road in the Puna District

Source: Hawaiʻi Emergency Management Agency

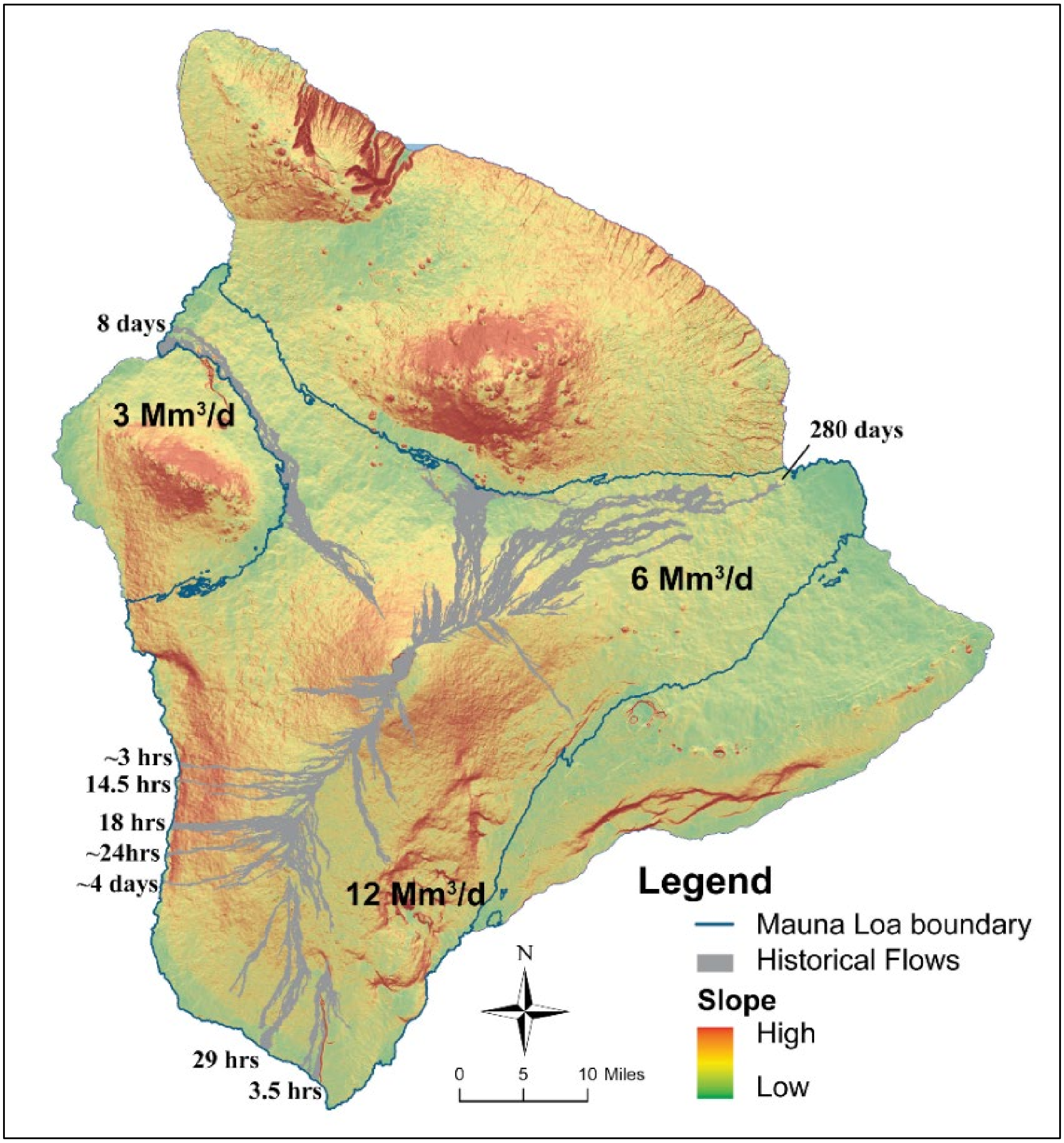
Geologists monitor active vents and lava flows to observe and document newly created volcanic features and to sample lava or tephra for chemical and mineral analyses. This helps in understanding what a volcano is doing and how the activity might impact adjacent communities. Measuring the effusion rate (the volume of lava flow erupted per unit of time) is used to characterize the vigor of an eruption (U.S. Geological Survey n.d.). During ongoing eruptions, lava flows are monitored for changes such as increases in eruption rate and overflows from established channels because these may result in changing hazards downslope.

Warning Time

The speed of a lava flow is determined not only by the steepness of the terrain but also by the effusion rate and rheology (viscosity, density, etc.) of lava that is erupted, with higher effusion rates producing faster (and usually larger) flows. The leading edge of a basalt lava flow can travel as fast as 6 miles per hour on steep slopes and nearly 20 miles per hour when confined to a channel or lava tube (U.S. Geological Survey n.d.).

During an eruption, advance rates of lava flow fronts are based on any available observations of the flow front and the overall advance rate of similar, earlier lava flows that passed through the same location. However, this method is highly uncertain because factors that control flows are always changing, such as the eruption rate, ground slope, and the complex interaction of ʻaʻā and pāhoehoe flows with the local terrain over which the flow is moving (U.S. Geological Survey n.d.). Figure 4.14-8 shows historical lava flows for eruptions at Mauna Loa.

Figure 4.14-8. Lava Flows of Mauna Loa

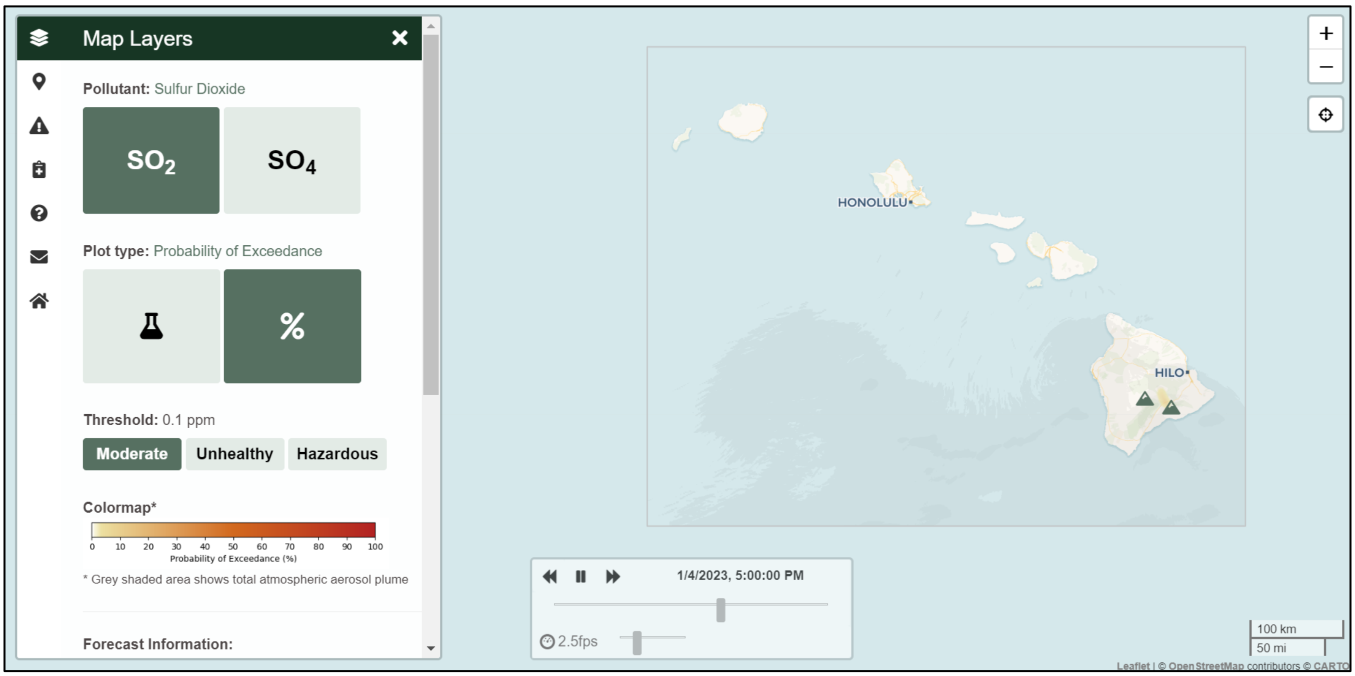


Source: (U.S. Geological Survey n.d.)
Note:
Mm3/d Million cubic meters per day

Volcanic Gases and Vog

The extent of the hazard posed by volcanic gases and vog depends on the amount of magma being erupted and the concentration of gas in that magma. The Vog Measurement and Prediction Project (VMAP) provides real-time vog forecasts of vog trajectories and vog concentrations for the state when the emission rate is known. Each day, VMAP provides a summary and forecast for the Island of Hawaiʻi and statewide and is online here: http://weather.hawaii.edu/vmap/. Figure 4.14-9 is an example of the SO_2 concentration for the entire state. This particular emission rate is for a period of time when Mauna Loa was below the detection limit and Kīlauea had emissions predicted of 153 tonnes per day.

Figure 4.14-9. SO_2 Concentration Map, Statewide



Source: School of Ocean and Earth Science and Technology 2023

Warning Time

The HVO conducts gas monitoring to determine changes in emission rates of certain gases, chiefly sulfur dioxide (SO_2) and carbon dioxide (CO_2). Changes are compared with other monitoring information to assess magma supply and eruption rates, issue eruption warnings, improve gas-hazard assessments and vog forecasts, and better understand how Hawaiian volcanoes work. Additionally, the State of Hawaiʻi Department of Health (DOH) monitors the air quality for the state, including vog and its effects on people. Stationary air quality monitors that measure particulate levels are located in Hilo, Keaʻau, Mountain View, Pāhala, Hawaiian Ocean, Kona, and Waikoloa on Hawaiʻi Island, and on Maui, Oʻahu, and Kauaʻi. The State of Hawaiʻi DOH also has air monitoring stations for SO_2 on the islands of Hawaiʻi, Oʻahu, and Kauaʻi (U.S. Geological Survey n.d.). The Hawaiʻi Interagency Vog Information Dashboard (HIVID) is an excellent source of background information and up-to-date measurements and observations: https://vog.ivhhn.org/.

Previous Occurrences and Losses

All eruptions since 1778 have been at Mauna Loa and Kīlauea, except for the 1800–1801 eruption of Hualālai on the west coast of the Island of Hawaiʻi. Many sources provide information regarding previous occurrences and losses associated with volcanic hazard events throughout the State of Hawaiʻi. The 2018 SHMP discussed specific volcanic events that occurred in Hawaiʻi through June 2018. For this 2023 SHMP Update, volcanic events were summarized between January 1, 2018, and December 31, 2022 (Table 4.14-5). Major events include those that resulted in losses or fatalities, events that resulted in the activation of the state and/or county emergency operations center, and/or events that led to a FEMA disaster declaration. For events prior to 2018, please refer to Appendix E (Hazard Profile Supplement).

Table 4.14-5. Volcanic Hazard Events in Hawaiʻi, 2018 to 2022

Date(s) of Event	Event Type	Counties Affected	Description
May – September 2018	Kīlauea Volcanic Eruption and Earthquakes (DR-4366)	Hawaiʻi	▪ On April 30, the Puʻu ʻŌʻō crater collapsed prompting seismicity in the Lower Puna District. ▪ On May 1, the USGS HVO issued a report that a migration of seismicity and deformation downrift (east) of Puʻu ʻŌʻō indicated that a large area along the east rift zone was potentially at risk of new outbreak, possibly in the Lower Puna area. ▪ On May 2, the first small ground cracks appeared in the Leilani Estates area. ▪ Between May 3 and May 27, 24 fissures opened in the lower east rift zone. ▪ On May 11, FEMA issued a major disaster declaration for the State of Hawaiʻi due to the eruption of Kīlauea. The County of Hawaiʻi was included in this declaration. ▪ On May 16, heavy de-gassing was occurring at each vent within the Leilani Estates neighborhood and the lower East Rift. The Hawaiʻi Fire Department reported air quality condition RED (immediate danger to health) in areas around Lanipuna Gardens and surrounding farm lots on Pohoiki Road. ▪ On May 17, HVO indicated an explosive eruption at Kīlauea summit occurred at 4:17 a.m. with ash clouds reaching 30,000 feet before drifting downwind. ▪ On May 20, white plumes of acid and extremely fine shards of glass billowed over the Island of Hawaiʻi as molten rock from Kīlauea poured into the ocean. The rate of sulfur dioxide gas shooting from the ground fissures tripled, leading County of Hawaiʻi to repeat warnings about air quality. At the volcano's summit, two explosive eruptions unleashed clouds of ash. Winds carried much of it toward the southwest. Since May 3, Kīlauea burned some 40 structures, including two dozen homes, since it began erupting in the Leilani Estates neighborhood. About 2,000 people were evacuated from their homes, including 300 who were staying in shelters. ▪ May 31, 2018, Mandatory Evacuation Order in Effect for Leilani Estates. Hawaiian Volcano Observatory reports that vigorous lava eruptions continue from the lower east rift zone fissure system in the area of Leilani Estates and Lanipuna Gardens. Over the following several months, lava continued to erupt, most notably from Fissure 8 (Ahuʻailaʻau) covering 13.7 square miles, more than 600 residences, over 100 other structures, and causing about $800 million in property damage.

Date(s) of Event	Event Type	Counties Affected	Description
December 2020 – March 2021	Kīlauea Volcanic Eruption	Hawaiʻi	▪ On December 20, the USGS Hawaiian Volcano Observatory (HVO) detected a glow within Halemaʻumaʻu crater at the summit of Kīlauea volcano. As lava cascaded into Halemaʻumaʻu crater, it instantly vaporized the growing lake of water that had been developing in the crater since 2018. ▪ By December 24, the lake of water was replaced by a lava lake more than 500 feet deep. ▪ On December 26, the North vent was submerged into the lava lake. The West vent increased its outflow of lava into the lake. The lower inlet of the West vent was eventually submerged, and a dome fountain was created by the upwelling of the outflowing lava. ▪ By January 11, 2021, surface activity at the West vent had increased. But the dome fountaining in the lake had ceased. Weeks of lava spatter had formed a large cinder cone, and eruption activity slowed. ▪ After 5 months of activity, a decrease in effusion indicated that the eruption in Halemaʻumaʻu at the summit of Kīlauea was going to pause. HVO field crews did not observe any signs of lava lake activity on May 25 and reported no signs of active surface lava. The next day Kīlauea was no longer erupting. The crusted-over lava lake was last measured at 229 m (751 ft) deep and was stagnant across its surface.
September 2021 – January 2023	Kīlauea Volcanic Eruption	Hawaiʻi	▪ On September 29, three fissures opened within Halemaʻumaʻu crater. The new fissures generated lava flows on the surface of a previous lava lake surface, creating a new lava lake, eventually growing to nearly 300 acres in size. ▪ Lava flooded the floor of the Halemaʻumaʻu crater for the first week of the eruption. The eruption then focused on the West vent in the crater. ▪ Over the next 14 months, lava flows continued to fill in the crater, ultimately effusing over 29 billion gallons of lava and raising the crater floor to nearly 500 feet higher than before the eruption. Although the eruption experienced 24 short-term pauses, an active portion of the lava lake was almost always visible, making for ideal viewing from several caldera overlooks for over a year. ▪ Lava supply to the crater stopped December 9. ▪ The summit eruption resumed January 5, 2023
November 2022 – December 2022	Mauna Loa Volcanic Eruption	Hawaiʻi	▪ On November 27, new fissures opened some distance away from the summit along the Northeast Rift Zone. Soon after, the summit fissures stopped erupting. ▪ By Friday, December 2, the eruption was limited to fissure 3 along the Northwest Rift Zone. Fissure 3, the only active fissure, was producing between 50 and 100 cubic yards of lava per second, flowing down slope and out of the park to the north toward Daniel K. Inoye State Highway 200 (Saddle Road). ▪ On December 13, 2022, the Hawaiian Volcano Observatory determined that "Mauna Loa is no longer erupting." Adding, "Lava supply to the fissure 3 vent on the Northeast Rift Zone ceased on December 10 and sulfur dioxide emissions have decreased to near pre-eruption background levels."

Sources: U.S. Geological Survey 2018; NPS 2022a; NPS 2022b; NPS 2023; Kīlauea Recovery and Resilience Plan 2020

Disaster and Emergency Declarations

The following disaster declarations and emergency proclamations related to volcanic hazards have been issued for Hawaiʻi:

- **Federal disaster (DR) or emergency (EM) declarations, 1955 – 2022**: 6 events classified as one or a combination of volcano or earthquake with volcanic disturbances
- **Hawaiʻi state emergency proclamations, 2018 – 2022**: 2 volcanic events
- **USDA Agricultural Disaster Declarations, 2012 – 2022**: None

One volcanic hazard event that affected the State of Hawaiʻi was declared a FEMA disaster between 2018 and 2022. It is identified in Table 4.14-6. For events prior to 2018, please refer to Appendix E (Hazard Profile Supplement). Appendix D (Map Atlas) illustrates the number of FEMA-declared volcanic hazard-related disasters by county.

Table 4.14-6. Volcanic Hazard-Related State and Federal Declarations, 2018 to 2022

Year	Event Type	Date Declared	Federal Declaration Number	Counties Affected
May 2018	Hawaiʻi Kīlauea Volcanic Eruption and Earthquakes	May 11, 2018	DR-4366	Hawaiʻi

Source: FEMA 2023

PROBABILITY OF FUTURE HAZARD EVENTS

Overall Probability

Explosive eruptions of any size take place infrequently in the State of Hawaiʻi. Eruptions are often preceded with some warning. The HVO rates the potential threat, based in part on the probability of future eruptions, from each of the volcanoes it monitors as follows (U.S. Geological Survey n.d.):

- Kīlauea—Very High. This volcano has been erupting continuously since 1983.
- Mauna Loa—Very High. It last erupted in 1984 and is considered certain to erupt again.
- Hualālai—High. It is likely to erupt again.
- Mauna Kea—Moderate.
- Haleakalā—Moderate.

Overall, volcanic hazard events will continue to occur in the State of Hawaiʻi. As noted earlier, there are six active volcanoes in the state, with Kīlauea currently erupting at the time of this plan update. Based on historical record, the state has experienced six FEMA declarations associated with volcanic hazards since 1954. Based on the historic FEMA disaster declaration record, the state may experience a major volcanic event that leads to a FEMA declaration roughly once every 10 years. Looking at volcanic hazard events that occurred in the State of Hawaiʻi since 1823, there have been 92 volcanic eruptions with varying severity and impacts. Based on this data, the State of Hawaiʻi may experience one volcanic eruption every two years. An eruption may last one day, or several decades. Over the last 50 years, about 37 years have included continuous volcanic activity from two eruptions

(Maunaulu and Puʻu ʻŌʻō). Based on data from the past five decades, the State of Hawaiʻi has a 72 percent chance of a continuous eruption in any given year.

Climate Change Impacts

Climate change is not expected to increase the probability of volcanic events, but changing future conditions may impact the dispersion and areas of impact of the volcanic hazard. As discussed in other hazard sections in this plan, projections indicate potential changes in wind and rainfall activity in the state. Any changes in wind and rainfall frequency and intensity may alter the dispersion of volcanic gas emissions, adversely impacting human health. For details regarding climate change as a distinct hazard and its unique impacts to the State of Hawaiʻi, refer to Section 4.2 (Climate Change and Sea Level Rise).

The types of volcanic activity that could impact climate are not those typically associated with Hawaiian volcanoes. The massive outpouring of gases and ash can influence climate patterns for years following a volcanic eruption. The conversion of sulfur dioxide to sulfuric acid is the most significant climate impact from a volcano. The Pinatubo eruption in the Philippines in 1991 was one of the largest volcanic events in the 20th century, injecting 20 million tons of sulfur dioxide into the stratosphere. It ultimately cooled the Earth's surface by about 1°F for 3 years after its eruption. In contrast, the carbon dioxide released in recent eruptions in Hawaiʻi has not been shown to lead to a detectable increase in global warming (USGS 2005).

4.14.2 VULNERABILITY ASSESSMENT

To assess the state's risk from volcanic hazards, the spatially delineated lava flow hazard zones for the Counties of Hawaiʻi (zones 1 through 4) and Maui (zones 1 and 2) were used. The Counties of Kauaʻi and City and County of Honolulu do not have USGS lava maps, Therefore, no results are reported in the tables below.

Lava Flow Hazard Area Definition

To assess vulnerability to lava flow, the following datasets were used:

- **County of Hawaiʻi** – Lava flow zones 1 through 4 in the spatial layer available on the Hawaiʻi Statewide GIS Programs Geoportal (originally prepared by USGS HVO 1992).
- **County of Maui** – Lava flow zones 1 and 2 in the spatial layer provided by USGS.

HI-EMA selected the following range of zones to define the lava flow hazard areas: Zones 1 through 4 for the County of Hawaiʻi; and Zones 1 and 2 for the County of Maui. Overall, an asset is considered exposed if it is located in a lava flow hazard area. During an active lava flow event, total loss of exposed assets is assumed. A qualitative discussion regarding potential vog impacts is also presented below.

Assessment of State Vulnerability and Potential Losses

This section discusses the state asset exposure and potential losses due to lava flows. State assets include state buildings, state roads and critical facilities.

State Assets

The spatial analysis determined that there are 95 state buildings in the County of Maui and 1,020 state buildings in the County of Hawaiʻi located in the lava flow hazard areas (see Table 4.14-7 through Table 4.14-9). Greater than 80% of the state buildings located in the County of Hawaiʻi are located in the lava flow hazard area. The majority of these buildings are occupied by the Department of Education, University of Hawaiʻi, and Hawaiʻi Public Housing Authority. Once the lava flow reaches the buildings, it is assumed the entire structure will be burned, and the land will be buried. Only replacement cost value was available for state buildings; however, a more accurate reflection of loss to the lava flow hazard would be the combined value of the land and structure using tax-assessed data.

Table 4.14-7. State Buildings Located in the Lava Flow Hazard Area by County

County	Total Number of State Buildings	Total Replacement Cost Value	State Buildings in the Lava Flow Hazard Area			
			Number	Percent (%) of Total	Total Replacement Cost Value	Percent (%) of Total
County of Maui	831	$3,097,491,689	95	11.43%	$222,068,001	7.17%
County of Hawaiʻi	1,261	$4,638,567,141	1,020	80.89%	$3,061,350,031	66.00%
Total	**2,092**	**$7,736,058,830**	**1,115**	**53%**	**$3,283,418,032**	**42.44%**

Source: USGS Hawaiian Volcano Observatory 1992; United States Geological Survey 2006; State of Hawaiʻi Risk Management Office 2017

Table 4.14-8. State Buildings in the County of Hawaiʻi Located in the Lava Flow Hazard Area by Agency

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Hazard Area	Percent (%) of Total Buildings	Value in the Hazard Area	Percent (%) of Total Value
Dept of Accounting & General Services	23	$49,800,037	9	39.13%	$43,091,860	86.53%
Dept of Agriculture	14	$14,457,181	8	57.14%	$9,566,284	66.17%
Dept of Attorney General	5	$8,057,004	5	100.00%	$8,057,004	100.00%
Dept of Budget & Finance	4	$1,102,861	4	100.00%	$1,102,861	100.00%
Dept of Business, Economic Development and Tourism	1	$21,930,055	1	100.00%	$21,930,055	100.00%
Dept of Commerce & Consumer Affairs	0	$0	0	0.00%	$0	0.00%
Dept of Defense	7	$21,294,676	7	100.00%	$21,294,676	100.00%
Dept of Education	806	$3,032,014,198	621	77.05%	$1,558,392,474	51.40%
Dept of Hawaiian Home Lands	4	$4,437,602	2	50.00%	$2,156,000	48.58%
Dept of Health	6	$16,433,860	6	100.00%	$16,433,860	100.00%
Dept of Human Resources Development	0	$0	0	0.00%	$0	0.00%
Dept of Human Services	18	$26,873,841	14	77.78%	$19,008,602	70.73%
Dept of Labor and Industrial Relations	8	$14,262,182	8	100.00%	$14,262,182	100.00%
Dept of Land and Natural Resources	2	$4,309,241	2	100.00%	$4,309,241	100.00%
Dept of Public Safety	52	$60,003,409	52	100.00%	$60,003,409	100.00%

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Hazard Area	Percent (%) of Total Buildings	Value in the Hazard Area	Percent (%) of Total Value
Dept of Taxation	0	$0	0	0.00%	$0	0.00%
Dept of Transportation	7	$145,908,345	5	71.43%	$144,544,745	99.07%
Hawaiʻi State Ethics Commission	0	$0	0	0.00%	$0	0.00%
Hawaiʻi Health Systems Corporation	34	$268,254,553	23	67.65%	$241,774,312	90.13%
Hawaiʻi Housing Finance & Development Corporation	29	$86,029,651	29	100.00%	$86,029,651	100.00%
Hawaiʻi Public Housing Authority	63	$224,042,406	55	87.30%	$196,187,666	87.57%
Hawaiʻi State Legislature	0	$0	0	0.00%	$0	0.00%
Hawaiʻi State Public Library System	11	$42,426,683	6	54.55%	$19,817,400	46.71%
Judiciary	13	$107,355,122	11	84.62%	$106,301,953	99.02%
Legislative Reference Bureau	0	$0	0	0.00%	$0	0.00%
Office of Hawaiian Affairs	2	$544,989	2	100.00%	$544,989	100.00%
Office of the Auditor	0	$0	0	0.00%	$0	0.00%
Office of the Governor	0	$0	0	0.00%	$0	0.00%
Office of the Lieutenant Governor	0	$0	0	0.00%	$0	0.00%
Office of the Ombudsman	0	$0	0	0.00%	$0	0.00%
Research Corporation of the University of Hawaiʻi	0	$0	0	0.00%	$0	0.00%
University of Hawaiʻi	152	$489,029,245	150	98.68%	$486,540,807	99.49%
Total	**1,261**	**$4,638,567,141**	**1,020**	**80.89%**	**$3,061,350,031**	**66.00%**

Source: *USGS Hawaiian Volcano Observatory 1992; United States Geological Survey 2006; State of Hawaiʻi Risk Management Office 2017*

Table 4.14-9. State Buildings in the County of Maui Located in the Lava Flow Hazard Area by Agency

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Hazard Area	Percent (%) of Total Buildings	Value in the Hazard Area	Percent (%) of Total Value
Dept of Accounting & General Services	5	$11,155,000	0	0.00%	$0	0.00%
Dept of Agriculture	6	$14,837,348	0	0.00%	$0	0.00%
Dept of Attorney General	2	$4,596,267	0	0.00%		0.00%
Dept of Budget & Finance	3	$928,470	0	0.00%	$0	0.00%
Dept of Business, Economic Development and Tourism	1	$9,978,917	1	100.00%	$9,978,917	100.00%
Dept of Commerce & Consumer Affairs	0	$0	0	0.00%	$0	0.00%
Dept of Defense	3	$16,512,909	0	0.00%	$0	0.00%
Dept of Education	563	$1,643,027,339	70	12.43%	$128,103,796	7.80%
Dept of Hawaiian Home Lands	2	$689,000	0	0.00%	$0	0.00%
Dept of Health	3	$4,843,533	0	0.00%	$0	0.00%
Dept of Human Resources Development	0	$0	0	0.00%	$0	0.00%
Dept of Human Services	15	$40,181,697	0	0.00%	$0	0.00%

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Hazard Area	Percent (%) of Total Buildings	Value in the Hazard Area	Percent (%) of Total Value
Dept of Labor and Industrial Relations	6	$7,933,611	0	0.00%	$0	0.00%
Dept of Land and Natural Resources	15	$7,364,163	1	6.67%	$552,425	7.50%
Dept of Public Safety	24	$67,950,438	0	0.00%	$0	0.00%
Dept of Taxation	0	$0	0	0.00%	$0	0.00%
Dept of Transportation	28	$221,677,724	1	3.57%	$191,500	0.09%
Hawaiʻi State Ethics Commission	0	$0	0	0.00%	$0	0.00%
Hawaiʻi Health Systems Corporation	36	$658,673,127	21	58.33%	$79,315,317	12.04%
Hawaiʻi Housing Finance & Development Corporation	28	$78,210,082	0	0.00%	$0	0.00%
Hawaiʻi Public Housing Authority	4	$15,058,800	0	0.00%	$0	0.00%
Hawaiʻi State Legislature	0	$0	0	0.00%	$0	0.00%
Hawaiʻi State Public Library System	7	$20,774,018	1	14.29%	$3,926,046	18.90%
Judiciary	9	$51,294,291	0	0.00%	$0	0.00%
Legislative Reference Bureau	0	$0	0	0.00%	$0	0.00%
Office of Hawaiian Affairs	2	$331,760	0	0.00%	$0	0.00%
Office of the Auditor	0	$0	0	0.00%	$0	0.00%
Office of the Governor	0	$0	0	0.00%	$0	0.00%
Office of the Lieutenant Governor	1	$2,257,785	0	0.00%	$0	0.00%
Office of the Ombudsman	0	$0	0	0.00%	$0	0.00%
Research Corporation of the University of Hawaiʻi	0	$0	0	0.00%	$0	0.00%
University of Hawaiʻi	68	$219,215,409	0	0.00%	$0	0.00%
Total	**831**	**$3,097,491,689**	**95**	**11.43%**	**$222,068,001**	**7.17%**

Source: USGS Hawaiian Volcano Observatory 1992; United States Geological Survey 2006; State of Hawaiʻi Risk Management Office 2017

Lava flows can close and ultimately destroy roads. This may result in the isolation of areas and larger regional issues such as loss of commerce and increased traffic on other roadways. Utilities that commonly follow roads, including those underground, will be buried and probably burned or rendered useless by excess heat resulting in disruption of services. Table 4.14-10 shows the length of state roads exposed to lava flow hazard (zones) by county. The County of Hawaiʻi has the greatest number of miles (218.7 miles) exposed, which makes up 57.67% of all state roads in the county. A complete list of state roads located in the lava flow hazard zones is included in Appendix F (State Profile and Risk Assessment Supplement).

Table 4.14-10. State Roads Located in the Lava Flow Hazard Area by County

County	Length (in miles)		
	Total Length	Length of State Road in Hazard Area	Percent (%) of Total Length
County of Maui	245.9	22.1	8.99%
County of Hawaiʻi	379.2	218.7	57.67%
Total	**625.1**	**240.8**	**38.52%**

Source: *USGS Hawaiian Volcano Observatory 1992; United States Geological Survey 2006; State of Hawaiʻi Department of Transportation 2022*

Community Lifelines and Critical Facilities

Table 4.14-11 summarizes the total number of community lifelines and critical facilities by category located in the lava flow hazard area in the Counties of Hawaiʻi and Maui. The County of Hawaiʻi has 201 community lifelines located in the lava flow hazard area. The County of Maui has 38 community lifelines located in the lava flow hazard area. Table 4.14-12 and Table 4.14-13 summarize the number and percentage of exposed critical facilities by category in the Counties of Hawaiʻi and Maui, respectively. Hazardous Materials has the largest percentage (100%) of their facilities within the County of Hawaiʻi lava flow hazard area. Energy has the largest percentage (25%) of their facilities within the County of Maui lava flow hazard area.

Similar to state buildings, only replacement cost value was available for community lifelines and critical facilities; however, a more accurate reflection of loss to the lava flow hazard would be the combined value of the land and structure using tax-assessed data. Additionally, the loss of service provided by each destroyed community lifeline and critical facility would increase the total loss from the hazard.

Table 4.14-11. Community Lifelines and Critical Facilities Located in the Lava Flow Hazard Area in Counties of Hawaiʻi and Maui

County	Community Lifeline Categories								Additional Critical Facilities
	Communications	Energy	Food, Water, Shelter	Hazardous Material	Health & Medial	Safety & Security	Transportation	Total in the Hazard Area	
County of Maui	4	1	13	0	6	8	2	34	4
County of Hawaiʻi	24	8	59	4	27	48	15	185	16
Total	**28**	**9**	**72**	**4**	**33**	**56**	**17**	**219**	**20**

Source: *USGS Hawaiian Volcano Observatory 1992; United States Geological Survey 2006; Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020*

Table 4.14-12. Community Lifelines and Critical Facilities Located in the Lava Flow Hazard Area in the County of Hawai'i, by Category

Category	Total Number of Facilities in the County of Hawaiʻi	Total Replacement Cost Value	Number of Facilities in Hazard Area	Percent (%) of Total Facilities	RCV in the Hazard Area	Percent (%) of Total RCV
Communications	31	$93,481,861	24	77.42%	$73,877,926	79.03%
Energy	9	$198,746,450	8	88.89%	$188,244,650	94.72%
Food, Water, Shelter	80	$2,680,336,405	59	73.75%	$1,938,647,355	72.33%
Hazardous Material	4	$145,176,000	4	100.00%	$145,176,000	100.00%
Health and Medical	36	$716,428,294	27	75.00%	$435,601,169	60.80%
Safety and Security	65	$2,231,470,278	48	73.85%	$1,542,345,673	69.12%
Transportation	17	$616,998,000	15	88.24%	$544,410,000	88.24%
Additional Critical Facilities	28	$90,935,100	16	57.14%	$51,464,800	56.60%
Total	**270**	**$6,773,572,388**	**201**	**74.44%**	**$4,919,767,573**	**72.63%**

Source: *USGS Hawaiian Volcano Observatory 1992; United States Geological Survey 2006; Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020*

Table 4.14-13. Community Lifelines and Critical Facilities Located in the Lava Flow Hazard Area in the County of Maui, by Category

Category	Total Number of Facilities in the County of Maui	Total Replacement Cost Value	Number of Facilities in Hazard Area	Percent (%) of Total Facilities	RCV in the Hazard Area	Percent (%) of Total Value
Communications	22	$145,876,494	4	18.18%	$24,153,738	16.56%
Energy	4	$147,298,900	1	25.00%	$36,294,000	24.64%
Food, Water, Shelter	74	$2,380,051,303	13	17.57%	$445,330,255	18.71%
Hazardous Material	0	$0	0	0.00%	$0	0.00%
Health and Medical	50	$784,590,174	6	12.00%	$147,573,808	18.81%
Safety and Security	77	$23,758,378,102	8	10.39%	$2,920,913,866	12.29%
Transportation	23	$834,762,000	2	8.70%	$72,588,000	8.70%
Additional Critical Facilities	34	$193,201,010	4	11.76%	$16,711,800	8.65%
Total	**284**	**$28,244,157,982**	**38**	**13.38%**	**$3,663,565,466**	**12.97%**

Source: *USGS Hawaiian Volcano Observatory 1992; United States Geological Survey 2006; Hawaiʻi Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020*

Assessment of Local Vulnerability and Potential Losses

This section provides a summary of statewide exposure and potential losses to population, general building stock, environmental resources, and cultural assets by county.

The local HMPs were reviewed to integrate risk assessment results into the 2023 SHMP Update; a summary of information available is below.

- **County of Kauaʻi** –The County HMP did not include Volcanic Activity as a standalone hazard.
- **City and County of Honolulu** – The City and County of Honolulu only characterizes Vog as a hazard of concern, as all volcanic structures on the island are considered extinct and only neighboring volcanoes on the Island of Hawaii and possibly Haleakalā on Maui present a threat to the area. The HMP discusses health impacts and impacts to plant tissues from SO_2 (City and County of Honolulu 2020).
- **County of Maui** – The Maui County HMP discusses two categories of volcanic risk: lava flows and vog. The HMP includes a map of Lava Flow Hazard Zones posed by Haleakalā. While all residents are considered at risk from vog, certain populations, such as single parent and dependent households, elderly populations, residents living below the poverty line, residents without adequate communication infrastructure and/or limited English proficiency, residents living in properties built prior to the 1950s, and residents with limited mobility are at particular risk from lava flows (County of Maui 2020).
- **County of Hawaiʻi** – The Hawaiʻi County HMP collaborated with the USGS Hawaiian Volcano Observatory to describe eight categories of volcanic hazards, including lava flow, laze, vog, acid rain, explosive eruption, ashfall, volcanic glass, and ground failure/subsidence (earthquakes and tsunamis are included separately as standalone hazards). The HMP characterizes the six volcanos on or adjacent to the island. The County found that 2,263 residents and 974 buildings are located in Lava Inundation Zone 1 (the highest risk area) and 15,315 residents and 6,555 buildings are located in Lava Inundation Zone 2 (the second highest risk area). Vog is expected to impact all residents within the County. (County of Hawaiʻi 2020).

Socially Vulnerable and Total Population

The communities and populations especially vulnerable to volcanic eruptions include low-income communities, migrant populations, populations whose primarily language is not English, indigenous populations, communities of older adults, and those with respiratory and other health concerns. These populations may be more susceptible to transport and communication challenges. They may also be impacted by the effects of toxic volcanic ash and problems of the respiratory system, eyes, and skin. Psychological effects, injuries, waste disposal and water supply issues, collapse of buildings and power outage are all likely to impact vulnerable populations (Zuskin, et al. 2007).

Lava Flows

Lava flows endanger people's property, livelihood, and peace of mind, but less commonly, their lives. The leading edge of Hawaiian lava flows generally move more slowly than the speed at which people walk, although the lava in the channel behind the front may be flowing much faster. On steep slopes, a large flow could travel rapidly enough to endanger persons in its path. During the 1950 eruption of Mauna Loa, the fast-moving lava flows reached the South Kona Coast in about 3 hours, having traveled 11 miles during that timeframe (Hawaiian Volcano Observatory 2016).

For the County of Hawaiʻi, Table 4.14-14 shows that an estimated 80% of the county population is living in the lava flow hazard area. For the County of Maui, Table 4.14-14 shows that an estimated 12% of the county population is living in the lava flow hazard area. This analysis does not include the number of tourists and visitors in the state whose lodgings are located in the lava flow hazard area. Therefore, this estimate may be underestimating exposure and vulnerability.

Table 4.14-14. 2020 U.S. Census Population Located in the Lava Flow Hazard Area by County

County	Population				
	Total Population	Population in the Hazard Area	Population Exposed as % of Total Population	Socially Vulnerable Population in the Hazard Area	Socially Vulnerable Population Exposed as % of Total Population
County of Maui	167,093	20,033	12%	0	0%
County of Hawaiʻi	201,350	161,698	80%	36,475	18%
Total	**368,443**	**181,731**	**49%**	**36,475**	**10%**

Source: *USGS Hawaiian Volcano Observatory 1992; United States Geological Survey 2006; U.S. Census Bureau 2020; Centers for Disease Control and Prevention 2018*

The populations considered most vulnerable to hazards in general include the elderly (persons over the age of 65) and individuals living below the U.S. Census poverty threshold. These socially vulnerable populations are most susceptible based on many factors including their physical and financial ability to react or respond during a hazard. The socially vulnerable population located in the lava flow hazard area makes up approximately 18% of the population in the County of Hawaiʻi and 0% in the County of Maui.

Volcanic Gases and Vog

The term 'vog' refers to the hazy air pollution caused by the volcanic emissions from Kīlauea volcano, which are primarily water vapor (H_2O), carbon dioxide (CO_2), and sulfur dioxide (SO_2) gas (Interagency Vog Dashboard 2023). Toxic gases emitted from a volcano can travel great distances and cause respiratory distress. Sulfur dioxide (SO_2) is irritating to the eyes, nose, throat and respiratory tract. The most vulnerable populations to vog include children and individuals with pre-existing respiratory conditions such as asthma, emphysema, bronchitis, and chronic lung or heart disease. Vulnerable populations may respond to very low levels of sulfur dioxide in the air. Prolonged or repeated exposure to higher levels may increase the danger.

The acute health threats posed by the gas discharges are largely associated with the acid gases, sulfur dioxide being the greatest threat because it is discharged at the highest rates and is also accompanied by sulfuric acid aerosols. The acute threats (to human health) typically fall off rapidly with distance from the vent. Although epidemiological data demonstrating the adverse impacts of gas exposure have been difficult to develop, anecdotal reports of families and individuals moving out of the exposed communities to avoid the effects of the gases are quite common. Future threats from these gases will also be dependent on the location of future eruptions.

As with the acute effects, documentation of the human health impacts of lower-level chronic exposure to the volcanic gases in downwind communities has proven difficult: epidemiological studies have documented only relatively minor impacts from sulfur dioxide exposure, but anecdotal reports of respiratory discomfort and eye irritation are extremely common and extend beyond the County of Hawaiʻi to the City and County of Honolulu during weather conditions conducive to transport of the plume along the island chain.

Of more concern is the presence of fluoride ion in the gas discharges. Because the use of roof-catchment of rainfall for domestic water consumption is a common practice in communities in the County of Hawaiʻi around and downwind of Kīlauea, there is the potential for accumulation of fluoride in these systems. More recent studies by

Donald Thomas and Trisha Macomber on public health hazards associated with rainfall catchment systems exposed to vog emitted from Kīlauea's Halemaumau Crater have shown that there is a clear influence on the emissions of vog on rainfall catchment systems located downwind from the source (Thomas and Macomber 2010). Thomas and Macomber's study indicates that an increase in fluoride and sulfate concentrations arise from dry deposition of vog plumes. The study found that levels of these compounds did not exceed the World Health Organization standards for drinking water. However, this finding precludes possible exceedance in the levels of the compounds in the catchment systems due to variations in the levels of the compounds in the plume of vog or exceedance in the levels of the compounds in catchment systems not sampled in the study.

In late 1980s, studies conducted on private rainfall catchment systems in the South Kona area revealed higher than average acidity in several water samples. Drinking the acidic water does not pose a health hazard, but such water can leach lead from the lead roof flashings, lead-headed nails, and solder connections found in many plumbing systems, resulting in unsafe levels of lead in the drinking water. Extensive testing in 1988 determined that many rainfall catchment systems in the County of Hawaiʻi, particularly those in the districts adjacent to or downwind of the active vent, contained elevated levels of lead.

The University of Hawaii's College of Tropical Agriculture and Human Resources notes that acidic rainwater is not normally a problem. The main concern is when heavy metals and other leached materials get into the water and are consumed. A common method for this to occur is when the copper in most water pipes becomes eroded and can be tasted in the drinking water (Hawaiʻi College of Tropical Agriculture and Human Resources n.d.) Hawaii's guidelines on rainfall catchment systems suggests that the key to a good system is to choose building materials that will not leach toxins into the water under normal or acid rain conditions. For example, the most common type of roofing material used for water catchment is galvanized metal that has been painted or enameled with a nontoxic paint. This may be difficult for owners of older homes, which may contain lead-based paint, lead-based solder, or lead-gasketed roofing nails at particularly high risk of lead mobilization into the domestic water supply by the acidic rainwater (Macomber 2020).

General Building Stock

Lava Flows

Man-made structures that escape other damage from an eruption can be damaged or destroyed by cracking, tilting, or settling of the ground beneath them. Ground cracks will remain after the eruption is over and can pose a threat to unwary people and animals if the cracks are obscured by heavy vegetation (Aabech n.d.). Similar to the analyses presented earlier, the general building stock data were overlaid with the lava flow hazard area to assess exposure. Table 4.14-15 summarizes the replacement costs and percentages for the Counties of Hawaiʻi and Maui. The County of Hawaiʻi has the greatest estimated potential losses (78.64%) to general building stock. As stated earlier, once lava flow reaches a building, it is assumed that both the structure and land are lost.

Table 4.14-15. General Building Stock Located in the Lava Flow Hazard Area by County

County	Total Replacement Cost Value	Replacement Cost within the Lava Flow Hazard Area	Percent (%) of Total
County of Maui	$50,796,693,140	$8,744,095,957	17.21%
County of Hawaiʻi	$58,395,349,136	$45,919,253,291	78.64%

County	Total Replacement Cost Value	Replacement Cost within the Lava Flow Hazard Area	Percent (%) of Total
Total	$109,192,042,277	$54,663,349,248	50.06%

Source: USGS Hawaiian Volcano Observatory 1992; United States Geological Survey 2006; NIYAM IT 2022; United States Army Corps of Engineers 2022

A hazard event can have great impacts on the local and statewide economy. In the far downwind community, on the western side of the Island of Hawaiʻi, weather conditions tend to accumulate the vog discharge into a thick haze that results in persistently overcast skies. The economy in the communities on the western side of the island is heavily dependent on tourism; the primary attraction is balmy weather, blue skies, and access to ocean activities. In 2018 during and following the eruption of Kīlauea, discussions on the state's tourism industry expressed concern that the adverse air quality associated with the ongoing eruption is reducing the attractiveness of this area as a vacation spot, resulting in a loss of income to all the businesses that rely on tourism for their success (Hawaiʻi Tourism Authority 2018). During the November 2022–December 2022 eruption of Mauna Loa, the opposite happened; tourism boomed during an otherwise slow tourism season (Selsky, McAvoy and Daley 2022).

The Kīlauea volcanic event placed a damper on the Hawaiian economy. According to interviews conducted by NPR, business owners and their employees indicated the normally busy tourism area felt like a ghost town. Tourism officials stated the booking pace for the summer of 2018 slowed by almost 50%; many local business owners blamed the over-excited news coverage, making possible tourists believe the whole island is erupting and sinking into the sea (NPR 2018). According to the University of Hawaiʻi Economic Research Organization, bookings for travel to the County of Hawaiʻi were down due to the eruption. The 2018 eruption closed Hawaiʻi Volcanoes National Park, the County of Hawaii's biggest tourist attraction (University of Hawaiʻi 2018). Tourists may have been apprehensive to visit, resulting in decreased or canceled bookings that can equate to a direct economic loss potentially in the millions. As discussed later in the Environmental Resources subsection below, agriculture in the state have experienced loss due to the volcanic gases.

Land Use Districts

Table 4.14-16 shows the square miles of the lava flow hazard area in each state land use district statewide; refer to Appendix F for results for the County of Hawaiʻi and the County of Maui. More than half of the Conservation District lands statewide are located in lava flow zones. Conservation District lands contain valuable environmental and ecological resources. Additional discussion of exposure and vulnerability of these resource areas can be found in the Environmental Resources and Cultural Assets sections below. Almost a quarter of Urban District lands statewide are located in lava flow zones. Over half (52%) of the Conservation District lands are located in lava flow zones.

Table 4.14-16. State Land Use Districts Located in the Lava Flow Hazard Area

Land Use District	Total (square miles)	Square Miles in Volcano Lava Flow Zones	Percent (%) of Total Area
Agricultural	2,973.6	1,122.7	37.8%
Conservation	3,202.9	1,664.0	52.0%
Rural	16.3	3.0	18.4%

Land Use District	Total (square miles)	Square Miles in Volcano Lava Flow Zones	Percent (%) of Total Area
Urban	319.1	75.5	23.7%
Total	**6,511.9**	**2,865.2**	**44.0%**

Source: USGS Hawaiian Volcano Observatory 1992; United States Geological Survey 2006; State Land Use Commission, Hawai'i Statewide GIS Program 2021; Honolulu County GIS 2022

Environmental Resources

Besides respiratory tract health effects similar to those in humans, vog can also cause the death of wildlife and livestock because of contaminated food consumption. Wildlife and livestock that graze, for example, can die after ingesting water or grass that has been heavily contaminated by falling ash and other volcanic particles. When vog mixes directly with moisture on the leaves of plants, it can cause severe chemical burns, which can damage or kill the plants. Sulfur dioxide (SO2) gas can also diffuse through leaves and dissolve to form acidic conditions within plant tissue (USGS n.d.).

Also of great concern to wildlife and livestock is the deposition of fluoride salts carried by vog onto forage crops. Scientific literature has documented a number of events where sheep, cattle, and horses have suffered significant losses as a result of acute exposure as well as chronic exposure and accumulation of fluoride salts by grazing animals (Koli, Yadav and Yadav 2017).

In 2010, Donald Thomas from the Center for the Study of Active Volcanoes and Trisha Macomber from the University of Hawaii's College of Tropical Agriculture produced a study on the effects of fluoride and sulfates on forage lands downwind of Kīlauea's Halemaumau Crater (Thomas and Macomber 2010). The study shows that forage samples contained fluoride and sulfate values higher than recommended by the World Health Organization. The study also indicates that although elevated concentrations of fluoride and sulfate do induce adverse health/nutritional effects on grazing animals, the high levels of these compounds do not impact the quality of meat from those animals that would be used for public consumption.

The general effects of sulfur dioxide exposure to plants varies between plant species, age, and the sulfur dioxide dosage; these effects may include:

- reduced seed germination
- enhanced susceptibility to other diseases
- foliar necrosis (spots, blight)
- epicuticular wax erosion
- rupture of epidermis, plasmolysis
- reduced chlorophyll content
- increased membrane permeability of plant leaves
- decreased plant growth (root length, shoot length, leaf numbers)
- plant organ or entire plant death

Downwind of Kīlauea, farmers growing food crops, foliage crops, and cut flowers have all experienced immediate and severe losses due to damage arising from exposure to high concentrations of sulfur dioxide and sulfuric acid aerosols. Although downwind ranches did not experience immediate impacts, over time, they have found that horses, cattle, and goats have developed serious adverse health impairments consistent with chronic fluoride exposure as well as severe mineral deficiencies. At the present time, the mediating factors in these health impacts are not well understood, although excess bone fluoride has been measured and therefore chronic exposure to and intake of fluoride is clearly one aspect of the problem. A secondary economic issue has been greatly accelerated corrosion of fencing, pipelines, and deterioration of ranching equipment. Anecdotal reports of service life losses of 60% to 70% suggest that the economic impacts of these losses could be severe.

The impacts resulting from gas discharge detailed above are based on existing rates of discharge from more or less fixed locations of emissions. In the event of significant increases in the discharge rate from Kīlauea or an eruption by Mauna Loa with 10 or more times the gas production rate of Kīlauea, the impacts from the gas can be expected to increase correspondingly.

Table 4.14-17 summarizes the environmental resources located in lava flow hazard areas. Coastal features, reefs, and other marine habitats, although not located in the lava flow hazard areas, may be impacted once the lava reaches the ocean. In the County of Hawaiʻi, 74.1% of Parks and Reserves are located in the lava flow hazard area. In the County of Maui, 31.2% of Critical Habitat is located in the lava flow hazard area.

Cultural Assets

Cultural sites are non-renewable resources. Lava flows can cut off or cover cultural sites and native land. A large percentage of the Hawaiian Home Lands are located in lava flow hazard areas; 34.9 square miles in the County of Maui or nearly 34% of the county total; and 35.9 square miles in the County Hawaiʻi or 18.8% of the county total (see Table 4.14-18). Table 4.14-19 summarizes cultural resources in lava flow hazard areas.

Table 4.14-17. Environmental Resources Located in the Lava Flow Hazard Area

Environmental Asset	Area (in square miles)					
	County of Hawaiʻi			County of Maui		
	Total Asset Area	Lava Flow Hazard Area	Hazard Area as Percent (%) of Total Area	Total Asset Area	Lava Flow Hazard Area	Hazard Area as Percent (%) of Total Area
Critical Habitat [a]	447	233	52.3%	293	92	31.2%
Wetlands	1,149	4	0.3%	1,382	39	2.8%
Parks and Reserves	2,023	1,498	74.1%	409	72	17.6%
Reefs [b]	9	0	0.3%	26	0	0.0%
Total [c]	**3,627**	**1,736**	**47.9%**	**2,110**	**202**	**9.6%**

Source: USGS Hawaiian Volcano Observatory 1992; United States Geological Survey 2006; U.S. Fish and Wildlife Service; Pacific Islands Office 2022l U.S. Fish and Wildlife Service 2021, 2017; Hawaiʻi State Department of Land and Natural Resources, Division of Forestry and Wildlife 2022; NOAA raster nautical charts 2020; State of Hawaiʻi Department of Land and Natural Resources, Division of State Parks 2021

Notes:

a. *Critical habitat area mileage includes the combined area of coverage of individual critical habitat areas*
b. *Reefs include artificial and coral reefs.*
c. *Total square miles includes environmental assets within 3 nautical miles of each county and may be over reported as some environmental asset areas may overlap.*

Table 4.14-18. Hawaiian Home Lands Located in Lava Flow Hazard Area

County	Area (in square miles)		
	Total Area	Lava Flow Hazard Area	Hazard Area as Percent (%) of Total
County of Maui	102.6	34.9	34.0%
County of Hawaiʻi	191.5	35.9	18.8%
Total	**294.0**	**70.8**	**24.1%**

Source: *USGS Hawaiian Volcano Observatory 1992; United States Geological Survey 2006; Hawaiʻi State Department of Hawaiian Homelands 2021*

Table 4.14-19. Cultural Resources Located in Lava Flow Hazard Area

Cultural Resource Site Type	Area (in square miles)		
	Total Square Miles of Asset	Total Square Miles in the Hazard Area	Percent (%) of Total Asset Area
Archaeology	90.9	19.2	21.1%
Burial Sensitivity Area	2.1	0.5	24.5%
Historic Building	2.7	0.4	15.3%
Historic District	849.4	358.2	42.2%
Historic Object	9.6	9.6	99.9%
Historic Structure	20.7	16.5	79.4%
Total	**975.4**	**404.4**	**41.5%**

Source: *USGS Hawaiian Volcano Observatory 1992; United States Geological Survey 2006; Department of Land and Natural Resources, Hawaiʻi State Historic Preservation Division 2022*

Future Changes that May Impact State Vulnerability

Understanding future changes that impact vulnerability in the state can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The State of Hawaiʻi considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

Potential of Projected Development

Lava flow hazard areas were overlain on areas that may experience significant changes in development or redevelopment in future years (see Table 4.14-20; refer to Section 3 for more information on projected development areas). The results of this assessment indicate that 42.39% of the Maui Development Project areas and roughly 39% of the Enterprise Zones in the County of Maui and the County of Hawaiʻi are located in lava flow hazard areas. County governments may wish to limit the density of development in these areas to prevent increasing exposure of life and property to the lava flow hazard.

Table 4.14-20. Maui Development Projects and Enterprise Zones Located in Lava Flow Hazard Areas

County	Area (in square miles)					
	Maui Development Projects (Total Area)	Total Area Exposed to Hazard	Hazard Area as Percent (%) of Total	Enterprise Zones (Total Area)	Total Area Exposed	Hazard Area as Percent (%) of Total
County of Maui	27.6	11.7	42.39%	1,059.80	168.57	15.91%
County of Hawaiʻi	0	0	0	1,274.90	728.1	57.11%
Total	**27.6**	**11.7**	**42.39%**	**2,334.70**	**896.67**	**38.41%**

Source: Maui County Planning Department 2016; Hawaiʻi Community Development Authority 2021; Community Economic Development Program, Department of Business, Economic Development & Tourism, County Planning Departments 2021; Tetra Tech Requested Data from Doug Bausch 2022.

Projected Changes in Population

As the age distribution of the population changes resulting in an increase in the number of elderly and young persons in the state, vulnerability to the impacts of volcanic gases and vog may increase as these populations tend to be more susceptible to negative impacts.

Volcanic Hazard Mitigation Success Story

Credit: Steven Businger and Nadya Moisseeva 2021

In 2021, the University of Hawaiʻi Atmospheric Sciences team was awarded an HMGP grant to install a ceilomoter at Pahala Elementary School in Hawaiʻi County. This tool has significantly improved the ability to forecast areas of heavy vog and poor air quality from volcanic emissions as part of the Vog Measurement and Prediction Program (VMAP) at UH. Forecasts are used to provide air quality warnings to the community, including the most vulnerable populations.

For more details on the VMAP project, please see Vog Measurement and Prediction (VMAP) | Home (hawaii.edu)

Section 4.15 Wildfire

NOTE: The August 2023 wildfire response and recovery is ongoing at the time this SHMP is being finalized. This section will be updated with additional wildfire hazard mitigation information as it becomes available.

Wildfire

Wildfires are unplanned and uncontained fires that burn in undeveloped land. Many Hawai'i communities and elements of infrastructure are in wildfire risk areas. Each island has unique wildfire risk areas, firefighting access, and local planning and preparedness efforts. The statistics below represent the statewide high wildfire risk area.

CHANGES SINCE 2018

+3 Declared Disasters

+28 Wildfire Events

COUNTIES MOST VULNERABLE

Kaua'i Honolulu **Maui** Hawai'i

SOCIALLY VULNERABLE POPULATION

9.8% Of Total Population

139,126 Persons

CLIMATE PROJECTIONS

Dry vegetation from increased temperatures may intensify wildfire danger

Average temperatures in Hawai'i could increase by as much as 5–7.5° F by the end of the century

Rainfall Changes An increase in consecutive dry days and decrease in total rainfall may increase wildfires.

HAZARD RANKING

Low Medium High

COMMUNITY LIFELINES

239 Total

Safety and Security — Greatest

2,896 State Buildings

SQUARE MILES

82 Environmental Resources

51 Hawaiian Home Lands

39 Cultural Resources

335 Miles of State Road

CONTENTS

TABLES

FIGURES

[1] *Section Cover Photo: Leilani Wildfire near Waikoloa. Photo courtesy of DLNR*

SECTION 4. RISK ASSESSMENT

NOTE: The August 2023 wildfire response and recovery is ongoing at the time this SHMP is being finalized. This section will be updated with additional wildfire hazard mitigation information as it becomes available.

4.15 WILDFIRE

2023 SHMP Update Changes

- New and updated figures from federal and state agencies are incorporated.
- This section now includes a discussion of how wildfires impact socially vulnerable populations and community lifelines.
- Wildfire events that occurred in the State of Hawaiʻi from January 1, 2018, through December 31, 2022 were researched for this 2023 SHMP Update.
- Six types of cultural resources (archaeology, burial sensitivity area, historic building, historic district, historic object, and historic structure) are added to the vulnerability assessment.

4.15.1 HAZARD PROFILE

Wildfires in the State of Hawaiʻi destroy native forests, alter soil composition, and threaten human safety and infrastructure. The State of Hawaii's native ecosystems are not fire adapted. In many cases, once an area burns, it is generally replaced by fire-prone non-native species, permanently changing the State of Hawaii's landscape (DLNR 2013). Over 25% of the state contains non-native, fire-prone grasses and shrubs, which fuels the fires that occur in the state (Figure 4.15-1). This percentage grows each time fire burns into native forest because the forest is then further invaded by fire-prone non-native species (DLNR 2021).

Each year, approximately 0.5% of the State of Hawaii's total land area burns, which is equal to or greater than the proportion burned of any other state (DLNR 2021). Over 98% of the total wildfires are human-caused. In the last 10 years, nearly 1,000 wildfires burned an average of 20,000 acres per year statewide. On the Hawaiian Islands, damages spread mauka to makai (from the mountain to the ocean) quickly, leading to catastrophic impacts to natural resources (Trauernicht, et al. 2015).

HAZARD DESCRIPTION

"Wildfire" is the term applied to any unwanted and unplanned fire burning in undeveloped land regardless of whether it is naturally or human-induced. While sometimes caused by lightning, between 2001-2010, 85% of fires in the United States were caused by humans (FEMA 2015).

Figure 4.15-1. 2022 Leilani Wildfire in Hawaiʻi County Burns Fire-Prone Grasses and Shrubs

Credit: DLNR

Fire hazards present a considerable risk to native ecosystems and biodiversity, including threatened and endangered plant and animal species. As a consequence of wildfire, vulnerability to flooding increases due to the reduction or elimination of plant materials and root systems to stabilize soils resulting in negative impacts, including potential destruction of watersheds affecting water quality and availability. Wildfire near coastal areas and increased erosion is a key threat to coral reef ecosystems. While wildfire damages terrestrial and aquatic systems, losses to cultural and economic resources and community infrastructure also occur.

The potential for significant damage to life and property exists in areas designated as “wildland urban interface (WUI) areas,” where development is adjacent to densely vegetated areas. Across the mainland U.S. the WUI is roughly defined as the zone where natural areas and development meet. In the State of Hawaiʻi, this definition has been expanded. Steep slopes create linkages between upland wildland fires and downslope impacts on communities, coastal areas, and municipal resources. Conversely, wildfires ignited near developed areas quickly spread into forested areas because of invasive grasses, putting threatened and endangered plant and animal species at risk (DLNR 2016).

The State of Hawaiʻi is also unique in that the vegetation surrounding communities is rapidly undergoing changes that yield higher wildfire risk, in large part due to increased invasion by fire-prone species from changes in land uses (such as active agriculture becoming unmanaged fallow land). In 2013, Hawaiʻi Wildfire Management Organization (HWMO) updated the Communities at Risk From Wildfire (CAR) map (discussed in the Location section of this profile). All developed areas across the state were assessed for risk and rated from Low to High based on 36 hazard characteristics that contribute to wildfire risk.

The WUI is the approximate area where the natural environment and development meet. According to the 2016 Hawaiʻi Forest Action Plan, the wildland areas in the WUI are made up of vast tracts of land that were once used and maintained for agricultural purposes but are now fallow and dominated by highly fire-prone invasive grasses. Wildfires in the WUI move quickly into forested areas because of the invasive grasses, putting threatened and endangered plant and animal species at risk (DLNR 2016).

Overall, WUI fires can be as damaging or even potentially more damaging than urban structural fires. This is due to the fact that wildland fires are often more difficult to control and behave differently from structural fires. When these fires erupt, people and structures must take priority, often at a devastating expense to natural resources. Current home and structure building standards allow structures to be built and maintained in a manner that leaves them and their occupants vulnerable (National Wildfire Coordinating Group 2006). Thus, wildfires become a significant threat to both humans and natural resources and often result in ecological losses to the State of Hawaiʻi.

According to National Geographic, there are four types of wildfires: ground wildfires, surface wildfires, crown wildfires, and spotting wildfires.

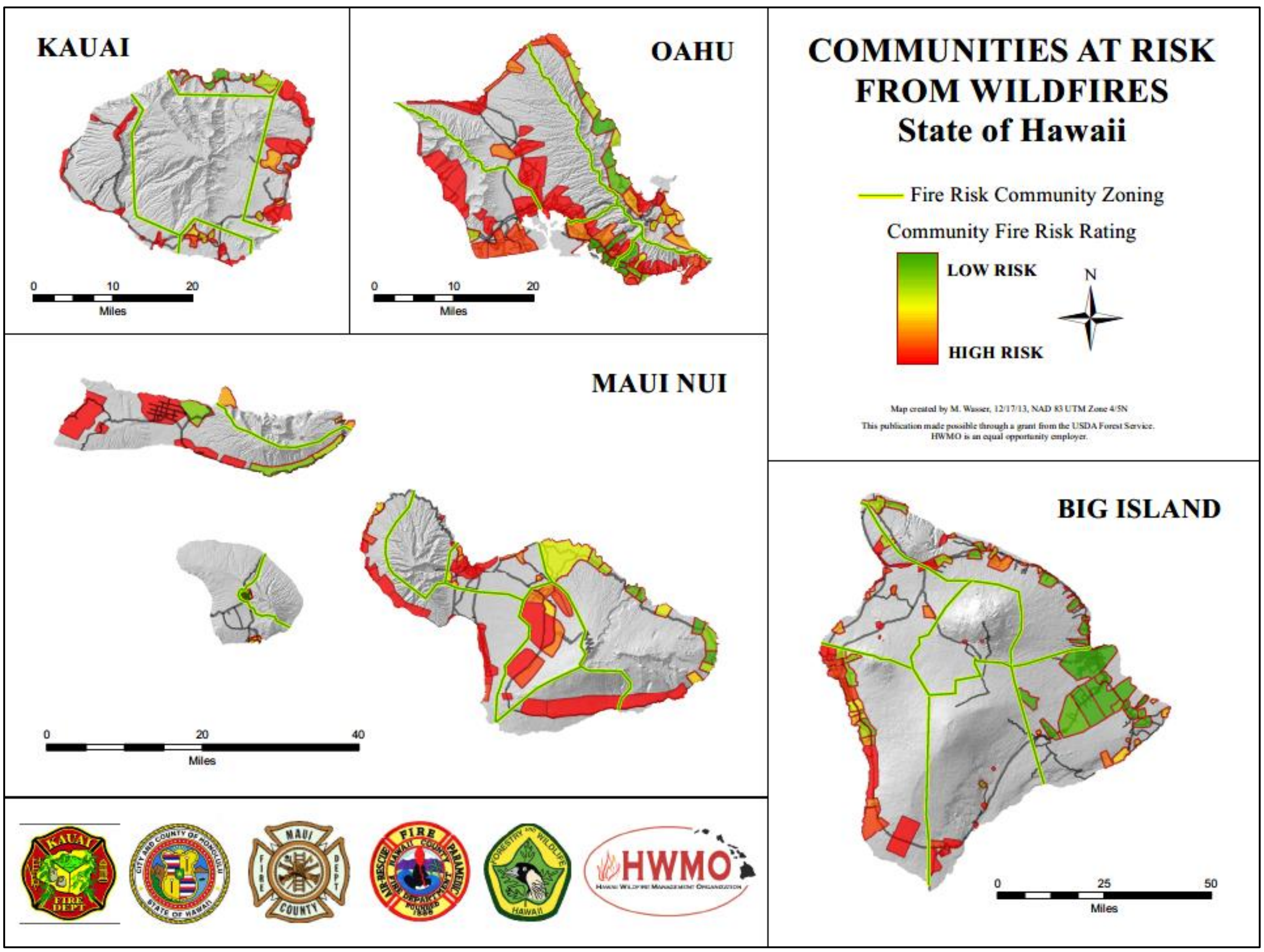
- **Ground Wildfires**—These wildfires burn in natural litter, duff, roots, or sometimes high-organic soils. Once they start, they are very difficult to detect and control. In addition, ground fires may rekindle.
- **Surface Wildfires**—These wildfires burn in grasses and low shrubs (up to 4 feet tall) or in the lower branches of trees. Surface wildfires may move rapidly, and the ease of control depends upon the fuel involved. Brush fires are a type of surface fire, which the State of Hawaiʻi is quite vulnerable to during periods of prolonged drought and high winds. Brush fires burn vegetation that is less than six feet tall, such as grasses, grains, brush, and saplings.
- **Crown Wildfires**—These wildfires burn on the tops of trees. Once started, they are very difficult to control since wind plays an important role in the spread of this type of wildfire.
- **Spotting Wildfires**— These wildfires can be started by surface wildfires and crown wildfires and carried by wind. A characteristic of spotting wildfires is that large embers are thrown ahead of the main fire. Once spotting begins, the wildfire will be very difficult to control (National Geographic 2022).

Location

Steep slopes, rough terrain, strong winds, and a large percentage of highly ignitable invasive grasses characterize the landscape for much of the State of Hawaiʻi. Invasive insects and pathogens, such as Rapid ʻŌhiʻa Death, have contributed to tree mortality across the state (Hawaiʻi Invasive Species Council 2023). Areas experiencing tree mortality are more susceptible to wildfire. Coupled with warm weather, recurring drought conditions, changes in land use and maintenance, and a history of human-caused fires put the state at increased risk to wildfire (DLNR 2016).

In the State of Hawaiʻi, most wildfire ignitions occur in the WUI which impacts the state's population, infrastructure, and environmental resources. The WUI areas often experience significant risk of losses to property and life, and to natural resource function. As stated, a majority of wildfires in the State of Hawaiʻi are human-caused. These fires typically occur near developments, power line rights-of-way, and along roadways. Additionally, sprawling dry, non-native grasslands surround many of the communities. Once ignited along the WUI, wildfire can spread quickly through residential areas, threatening both property and life. Wildfires can also spread from the interface to higher elevations, threatening natural areas and protected species (NASA 2021). Nationally, CAR maps delineate communities that share similar environmental conditions, land use characteristics, fuel types, hazards, and general wildfire issues, and provide ratings to characterize generalized hazards in each area. The U.S. Department of Agriculture's Forest Service recently updated the Wildfire Risk to Communities interactive online tool to include tribal and trust lands in all 50 states (USDA 2022). The State of Hawaiʻi Department of Land and Natural Resources (DLNR)-Division of Forestry and Wildlife (DOFAW) has been developing the State of Hawaiʻi CAR maps for more than a decade and has developed streamlined community boundaries for the purposes of the Hawaiʻi CAR map. In 2013, HWMO partnered with DLNR-DOFAW and the county fire departments across the State of Hawaiʻi to update the Hawaiʻi CAR maps. The original community boundaries were replicated in the 2013 map update, with changes made to reflect current hazards and subdivision expansions. The CAR for the entire State of Hawaiʻi is shown in Figure 4.15-2.

Figure 4.15-2. Communities at Risk from Wildfires – State of Hawaiʻi



Source: HWMO 2013

Many communities in the State of Hawaiʻi are located in high-risk areas due unmitigated fuels, limited community engagement, insufficient water and firefighting resources, and under-addressed pre- and post-fire planning and preparedness. These characteristics make fire suppression difficult and can promote fire spread, thus endangering communities (HWMO 2021).

The HWMO is in the process of developing Community Wildfire Protection Plans (CWPPs) in partnership with local agencies to address the intent and requirements of the Healthy Forests Restoration Act (HFRA) of 2003 – HR1904, which describes the CWPP as a fire mitigation and planning tool for an "at-risk'" community. A CWPP identifies and prioritizes areas for hazardous fuel reduction treatments and recommends the types and methods of treatment on federal and non-federal land that will protect one or more at-risk communities and essential infrastructure and recommends measures to reduce structural ignitability throughout the at-risk community. A CWPP may address issues such as wildfire response, hazard mitigation, community preparedness, structure protection, or all of the above (National Wildfire Coordinating Group n.d.). These locally administered plans serve to provide an indication of risk throughout the state, focusing on developed areas. Plans listed below are available online at: Community Wildfire Protection Plans (CWPPs) — Hawaii Wildfire Management Organization and Division of Forestry and Wildlife: Forestry Program | Community Wildfire Protection Plans (hawaii.gov).

The statewide status of CWPPs is as follows:

- **Kauaʻi County**—Kauaʻi Community Wildfire Protection Plan (2016)
- **Honolulu County**—North Shore Oʻahu Community Wildfire Protection Plan (2021); West Oʻahu Community Wildfire Protection Plan (2016)
- **Maui County**—Molokaʻi Community Wildfire Protection Plan (2016); South Maui Community Wildfire Protection Plan (2016); Upcountry Maui Community Wildfire Protection Plan (2016); Western Maui (2014)
- **Hawaiʻi County**— Kaʻū Community Wildfire Protection Plan (2015); North Hawaiʻi Community Wildfire Protection Plan (2007); North Kona Community Wildfire Protection Plan (2016); Ocean View Commmunity Wildfire Protection Plan (2015); South Kona Community Wildfire Protection Plan (2015); Volcano Commmunity Wildfire Protection Plan (2015)

A comprehensive assessment of statewide wildfire risk, including undeveloped areas, is not available at this time. Information related to developed areas has been used to inform this plan. Figure 4.15-2 illustrates all developed areas in the State of Hawaiʻi that have been assessed with a gradient color scale used to indicate the overall risk rating for each area (from low to high risk). Gray areas represent undeveloped wildland areas; these areas were not assessed or rated for the purpose of the CAR map. Table 4.15-1 lists the area of high wildfire risk areas by county. The high wildfire risk areas were used to assess vulnerability for the purposes of the 2023 SHMP Update (discussed later in the vulnerability assessment subsection).

The following provides the context to the high wildfire risk hazard areas identified to date in each county. For further details of each, as well as mapping of the high-risk areas among communities, please refer to the CWPP.

Table 4.15-1. High Wildfire Risk Hazard Area by County

County	Total Area (Square Miles)	Square Miles in the High Wildfire Risk Hazard Area	Percent (%) of Total Area
County of Kauaʻi	624.2914	37.5	6.01%
City and County of Honolulu	598.5707	138.7	23.17%
County of Maui	1,176.28	163.1	13.87%
County of Hawaiʻi	4,039.64	192	4.75%
Total	**6,438.78**	**531**	**8.25%**

Source: Hawaiʻi Wildfire Management Organization, Division of Forestry and Wildlife

County of Kauaʻi

Steep slopes, rough terrain, difficult access, and a large percentage of highly ignitable invasive grasses, and numerous threatened and endangered native species characterize the County of Kauaʻi landscape. This, coupled with warm weather, recurring drought conditions, changes in land use, and a history of human-caused fires, puts the area at increased risk of wildfire. The proximity of development to fire-prone wildlands present hazardous conditions that now threaten Kauaʻi communities and natural resources. Overgrown vegetation close to homes, pockets of open space within subdivisions, and an increase of non-native high fire-intensity plants around developed areas and native forests pose increasing threats to commercial, community, environmental, and residential resources. Together, these factors create the fire environment that puts the County of Kauaʻi at risk of wildfire (HWMO 2016).

City and County of Honolulu

North Shore Oʻahu

Wildfire threats on the North Shore are imminent and can lead to widespread damage to watersheds, natural resources, and human communities. Located in an area of Oʻahu that is less developed than many other parts of the island, the North Shore region is considered at high risk of wildfire due to frequent human-caused ignitions, windy and seasonally dry conditions, steep and inaccessible terrain, extensive fire-prone grassland and shrubland areas (e.g., Mokuleʻia), and limited access and traffic congestion that slows emergency response times. (Department of Land and Natural Resources 2023)

West Oʻahu

In Western Oʻahu, wildfire occurrence is tied to broad climate patterns. More and larger fires typically occur in drier leeward areas. Rainfall in Western Oʻahu is highly variable over space and time and can greatly influence fire risk.

The widespread establishment of non-native grasslands and shrublands, especially in lower elevation areas, is a leading cause of increased fire risk in Western Oʻahu. Recurrent fires in these lower elevation grasslands and shrublands effectively "'erode" the edges of upland forested areas, which become replaced by grasses and increase the risk of future fires over time. Upper elevation forests in the Wai'anae mountains contain some of the few remaining tracts of native mesic forest. Lower elevation forests are more exposed to loss from wildfire due to the proximity of fire-prone grasslands and shrublands.

Typical of many areas, larger fires tend to occur during droughts and drier seasons, but wet periods may increase the quantity of available vegetative fuels, leading to an increase both in fire risk and in the frequency that mitigation measures such as firebreaks and fuels reduction need to be applied. Drier conditions tend to persist at lower elevations, making neighborhoods and lands near the coast particularly vulnerable to wildfire starts. Rainfall is typically greater in mauka (upland) areas, which may result in lower fire risk on average in these areas. However, due to more abundant vegetation in the higher elevations, mauka areas frequently experience moderate to high wildfire risk during periods of drought. Daily weather patterns, including diurnal thermal winds, also influence fire risk (HWMO 2016).

County of Maui

The County of Maui consists of distinct regions with differing risk to wildfire due to land use change, climate, topography, vegetation, natural resources, and availability of water sources.

The majority of wildfires in the County of Maui are caused by human error or arson, especially near developments, power line right of ways, and along roadsides. Additionally, sprawling dry, invasive, fire-prone grasslands surround many communities. Once ignited along the interface, wildfire can spread rapidly through residential areas, threatening both property and life. In coastal areas, increased erosion after fire degrades nearshore resource quality through increased sedimentation that damages coral reef ecosystems. Wildfires in the higher elevations threaten natural areas and watershed forests, creating changes to soil that affect groundwater infiltration and drinking water. Upland fires also threaten numerous protected species.

After 180 years of sugar production in the state, the last crop of sugarcane was harvested on Maui in 2016 as the last remaining plantation phased out their sugar operations (Agricultural Marketing Resource Center 2022), leaving unmanaged fallow land susceptible to wildfires.

Both the shoreline and upland areas have access roads (multiple ignition points) and include older settlement areas, historical buildings, and irreplaceable cultural and natural resources. Many of these roads are unpaved. Unmanaged fire fuels (primarily grasses and shrubs) in these areas create a significant hazard, as vehicles are common sources of fire ignition. Once ignited, these fires spread rapidly and threaten nearby community infrastructure, neighborhoods, grazing lands, and valuable native flora and fauna.

Brief overviews of the Upcountry Maui, South Maui, and Molokaʻi areas are provided below. A CWPP addressing Lānaʻi is not available at this time.

Upcountry Maui

Upcountry Maui sits entirely on the western slopes of Haleakalā, a 10,023-foot shield volcano, which makes up more than 75% of the County of Maui and spans from the island’s eastern coast to its central plains. It is characterized by a combination of residential and agricultural areas and rugged, often inaccessible terrain. The communities of Waiakoa, Lower Kula, Ulupaiakua, and Kula Hawaiian Homesteads have the highest risk from wildfires in Upcountry Maui (HWMO 2016).

Western Maui

Steep slopes, rough terrain, strong trade winds, and a large percentage of highly ignitable invasive grasses characterize the Western Maui landscape. This, coupled with warm weather, recurring drought conditions, and a history of human-caused fire starts puts the area at increased risk of wildfire. The proximity of development to fire-prone wildlands present hazardous conditions that now threaten every Western Maui suburban and rural community.

Abundant fire fuels and heavy winds in the lowland coastal areas promote rapid spread of fires, quickly endangering historical sites, recreational areas, forested watersheds, grazing lands, homes, and community infrastructure. Overgrown vegetation close to homes, pockets of open space within subdivisions, fallow agricultural fields, and an increase of non-native high fire-intensity plants around developed areas pose increasing threats to commercial, community, environmental, and residential resources (HWMO 2014).

South Maui

The South Maui landscape is characterized by residential areas surrounded by highly ignitable fire-prone grasses on its upland side and the Pacific Ocean on its coastal boundary. South Maui stretches along a coastal region of the downslope edge of two volcanic mountain areas and the saddle between them: Haleakalā, the West Maui Mountains to the northwest, and the central plains connecting the two. The South Maui CWPP planning area is characterized by a combination of residential, agricultural, and wildland areas. It stretches along a coastal region of the downslope edge of two volcanic mountain areas and the saddle between them: Haleakalā, the 10,023-foot shield volcano that comprises much of the Island of Maui, the West Maui Mountains to the northwest, and the central plains connecting the two.

Topography plays a key role in wildfire behavior and post-fire impacts in South Maui and its surrounding (and contributing) environs. Wildfires spread more quickly as they progress upslope and burn at higher intensity. Following wildfires, surface water from rain quickly travels downslope and increases soil erosion, causing downslope flooding and adding sediment to nearshore waters. These post-fire impacts can affect traffic and transportation routes, tourism and economic activities, and harm natural resources by way of runoff that smothers coral reefs and reduces water quality (HWMO 2016)

Molokaʻi

Molokaʻi is characterized by a combination of residential, commercial, and agricultural areas as well as rugged, often inaccessible terrain. A majority of Molokaʻi is dominated by non-native vegetation such as Christmas berry, kiawe, and several fire-promoting shrubs and grasses. These non-native, fire-prone grass, shrub, and tree species provide abundant fine fuels that cure quickly in dry conditions and are easily ignitable even in humid conditions. This allows fires to spread rapidly, creating dangerous conditions for communities and fire responders. These conditions are the leading cause of increased fire risk in the area. The communities of Kaluakoʻi, Maunaloa, Hoʻolehua, Kalamaʻula, Kaunakakai, and Kaweia have the highest risk from wildfires in Molokaʻi (HWMO 2016)

Lanaʻi

No CWPP exists for Lānaʻi.

County of Hawaiʻi

The County of Hawaiʻi is prone to wildfire conditions. On the leeward side, conditions are affected by a greater number of days with dry conditions and expansive grasslands. The windward side of the island has significant grassland cover and, although it has less number or dry days, becomes just as vulnerable to wildfire impacts during a drought. In addition, windward areas, including Puna and Hawaiʻi Volcanoes National Park, deal with lava-ignited wildfires (Trauernicht, et al. 2015).

Available information is provided for the communities of Kau, Northwest Hawaiʻi Island, Ocean View, and Volcano.

Kaʻu

The Kaʻu CWPP area is situated within the larger Hawaiʻi County district of Kaʻu. Formed from Mauna Loa and Kīlauea volcanoes and the prehistoric Ninole Volcano, the region is characterized by areas of barren lava, rocky substrate, and soil areas derived from volcanic ash. Elevations range from sea level to over 13,000 feet at the top of Mauna Loa. The Kaʻu region has a wide range of climatic conditions in a relatively small distance, providing diverse physical environments from the coastline to high elevations. Hazardous conditions exist throughout the Kaʻu area. Steep slopes, rough terrain, strong trade winds, and a prevalence of fire-promoting fuels characterize the Kaʻu landscape. This, coupled with warm weather, recurring drought conditions, and a history of human-caused fire starts puts the area at risk of wildfire. Both the shoreline and upland areas have access roads (multiple ignition points) and include older settlement areas, historical buildings, and irreplaceable cultural and natural resources. Many of these roads are unpaved. Unmanaged fire fuels (primarily grasses) in these areas create a significant hazard, as vehicles are common sources of fire ignition. Once ignited, these fires spread rapidly and threaten nearby community infrastructure, neighborhoods, grazing lands, and valuable native flora and fauna. Kaʻu is extremely isolated, and the closest water source can be many miles away. Catchment systems and hauled water are the only source of water for those residents not serviced by the two small municipal systems. The distances to water resources and the high cost of hauled water are problematic for residents, business owners, and farmers and hinder fire suppression capabilities in the area (HWMO 2015)

South Kona

South Kona stretches for approximately 30 miles between Kailua-Kona and Kaʻu on the leeward side of island. The South Kona area includes Kealakekua, Captain Cook, Honaunau, Napoʻopoʻo, Keʻei, Miloliʻi, Hoʻokena, Papa Bay, Kona Paradise, and other smaller communities and farm areas. Steep slopes and rough terrain dominate most of South Kona, with residential areas, businesses, community infrastructure, cultural resources, and farms spread throughout the district and ranging from sea level to upland areas. The region is primarily rural with low-density development. Over half of these residents depend on rain catchment and hauling or delivery of potable water.

Differences in climate, topography, and soils have resulted in unique natural ecosystems. In the past several hundred years of human habitation, pristine native ecosystems have diminished. Human activity and introduction of non-native plants and animals have displaced many of the historic plant and animal communities. Today, invasive grasses and shrubs and human-caused fire contribute to a cycle of hazardous wildfire conditions and increased post-burn conversion to non-native fire-promoting species. Despite the widespread alteration of native ecosystems, a few areas in South Kona remain as habitat for rare and endangered species and are protected. Upland areas are less disturbed and contain abundant ʻohia and koa forests (HWMO 2015)

Northwest Hawaiʻi Island

Within Northwest Hawaiʻi there are several communities, including, from north to south, Kawaihae, Waimea, Puakō, Puʻuanahulu, and Waikōloa. Communities covered by this CWPP vary in size from 100 single-family home subdivisions to more than 2,700 dwellings with single-family homes, condominiums, retail outlets, schools, historical sites, recreational areas, and commercial facilities. Some of the subdivisions in the coverage area are: Waikiʻi, Puakea Ranch, Kohala by the Sea, Kohala Ranch, Kohala Estates, Kawaihae Village, Puʻu Kapu, Puʻu Lani Ranch Estates, Kona Palisades, Kealakehe, and Hina Lani Estates. In addition, there are several internationally known world-class resorts that draw thousands of visitors from around the world.

The WUI areas in Northwest Hawaiʻi communities have a high risk of wildfire based on a wildfire hazard assessment. Wildland fires occur frequently throughout Northwest Hawaiʻi, threatening area residents. The largest wildfire in state history was in Northwest Hawaiʻi in 1969 and burned more than 47,000 acres. In 2005 a wildfire event burned 25,000 acres forcing the evacuation of thousands of people. The continued invasion of non-native plant species, which are considered high intensity burning fuels, increases the wildfire risk. Grazing of animals traditionally assisted in reducing fuel loads and wildfire risk. However, due to a variety of circumstances, grazing has been reduced or eliminated in many areas, which has contributed to the accelerated wildfire risk in areas that were previously less prone to wildfire. The lack of reliable water resources for both ground and helicopter fire suppression crews have also compromised the rapid response to these disasters and have contributed to the increased fire spread. Communities vary in their access of water, with some communities relying on private water systems or catchment water basins, with others accessing county water (HWMO 2007).

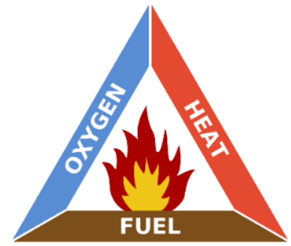
Ocean View

The community of Ocean View in the County of Hawaiʻi abuts Hawaiʻi Volcanoes National Park (HAVO) and is in a WUI environment. Covering a swath from sea level to a 13,000-foot mountaintop, the 377-square miles (333,000 acres) of Hawaiʻi Volcanoes National Park encompasses Mauna Loa, the world's largest volcano, as well as Kīlauea, the world's most active volcano. The Park's ecological zones include coastal strand, dry lowland, mesic and wet rain forest, seasonally dry montane, sub-alpine, and alpine. It is home to more than 50 federally listed endangered, threatened, and candidate endangered species, as well as numerous rare species. Kīlauea has made HAVO the state's largest tourist attraction, with more than 2.5 million visitors annually. In addition, Ocean View has experienced tremendous development in recent years. Many new residents are from other parts of the United States and unfamiliar with the wildfire risks of the community (HWMO 2015).

Volcano

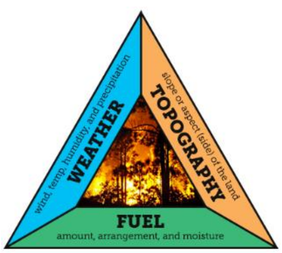
The community of Volcano in the County of Hawaiʻi also abuts HAVO and is in a WUI environment. Due to its location in proximity to HAVO, the community is impacted by lava flows within the Park which have caused several wildfires, some as large as 5,000 acres. Wildland fires originating within the Park have threatened the community of Volcano, which encompasses Volcano Village, the Volcano Golf Course Community, including the Golf Course Subdivision, Mauna Loa Estates, and Ohia Estates. Conversely, wildland fires caused by human error in neighboring towns, such as Volcano, could impact the Park. The Kīlauea Forest Reserve separates Volcano Village and the Golf Course Subdivision. To the east of Volcano Village is the Olaʻa Forest Reserve, a land tract of Native Hawaiian forest largely untouched by invasive species. Volcano has experienced tremendous development in recent years. Volcano Fairway Estates is a new subdivision (HWMO 2015).

EXTENT



Heat, fuel, and oxygen are all required for the creation and maintenance of any fire as depicted in the fire triangle shown in the adjacent image. The final element to the fire triangle is the chemical reaction between the components. When not enough heat is generated or when water is used to reduce the heat level; when the fuel is exhausted, removed, or isolated; when the oxygen supply is limited, then a side of the triangle is broken; or if the chemical reaction does not occur, the fire is extinguished.

- **Heat**—A heat source is needed for the initial ignition of fires. Heat is also generated by the fire. For a fire to grow, heat must be transferred to the initial and surrounding fuel. It allows fire to spread by removing the moisture from the nearby fuel, enabling it to ignite or travel more easily.
- **Fuel**—The fuel side of the triangle (as shown in the image above) refers to both the external and internal properties of the fuel. External properties refer to the type and the characteristics of the fuel material. Internal properties of fuel address aspects of fuel chemistry. Fuel is characterized by its moisture content, size and shape, quantity, and the location of the fuel type (ground, surface, ladder, or aerial).
- **Oxygen**—Air contains about 21% oxygen. Most fires require air with at least 16% oxygen content to burn under most conditions. Oxygen supports the chemical processes that occur during a land fire. When fuel burns, it reacts with oxygen from the surrounding air, releasing heat and generating combustion products (OSHA 2019) (US NPS 2016).



Fire Behavior Triangle

All wildfires begin with an ignition source. Fire behavior describes the manner in which fuels ignite, flames develop, and fire spreads. The "fire behavior triangle" illustrates how the three primary factors influence wildfire behavior: fuel, topography, and weather. Each point of the triangle represents one of the three factors; the sides represent the interplay between the factors. For example, drier and warmer weather combined with dense fuel loads and steeper slopes will cause more hazardous fires than light fuels on flat ground (US NPS 2017).

Warning Time

Wildfires are often caused by humans, intentionally or accidentally. There is no way to predict when one might break out. However, there are tools used to identify the possibility of fire weather in an area. Fire weather watches and red flag warnings are used to convey the possibility of severe fire weather to wildland fire agencies.

The National Weather Service (NWS) issues Fire Weather Watches and Red Flag Warnings to alert fire departments and residents of the onset, or possible onset, of critical weather and dry conditions that could lead to rapid or dramatic increases in wildfire activity (NWS 2019). Fire weather forecasts are available on the NWS website accessed at https://www.weather.gov/fire/ and provides a hazard/overview map, the NWS Fire Wx Forecast Map, Today's SPC Outlook, the Latest Wildland Fire Outlook, and Current Large Incidents.

- **Fire Weather Watch** – The NWS issues a Fire Weather Watch when potentially dangerous fire weather conditions are possible over the next 12 to 72 hours.

- **Fire Weather/Red Flag Warning** – The NWS issues a Fire Weather Warning or Red Flag Warning when fire danger exists and weather patterns that support extreme fire behavior are either occurring or expected to occur within 24 hours. Authorities may issue a Fire Weather Watch before a Warning, but a Warning may also be the initial notification. Your community may also use the National Fire Danger Rating System to provide a daily estimate of the fire danger (i.e., low, moderate, high, very high, and extreme).
- **Evacuation Notice** – If the danger is imminent, local authorities may issue an evacuation notice to alert residents that a fire is nearby, and it is important to leave the area. Evacuation orders vary by state and community and may range from voluntary to mandatory. When authorities issue a mandatory evacuation notice, leave the area immediately. (FEMA n.d.)

Previous Occurrences and Losses

The first reported disastrous wildfire in the State of Hawaiʻi was in 1901 on the Hāmākua Coast of the Island of Hawaiʻi. Over 30,000 acres of agricultural and forested lands burned during this fire over a period of three months (Trauernicht, et al. 2015). This event led to the establishment of Hawaii's Forest Reserve System and the integration of wildfire management into government forest management policy (DLNR 2021).

An abundance of wildfire information, specifically previous occurrences and losses associated with wildfire events, exists throughout the State of Hawaiʻi. The 2018 SHMP discussed specific wildfire events that occurred in the State of Hawaiʻi through 2017. For the 2023 SHMP Update, only wildfire events that burned over 100 acres between January 1, 2018, and December 31, 2022, were summarized. However, to provide a context for the overall frequency of wildfires, regardless of size, the state average number of wildland fires over the last decade is more than 1,000 wildfires burning more than 20,000 acres each year (Pacific Fire Exchange 2023). Table 4.15-2 provides the number of wildfires by year (from 2018 to 2022). On average, there were about 5 fires per year burning an average of more than 23,200 acres per year, though averages are not truly beneficial as wildfire incidents vary widely due to contributing factors. Table 4.15-3 lists the major wildfire events from 2018 to 2022.

Table 4.15-2. Summary of Wildfires from 2018 to 2022

Year	Wildfires	
	Number	Acres
2018	9	33,727
2019	9	16,835
2020	5	5,200
2021	2	41,400
2022	2	19,000
2023	1	*

** The Hawaiʻi and Maui County wildfires of August 2023 are an ongoing event; total impacts have yet to be determined.*
Sources: NOAA 2023

Table 4.15-3. Wildfire Events in the State of Hawaiʻi, 2018 to 2022

Date(s) of Event	Event Type	Counties Affected	Description
February 10, 2018 – February 12, 2018	Wildfire	Hawai'i	A lightning strike was thought responsible for a blaze on the Big Island of Hawai'i that scorched about 1000 acres of brush in the leeward part of the isle. The fire burned along Highway 190, Mamalahoa Highway, between Daniel K. Inouye Highway in South Kohala and Makalei in North Kona. The highway in that area was closed for more than 24 hours because of the fire. However, there were no reports of serious injuries or property damage.
March 11, 2018	Wildfire	Honolulu	A fire charred about 50 acres of brush near Whitmore Village in central Oʻahu. The blaze closed Kamehameha Highway in the area for several hours. Several abandoned vehicles and other items within homeless camps were damaged by the fire. However, no injuries were reported.
June 27, 2018	Wildfire	Hawai'i	A fire blackened about 52 acres of brush and kiawe in leeward Big Island. No structures were threatened by the blaze. No other property damage or injuries were reported as the fire raged near the Mauna Lani resort.
July 03, 2018	Wildfire	Maui	A fire blackened about 2,500 acres of fallow sugar cane and dry brush in Maui's Central Valley between Haleakalā Highway and Pulehu Road near Pukulani. Several homes and a few businesses were evacuated as a precaution. However, no structures were damaged, and no injuries were reported. The cause of the blaze was undetermined.
August 01, 2018 – August 06, 2018	Wildfire	Hawai'i	A blaze charred about 18,000 acres of mainly brush near Waikoloa on the leeward side of the Big Island of Hawai'i. The fire did not threaten any homes or other structures, and there were no reports of serious injuries. The cause of the blaze was under investigation.
August 04, 2018 – August 09, 2018	Wildfire	Honolulu	Two fires scorched around 9,000 acres of brush on O'ahu's leeward section, one near Waianae and the other in Makaha Valley. The fires caused the Department of Education to delay the opening of two elementary schools in the area by one day. One family described how the Waianae blaze destroyed their home and livelihood. The fires also threatened other properties in the area and the schools for a time. The cost of damages was not available. No significant injuries were reported. The causes of the fires were unknown.
August 24, 2018 – August 25, 2018	Wildfire	Honolulu	A fire near the Kahe Power Plant in West Oʻahu scorched 275 acres of dry brush. The blaze did not damage any structures or other property. A woman in the area was treated for smoke inhalation. The cause of the fire was believed to be from arcing from the power plant.
August 24, 2018 – August 26, 2018		Maui	Three fires blackened 2800 acres of brush in leeward West Maui near Lahaina. The blazes were fueled by dry vegetation and whipped up by winds from Hurricane Lane that was south of Maui County at the time. The fires damaged or destroyed 22 structures, including 13 homes with 60 individuals displaced; and 30 vehicles, along with a base yard that stored heavy equipment. Also, more than 100 homes had to be evacuated. A woman was injured by one of the fires and was taken to a hospital. The cost of damages had not yet been tabulated. The causes of the blazes were not known.
December 28, 2018	Wildfire	Hawai'i	A fast-moving blaze charred about 50 acres of brush in the North Kona District on the Big Island of Hawai'i. The fire started in the middle of the afternoon on the 28th near Hinalani Street and Ane Keohokalole Highway and was put under control by firefighters later that day. It had threatened several businesses and the Ulu Wini housing complex, but no damages or injuries were reported. A cause for the blaze was not provided.
January 06, 2019 – January 08, 2019	Wildfire	Hawai'i	A blaze charred about 200 acres of dry brush near Wailea in leeward East Maui. Around 100 people had to evacuate the area, including guests at a luxury hotel. Firefighters struggled for a time with the blaze because of breezy, swirling winds. No injuries were reported, and the cost of any damages was not available. The cause of the fire was not known.
February 05, 2019 –	Wildfire	Hawai'i	A blaze charred more than 110 acres of brush in the US Army's Pohakuloa Training Area on the slopes of Mauna Kea on the Big Island. The fire was about two miles north of the Daniel K. Inouye

Date(s) of Event	Event Type	Counties Affected	Description
February 07, 2019			Highway and on the Kona (west) side of Mauna Kea Access Road. No significant property damage or injuries were reported. The cause of the blaze was unknown.
March 10, 2019 – March 11, 2019	Wildfire	Honolulu	A blaze charred about 500 acres of dry brush in leeward Oʻahu. The fire came close to some homes in the area near Nānākuli, but firefighters were able to stop it before any damage could be done. The fire began in Nānākuli Valley and then branched off into Waianae Valley. No serious injuries or property damage were reported. The cause of the blaze was unknown.
May 19, 2019 – May 22, 2019	Wildfire	Honolulu	A blaze scorched around 525 acres of dry brush in rough terrain on Oʻahu. The fire started upslope of Kaukonahua Road north of Schofield Range near Wahiawa. It was difficult to contain because of the mountainous location of the blaze. No vegetation or structures or were threatened, and no injuries were reported. The cause of the fire was not known.
June 11, 2019 – June 12, 2019	Wildfire	Kaua'i	A fire charred about 500 acres of dry brush on the south side of Kauaʻi near Poipu. The blaze prompted some evacuations of local residents and road closures as a precaution. However, the fire did not result in any serious property damage or injuries. Its cause was not known.
July 11, 2019 – July 15, 2019	Wildfire	Maui	A pair of brush fires combined to create a major hazardous episode over a portion of Maui. The blaze blackened around 9200 acres of old, dry sugarcane plantation fields and unmanaged grasslands in the isle's Central Valley. The fire was first reported in the later morning on July 11th, south of Kahului and south of the intersection between Kuihelani Highway and Waiko Road. Many residents were evacuated from the area, roads were closed (see Figure 4.15-3), power was lost for a time, and many flights from the Kahului Airport were canceled. The Maui Humane Society also had to evacuate the animals at its shelter. The fire was fully contained by the morning of the 15th. No significant injuries were reported. The cost of damages was not available, and the cause of the blaze was not known.
September 04, 2019 – September 05, 2019	Wildfire	Honolulu	Two fires burned about 200 acres of dry brush in leeward Oʻahu in Kunia. Five individuals were asked to leave their homes for a time as firefighters contained the combined blaze. Three storage containers were damaged in the Kunia Farm lots. However, no injuries were reported. The cost of damages was not available. The cause of the fires was not known.
October 02, 2019 – October 07, 2019	Wildfire	Maui	A wind-swept fire began upslope from Maalaea in Maui, in the West Maui Mountains, that eventually consumed around 4600 acres of dry brush. The flames forced the evacuation of more than 450 residents along Maalaea Bay Road as the blaze moved close to homes in the area. The fire also forced the closure of streets and highways in parts of West and central Maui. However, in the end, there were no significant injuries or structural damages. The cause of the blaze was under investigation.
October 22, 2019 – October 24, 2019	Wildfire	Maui	Dry vegetation and a breezy wind flow contributed to the ignition and spreading of a nearly 1000-acre blaze over leeward West Maui. It started in Kahana above the Kapalua Airport and spread along the ridge line in that section of the West Maui Mountains. The fire closed the airport for a time because of a power outage, and flights were diverted to Kahului. Traffic in the area was also affected from time to time, and some residents were asked to evacuate as a precaution as the flames threatened to spread farther afield. However, no significant injuries were reported. The costs of any damages were not available. The cause of the blaze was not provided. Resulted in disaster declaration FM-5294.
April 23, 2020 – April 24, 2020	Wildfire	Hawai'i	An arcing electrical wire was the likely cause of a blaze that scorched about 400 acres of brush north of Kawaihae, near 59-125 Halekai Place, on the lee side of the Big Island. No injuries were reported, and no structures were threatened by the fire.
August 16, 2020 – August 18, 2020	Wildfire	Honolulu	A fire blackened around 2,000 acres of mainly dry brush in rugged terrain in the northwest part of Oʻahu. The cause of the blaze was not known, but it did close Kaukonahua Road near Waialua for a time as firefighters battled the flames. There were no reports of serious injuries or property damage.

Date(s) of Event	Event Type	Counties Affected	Description
August 30, 2020 – August 31, 2020	Wildfire	Maui	A blaze scorched a little more than 1,500 acres of dry brush south of Kahului in Maui's Central Valley. The fire damaged fiber cable in the area, but the cost of the damage was not reported. No significant injuries were reported.
September 30, 2020	Wildfire	Maui	A blaze charred about 550 acres of mainly blush on the slope above Kapalua Airport in West Maui. Personnel from a nearby water treatment plant were evacuated for a time as firefighters worked to bring the fire under control. There were no reports of significant property damage or injuries. The cause of the blaze was not known. The fire was not fully contained until noon on the 2nd of October.
December 26, 2020 – December 28, 2020	Wildfire	Maui	A wind-whipped fire in leeward West Maui near Olowalu charred more than 750 acres of mainly dry brush, although the blaze also destroyed the Olowalu Community Center, several vehicles and storage units, and partially damaged a residence on Luawau Street. No serious injuries were reported. Property damages totaled $266,000.00.
June 04, 2021 – June 07, 2021	Wildfire	Hawai'i	A fire blackened about 1,400 acres of dry brush in the Hāmākua District on the Big Island of Hawai'i, near Paauilo. The blaze forced the closure of Highway 19 between mile markers 34 and 36 for a time, but no residents needed to evacuate the area. The cause of the fire was not known.
July 30, 2021 – August 06, 2021	Wildfire	Hawai'i	One of the largest brush fires in Hawai'i County history started in the morning hours of Friday, July 30th, in the South Kohala District along Mana Road near Parker Ranch land. The wind-swept blaze blackened more than 40,000 acres of mainly dry pastureland and grasses, though the fire forced the evacuation of Waikoloa Village for a time as the month turned to August. The blaze also destroyed two homes in the area. The fire, as mentioned above, stretched into August. The cost of damages was unavailable, and the cause of the blaze was unknown. Resulted in disaster declaration FM-5404.
July 21, 2022 – July 22, 2022	Wildfire	Hawai'i	A fire blackened more than 2,000 acres of brush in the Army's Pohakuloa Training Area. No homes or other structures were threatened by the blaze. No injuries were reported. The cost of any damages was not available.
August 10, 2022 – August 17, 2022	Wildfire	Hawai'i	A fire in and around the U.S. Army's Pohakuloa Training area on the Big Island of Hawai'i reignited in August. The original blaze charred more than 2,000 acres of brush in July, but the area affected grew to about 17,000 acres in August. The fire was 90% contained by August 17. There were no reports of serious injuries. The cost of any damages was not available.
August 8, 2023	Wildfire	Hawai'i, Maui	Wildfires on Maui and Hawai'i burned thousands of acres, cut off communications, and forced closure of roads and schools and evacuations in the Kohala Ranch and Kula areas. The fires caused significant loss of life and property in Maui County. Thousands of people were without adequate shelter. The town of Lahaina was destroyed. As of late August, these fires had led to over 100 deaths, making them the deadliest U.S. wildfires in more than a century. The federal government issued one major disaster declaration (DR-4724) for these fires along with five fire management assistance declarations (FM-5474-HI, FM 5475-HI, FM-54-76-HI, FM 5477-HI, and FM-5478-HI). The Governor issued six emergency proclamations, including state of emergency proclamations and travel restrictions.

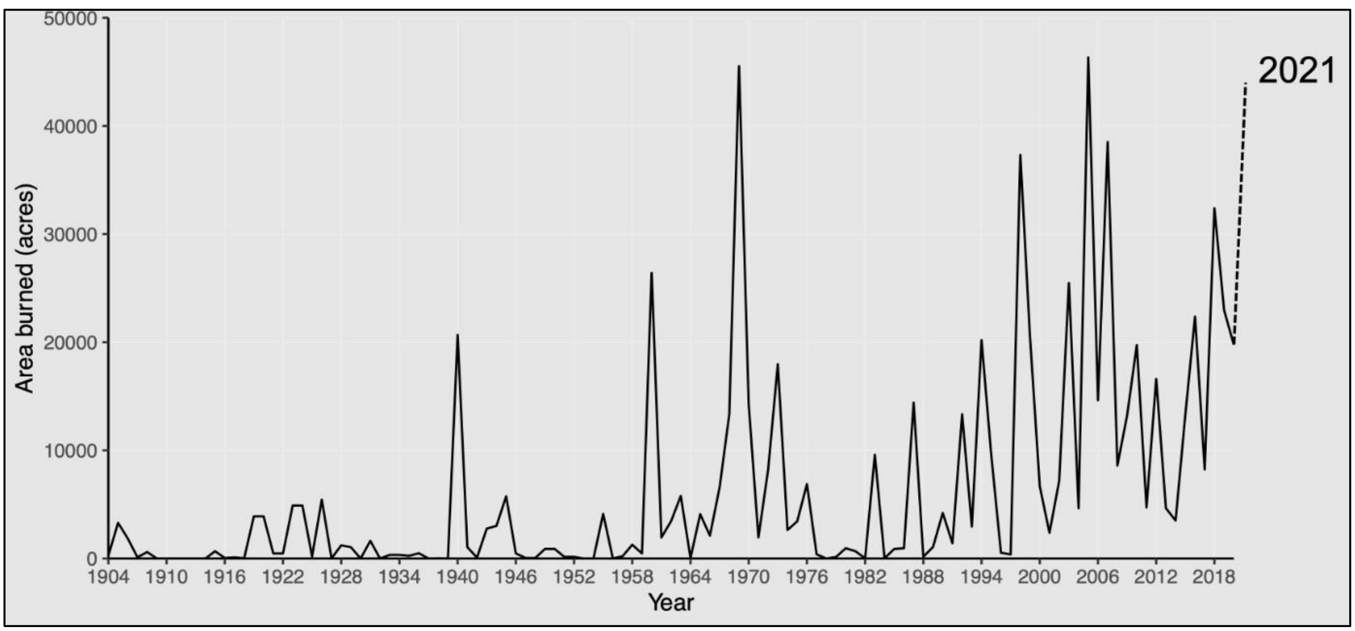
Sources: NOAA 2023

Figure 4.15-3. A 2019 Brush Fire Closes Kuihelani Highway in Maui County

Credit: The Maui News/Matthew Thayer

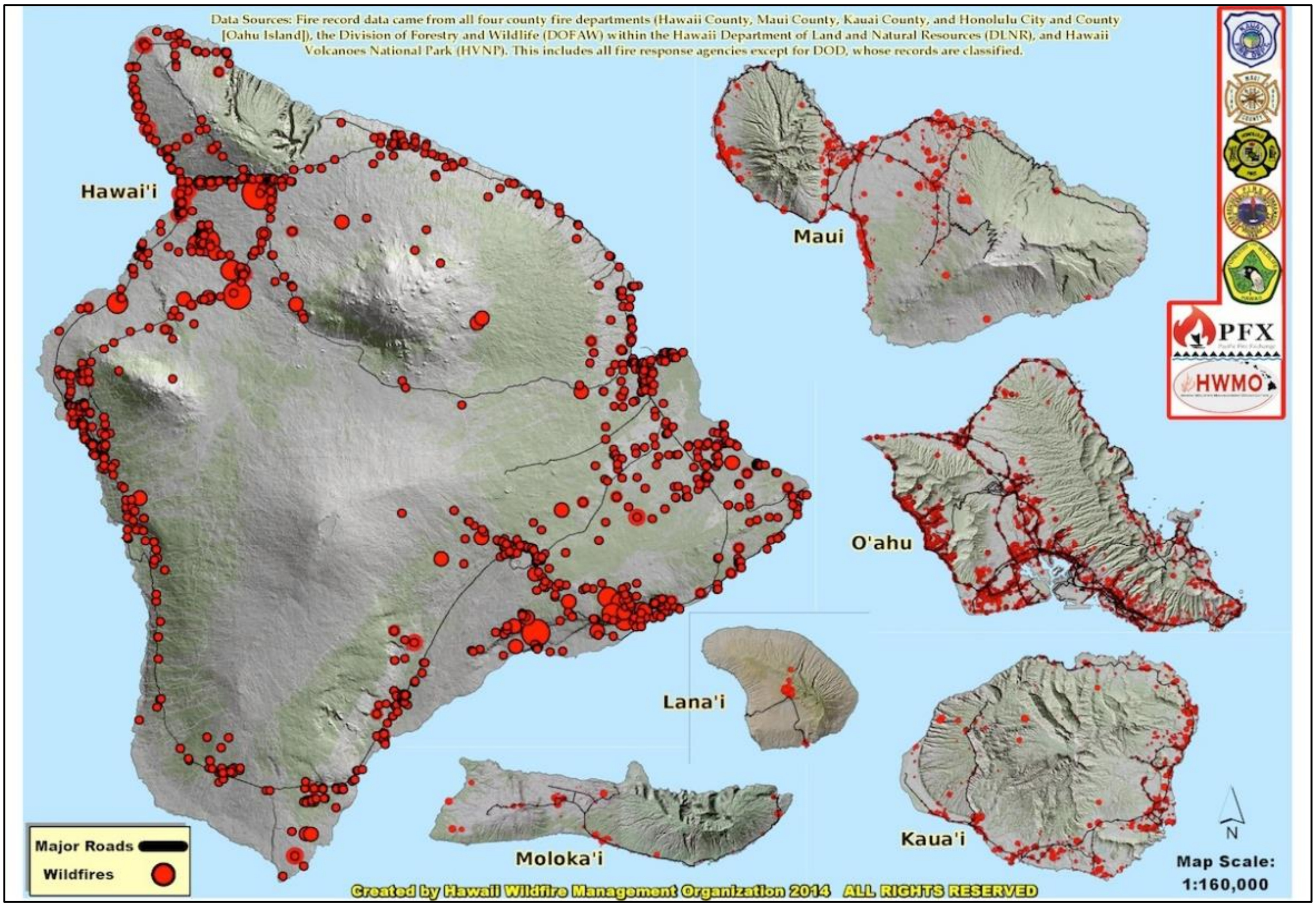
Figure 4.15-4 shows acres burned by wildfires since 1904 and Figure 4.15-5 illustrates wildfire incident locations that have been reported throughout the state. The location of these wildfires corresponds to the CARs previously discussed. A majority of these incidents occurred in the medium and high-risk areas previously documented.

Figure 4.15-4. Wildfire Occurence In Hawai'i, 1904-2021



Source: (Pacific Fire Exchange 2023)

Figure 4.15-5. Wildfire Incidents for the State of Hawai'i



Source: Pacific Fire Exchange 2016

Disaster and Emergency Declarations

The following disaster declarations, emergency proclamations, and fire management assistance declarations related to wildfires have been issued for Hawai'i:

- Federal disaster (DR), emergency (EM), or fire management assistance (FM) declarations, 1955 – 2022: 26 events classified as wildfire
- Hawai'i state emergency proclamations, 2018 – 2022: 3 wildfire events
- USDA Agricultural Disaster Declarations, 2012 – 2022: 7 wildfire events

Table 4.15-4 summarizes federally-declared wildfire events between 2018 and 2023. For events prior to 2018, please refer to Appendix E (Hazard Profile Supplement).

Table 4.15-4. Federal Declarations Related to Wildfire (2018 to 2022)

Incident Date	Declaration Number	County Affected	Name	Date Declared
October 22, 2019	FM-5294	Maui	Hawai'i Kahana Ridge Fire	October 23, 2019
August 1, 2021 – August 3, 2021	FM-5404	Hawaiʻi	Hawai'i Mana Road Fire	August 1, 2021
August 8, 2023	FM-5474	Hawaiʻi	Hawai'i Kohala RanchFire	August 8, 2023
August 9, 2023	FM-5475	Maui	Hawai'I Lahaina Fire	August 9, 2023
August 9, 2023	FM-5476	Maui	Hawai'i Upcountry Fire	August 9, 2023
August 9, 2023	FM-5477	Maui	Hawai'i Pulehu Fire	August 9, 2023
August 8, 2023	FM-5478	Hawaiʻi	Hawai'i Mauna Kea Beach Fire	August 9, 2023
August 8, 2023	DR-4724	Hawaiʻi, Maui	Hawai'i Wildfires	August 10, 2023

Source: FEMA 2023

Probability of Future Hazard Events

Overall Probability

In the State of Hawaiʻi, although wildfires can occur year-round, the fire season typically runs from the dry months of April through October. However, dry periods or periods of drought can extend the season. With drought and dry seasons, there is increased likelihood of wildland fires. See Section 4.5 for a discussion of the drought hazard.

For the 2023 SHMP Update, the best available information was collected to calculate the probability of future occurrence of wildfire events, of all magnitudes, for the State of Hawaiʻi. Information from the 2018 SHMP, HWMO, DLNR, and HI-EMA were used to identify the number of wildfire events of 100 acres or greater, that occurred between 1953 and 2022. Based on these statistics, the State of Hawaiʻi has a 100% chance of a wildfire occurring in any given year and may experience approximately 12 wildfire events each year.

There are additional factors that may increase the future occurrence of wildfires in the State of Hawaiʻi. Changing environmental conditions can lead to larger and more intense wildfires in the future. During an El Niño year, the Hawaiian Islands experience more rainfall than normal in the summer months and less rainfall than average during the winter months (NOAA 2015). The El Niño rainfall patterns have important consequences for the Pacific Islands:

- Wetter summer/fall increases fuel loads, particularly in typically dry areas, which are then more susceptible to increased wildfire activity during dry conditions
- Drier winters increase the potential for wildfire occurrence and spread (Trauernicht, et al. 2015).

Wildfire records from the State of Hawaiʻi show an increase in annual area burned during El Niño events. These patterns show that the state can anticipate late onset drought during the winter months following El Niño development and a higher fire danger throughout the winter (Trauernicht, et al. 2015).

Additionally, the number of CARs has increased over time due to changing land use patterns with increased commercial and residential development and more people living proximate to wildland areas. Also, some CARs that had a lower risk designation in the past are now at higher risk (DLNR 2016).

All of the factors listed above increase the risk of wildfires across the state and increase the probability of future occurrences each year.

Climate Change Impacts

Climate change has the potential to affect multiple elements of the wildfire system: fire behavior, frequency of ignition and ignition points, fire management practices, and vegetation fuels and fuel loading. By the middle of the 21st century, it is anticipated that there will be a 35% increase in days with high fire danger across the world (Trauernicht, et al. 2015).

In Hawai'i, temperatures are increasing by 0.3°F every decade, at four times the rate of half a century ago. It is predicted that average temperatures in the state could increase by as much as 5–7.5° F by the end of the century (State of Hawai'i 2022a). Increased temperatures may intensify wildfire danger by warming and drying out vegetation. When climate alters fuel loads and fuel moisture, forest susceptibility to wildfires changes.

Modeling is currently underway to predict the fire risk of invasive plants and the corresponding climate conditions that promote increased wildfires statewide (Pacific Islands Climate Adaptation Science Center 2022).

Wildfire is tied to rainfall patterns in the State of Hawaiʻi much more than temperature. Fires are more frequent in the dry leeward areas and larger fires occur under drought conditions. In the past 30 years, the state has experienced longer droughts, an increase in consecutive dry days, and decrease in the days of intense rainfall (State of Hawaiʻi 2022). All of which lead to perfect conditions for wildfires throughout the state. Additionally, a warming, drying climate, as well as increased frequency and strengths of El Niño events have led to drought conditions that are greatly increasing the risk of wildfires across the state (State of Hawaiʻi 2022).

4.15.2 VULNERABILITY ASSESSMENT

Wildfire Hazard Area Definition

To assess vulnerability to wildfire, the high-risk communities delineated by the Communities at Risk from Wildfire (CAR) data was used.

A spatial analysis was conducted utilizing the CAR data. For the purposes of this risk assessment, an asset is considered potentially vulnerable to the wildfire hazard if it is located in a high-risk community (noted as a high wildfire risk hazard area above). The wildfire risk data used for this analysis focuses on communities or developed areas. Therefore, the wildfire risk to state assets located outside of these communities could not be determined. Refer to Appendix F (State Profile and Risk Assessment Supplement), which provides more detailed results for the high wildfire risk hazard area analysis and the exposure analysis results for the assets located in the moderate wildfire risk areas.

Assessment of State Vulnerability and Potential Losses

To assess wildfire vulnerability and potential losses, a spatial analysis was conducted to review the state assets located in the high wildfire risk hazard area. This section discusses the vulnerability of state assets (state-owned or state-leased buildings and state roads) and critical facilities.

State Assets

The spatial analysis for the wildfire hazard determined there are 6,095 state buildings located in the high wildfire risk hazard area with the greatest number of state buildings located in the City and County of Honolulu (3,472 buildings with a replacement cost value of $17.393 billion). The majority of these buildings are occupied by the Department of Education and University of Hawaiʻi. Table 4.15-5 and Table 4.15-6 summarize the state buildings located in the high wildfire risk hazard area by county and agency, respectively.

Table 4.15-5. State Buildings Located in the High Wildfire Risk Hazard Area by County

County	Total Number of State Buildings	Total Replacement Cost Value	High Wildfire Risk Area			
			Number of State Buildings in Hazard Area	Percent (%) of Total	Total Value of State Buildings in Hazard Area	Percent (%) of Total
County of Kauaʻi	531	$990,850,824	377	71.00%	$723,336,152	73.00%
City and County of Honolulu	3,472	$17,393,945,915	1,645	47.38%	$3,732,170,912	21.46%
County of Maui	831	$3,097,491,689	626	75.33%	$2,162,488,835	69.81%
County of Hawaiʻi	1,261	$4,638,567,141	247	19.59%	$743,270,564	16.02%
Total	**6,095**	**$26,120,855,568**	**2,895**	**47.50%**	**$7,361,266,463**	**28.18%**

Source: *Hawaiʻi Wildfire Management Organization, Division of Forestry and Wildlife; State of Hawaiʻi Risk Management Office 2017*

Table 4.15-6. State Buildings Located in the High Wildfire Risk Hazard Area by Agency

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Hazard Area	Percent (%) of Total Buildings	Replacement Cost Value in the Hazard Area	Percent (%) of Total Value
Dept of Accounting & General Services	66	$953,963,738	18	27.27%	$136,984,302	14.36%
Dept of Agriculture	70	$147,607,399	27	38.57%	$65,504,797	44.38%
Dept of Attorney General	15	$108,425,480	5	33.33%	$11,375,127	10.49%
Dept of Budget & Finance	16	$28,968,679	6	37.50%	$1,500,219	5.18%
Dept of Business, Economic Development and Tourism	25	$645,480,379	2	8.00%	$31,908,972	4.94%
Dept of Commerce & Consumer Affairs	2	$40,197,360	0	0.00%	$0	0.00%
Dept of Defense	69	$267,352,836	28	40.58%	$130,366,498	48.76%
Dept of Education	4,090	$10,598,205,739	2,170	53.06%	$4,237,875,756	39.99%
Dept of Hawaiian Home Lands	12	$110,427,352	2	16.67%	$2,485,998	2.25%
Dept of Health	44	$387,068,440	10	22.73%	$18,295,256	4.73%
Dept of Human Resources Development	1	$5,973,872	0	0.00%	$0	0.00%
Dept of Human Services	130	$480,212,294	42	32.31%	$78,926,078	16.44%
Dept of Labor and Industrial Relations	22	$90,076,209	14	63.64%	$21,784,179	24.18%

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Hazard Area	Percent (%) of Total Buildings	Replacement Cost Value in the Hazard Area	Percent (%) of Total Value
Dept of Land and Natural Resources	90	$101,441,821	32	35.56%	$27,890,769	27.49%
Dept of Public Safety	154	$440,774,415	54	35.06%	$200,908,551	45.58%
Dept of Taxation	1	$7,174,162	0	0.00%	$0	0.00%
Dept of Transportation	68	$2,935,208,214	31	45.59%	$344,031,772	11.72%
Hawai'i State Ethics Commission	1	$984,533	0	0.00%	$0	0.00%
Hawaiʻi Health Systems Corporation	106	$1,230,852,871	51	48.11%	$759,713,058	61.72%
Hawaiʻi Housing Finance & Development Corporation	86	$360,851,671	79	91.86%	$239,092,499	66.26%
Hawaiʻi Public Housing Authority	273	$982,981,701	108	39.56%	$225,056,578	22.90%
Hawaiʻi State Legislature	2	$48,555,381	0	0.00%	$0	0.00%
Hawaiʻi State Public Library System	53	$525,584,082	28	52.83%	$105,523,199	20.08%
Judiciary	41	$534,877,354	17	41.46%	$108,926,672	20.36%
Legislative Reference Bureau	1	$2,996,162	0	0.00%		0.00%
Office of Hawaiian Affairs	11	$54,125,645	4	36.36%	$1,479,962	2.73%
Office of the Auditor	2	$1,921,180	0	0.00%	$0	0.00%
Office of the Governor	1	$2,996,162	0	0.00%	$0	0.00%
Office of the Lieutenant Governor	2	$4,588,849	1	50.00%	$2,257,785	49.20%
Office of the Ombudsman	1	$1,818,060	0	0.00%	$0	0.00%
Research Corporation of the University of Hawai'i	3	$4,189,026	0	0.00%	$0	0.00%
University of Hawai'i	637	$5,014,974,503	166	26.06%	$609,378,436	12.15%
Total	**6,095**	**$26,120,855,568**	**2,895**	**47.50%**	**$7,361,266,463**	**28.18%**

Source: Hawaiʻi Wildfire Management Organization, Division of Forestry and Wildlife; State of Hawaiʻi Risk Management Office 2017

Roads provide a vital transportation link between populated areas. Road closures, as a result of a wildfire event, will have significant impacts on those communities and each island as a whole. The state has more than 1,100 miles of state-owned roads located in the high wildfire risk areas.

Table 4.15-7 summarizes the length of state roads in the high wildfire hazard areas by county. The City and County of Honolulu has the greatest number of road miles (374.9 miles) exposed which is 33.97% of the total length of state roads in the County. A complete list of state roads located in the low, moderate, and high wildfire risk areas is included in Appendix F (State Profile and Risk Assessment Supplement).

Table 4.15-7. State Roads Located in the High Wildfire Risk Hazard Area by County

County	Length (in miles)		
	Total Length	Length of Road in Hazard Area	Length as Percent (%) of Total Length
County of Kauaʻi	103.7	32.8	31.63%
City and County of Honolulu	374.9	164.4	43.85%
County of Maui	245.9	71.4	29.04%
County of Hawaiʻi	379.2	66.7	17.59%
Total	**1,103.70**	**335.3**	**30.38%**

Source: Hawaiʻi Wildfire Management Organization, Division of Forestry and Wildlife; State of Hawaiʻi Department of Transportation 2022

Community Lifelines and Critical Facilities

Due to the state's geography, each county needs to be self-sufficient in terms of wildfire response and recovery personnel and equipment. The City and County of Honolulu has the greatest number of community lifeline facilities (71) located in the high wildfire risk hazard area compared to the other counties. Table 4.15-8 summarizes the total number of critical facilities by core category located in the high wildfire risk area by county. Table 4.15-9 summarizes the number and percentage of exposed critical facilities by core category. Transportation Services has 47.05% of their facilities located in the high wildfire risk hazard area.

Table 4.15-8. Community Lifelines and Critical Facilities Located in the High Wildfire Risk Hazard Area, by County

County	Community Lifeline Categories								Additional Critical Facilities
	Communications	Energy	Food, Water, Shelter	Hazardous Material	Health & Medial	Safety & Security	Transportation	Total in the Hazard Area	
County of Kauaʻi	9	7	16	4	11	42	5	94	8
City and County of Honolulu	45	26	87	1	31	129	4	323	12
County of Maui	12	1	50	0	41	52	16	172	20
County of Hawaiʻi	7	1	24	0	8	16	4	60	5
Total	**73**	**35**	**177**	**5**	**91**	**239**	**29**	**649**	**45**

Source: *Hawaiʻi Wildfire Management Organization, Division of Forestry and Wildlife; Hawaiʻi Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020*

Table 4.15-9. Community Lifelines and Critical Facilities Located in High Wildfire Risk Hazard Area, by Category

Category	Total Number of Facilities	Total Replacement Cost Value	Number of Facilities in Hazard Area	Percent (%) of Total Facilities	Value in the Hazard Area	Percent (%) of Total Value
Communications	188	$776,797,683	73	38.83%	$266,485,971	34.31%
Energy	89	$3,093,949,530	35	39.33%	$1,207,734,600	39.04%
Food, Water, Shelter	345	$11,847,189,588	177	51.30%	$6,061,744,738	51.17%
Hazardous Material	12	$436,474,800	5	41.67%	$181,470,000	41.58%
Health and Medical	193	$4,606,713,364	91	47.15%	$2,116,439,676	45.94%
Safety and Security	486	$38,164,188,232	239	49.18%	$24,943,225,762	65.36%
Transportation	56	$2,039,091,600	29	51.79%	$1,052,526,000	51.62%
Additional Critical Facilities	106	$447,698,794	45	42.45%	$240,606,490	53.74%
Total	**1,475**	**$61,412,103,591**	**694**	**47.05%**	**$36,070,233,237**	**58.73%**

Source: *Hawaiʻi Wildfire Management Organization, Division of Forestry and Wildlife; Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020*

Assessment of Local Vulnerability and Potential Losses

A wildfire has the potential to kill people, livestock, fish, and wildlife. Wildfires often destroy property, valuable forested watersheds, native species and their habitats, and recreational and scenic resources. Many communities in the State of Hawai'i are at high risk from wildfire due to unmitigated fuels, limited community engagement, insufficient water and firefighting resources, and under-addressed pre- and post-fire planning and preparedness (HWMO 2015). A wildfire would impact not only residents, visitors, and valued resources but also the state's economy, which relies heavily on revenues from the tourism industry. This section provides a summary of vulnerability and potential losses to population, general building stock, environmental resources, and cultural assets by county. Statewide exposure is examined; however, it is highly unlikely that a wildfire event would take place across all islands at the same time.

The local HMPs were reviewed to integrate risk assessment results into the 2023 SHMP Update; a summary of information available is below.

- **County of Kaua'i** – The County of Kaua'i HMP provides a qualitative overview of wildfire risk, including development risk and environmental impacts. The county used the Hawai'i Wildfire Management Organization's Communities at Risk for Wildfire mapping to determine the population at risk from wildfires; there are 53,329 residents living within high and medium wildfire risk areas. 330 critical facilities are within medium and high wildfire risk areas (County of Kaua'i 2020).
- **City and County of Honolulu** – The City and County of Honolulu HMP provides a qualitative overview of wildfire risk, including types of wildfires and the County's warning and response capacity. The HMP also includes a breakdown of historical wildfire fuel type, with more than 50% of fires occurring in non-native grassland (City and County of Honolulu 2020).
- **County of Maui** – The County of Maui HMP provides a qualitative overview of wildfire risk. The county used the Hawai'I Department of Land and Natural Resources (DLNR) Wildfire Risk Area data on at-risk Wildland-Urban Interface Communities, which categorizes communities into low, medium, and high risk wildfire areas, to determine areas of risk in the county. There are 53,557 buildings and 248 critical facilities within a wildfire risk area. Additionally, the HMP lists residents who are most vulnerable to wildfires, including single parent and dependent households, elderly residents, residents living below the poverty line, residents without adequate communication infrastructure and/or limited English proficiency, residents living in properties built prior to the 1950s, and residents with limited mobility (County of Maui 2020).
- **County of Hawai'i** – The County of Hawai'i HMP provides a qualitative overview of wildfire risk, including types of wildfires and the county's warning and response capacity. The county used the Hawai'i Wildfire Management Organization's Communities at Risk for Wildfire mapping to determine the population at risk from wildfires; there are 62,065 residents living within high and medium wildfire risk areas. 235 critical facilities are within medium and high wildfire risk areas (County of Hawai'i 2020).

Socially Vulnerable and Total Population

Given the response times to reported fires, the potential of injuries and casualties is minimal. Many communities and populations are especially vulnerable to wildfires, including low-income communities, migrant populations,

populations whose primary language is not English, indigenous populations, communities of older adults, and those with respiratory and other health concerns. Members of immigrant communities may be concerned about impacts to their immigration status and do not seek help. When a wildfire impacts an area with high rents where multiple families live in one structure, it may be difficult for those not listed on the lease to prove that they were affected by the fire; this could result in a lack of access to services. Additionally, fires quickly increase housing prices and rent prices, further displacing people already affected by the fire. Homelessness can increase.

Wildfires can also pose significant threats to the health and safety of those fighting the fires. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke.

Table 4.15-10 lists the estimated population living in the high wildfire risk hazard areas that could be impacted should a wildfire occur. The population in the County of Maui has the greatest percent of its population exposed, and the City and County of Honolulu has the greatest number of people located in the high wildfire risk hazard areas. This analysis does not include the number of tourists and visitors in the state whose lodgings are also located in these high-risk areas. Therefore, these results may be underestimating exposure and vulnerability.

Table 4.15-10. 2020 U.S. Census Population Located in the High Wildfire Risk Hazard Area by County

County	Population				
	Total Population	Population in the Hazard Area	Population Exposed as % of Total Population	Socially Vulnerable Population in the Hazard Area	Socially Vulnerable Population Exposed as % of Total Population
County of Kauaʻi	71,949	27,604	38.37%	725	1.01%
City and County of Honolulu	979,682	427,293	43.62%	117,049	11.95%
County of Maui	167,093	81,424	48.73%	20,679	12.38%
County of Hawaiʻi	201,350	32,080	15.93%	672	0.33%
Total	**1,420,074**	**568,401**	**40.03%**	**139,125**	**9.80%**

Source: *Hawai'i Wildfire Management Organization, Division of Forestry and Wildlife; U.S. Census Bureau 2020; Centers for Disease Control and Prevention 2018*

Population living along the WUI may only have one ingress/egress to their communities, making them highly vulnerable in the event of an evacuation. Additional vulnerabilities include communicating risks about the hazard. It can take days to translate information into languages other than English, hindering communication about evacuations and health and safety alerts. Indigenous populations may lose sacred sites; fisheries and hunting and gathering grounds may be degraded (National Academies Press 2020). Older adults do not have the mobility many others have, which can slow or prevent evacuation. Health problems related to wildfire smoke exposure can be as mild as eye and respiratory tract irritation and as serious as worsening of heart and lung disease, including asthma, and even premature death (US EPA 2022).

The high vulnerability population in the hazard area makes up 24.5% of the total state population in the high wildfire risk hazard area. Overall, the County of Maui has the highest population exposed as a percentage, both for population in the hazard area (48.73%) and high vulnerability population in the hazard area (12.38%).

Land Use Districts

Table 4.15-11 shows the square miles of high wildfire risk areas in each state land use district statewide; refer to Appendix F (State Profile and Risk Assessment Supplement) for results by county. Urban Districts in the state have a significant portion of their total land area in the high-risk areas, though Agricultural lands have the most with 322.3 square miles. Conservation District land in the state has the greatest number of total square miles; however, it has the smallest percentage of the state's total area (2.1%). Conservation District lands contain valuable environmental resources. Additional discussion of exposure and vulnerability of these resource areas can be found in the Environmental Resources section below.

Table 4.15-11. State Land Use Districts Located in the High Wildfire Risk Hazard Area

Land Use District	Total (square miles)	Square Miles in High Wildfire Risk Area	% of Total Area
Agricultural	2,973.6	322.3	10.8%
Conservation	3,202.9	67.0	2.1%
Rural	16.3	5.7	34.8%
Urban	319.1	139.4	43.7%
Total	**6,511.9**	**534.4**	**8.2%**

Source: *Hawaiʻi Wildfire Management Organization, Division of Forestry and Wildlife; State Land Use Commission, Hawaiʻi Statewide GIS Program 2021; Honolulu County GIS 2022*

General Building Stock

Similar to the analyses presented earlier, the general building stock data was overlaid with the high wildfire risk hazard area to assess vulnerability. Table 4.15-12 summarizes these values by county. Approximately $166 billion, which represents 44.6% of the total building stock replacement cost value in the state, is located in the high wildfire risk hazard area. As noted earlier, due to the state's geography, it is highly unlikely that wildfire loss will occur statewide as events are typically isolated to one island. The County of Maui has the largest percent (70.15%) of their building stock located in the high wildfire risk hazard area while the City and County of Honolulu has the highest dollar amount exposure with over $99 billion. The replacement cost value of buildings exposed is provided as an estimate for total loss. Appendix F (State Profile and Risk Assessment Supplement) provides the general building stock values located in the low and moderate wildfire hazard areas.

Table 4.15-12. General Building Stock Located in the High Wildfire Risk Hazard Area by County

County	Total Value	Replacement Value in Hazard Area	Replacement Value Exposed as % of Total
County of Kauaʻi	$24,246,497,228	$15,446,334,294	63.71%
City and County of Honolulu	$239,152,051,766	$99,773,338,383	41.72%
County of Maui	$50,796,693,140	$35,635,679,142	70.15%
County of Hawaiʻi	$58,395,349,136	$15,477,544,144	26.50%
Total	**$372,590,591,270**	**$166,332,895,963**	**44.64%**

Source: *Hawaiʻi Wildfire Management Organization, Division of Forestry and Wildlife; NIYAM IT 2022; United States Army Corps of Engineers 2022*

From an economic perspective, traffic and road closures during fire events and post-fire flooding resulting in blocked access to critical transportation facilities, such as airports, leads to loss of productivity. Impacts to environmental resources, such as damage to nearshore resources (e.g., fishponds, coral reefs, fisheries), recreational areas discussed below could have a negative impact on tourism as well (HWMO 2016).

Environmental Resources

Overall, wildfires have physical, chemical, and biological impacts on ecosystem resources and the environment (DeBano, Neary and Ryan 2005). Wildfires threaten air quality, water quality, soil properties, nutrient cycling, vegetation and wildlife habitat. During periods of heavy rainfall, the burned areas can erode becoming mud flows, debris flows, thereby increasing sedimentation loads in streams and rivers and the ocean and potentially impacting water quality, fisheries and long-term coral health. Further impacts include stream bank destabilization, which could worsen impacts of heavy rainfall and lead to riparian flooding.

The State of Hawaii's native ecosystems have evolved with little or no fire. Therefore, wildfire is a significant threat to native forested watersheds and native species, including threatened and endangered species. According to the Hawaiʻi Forest Action Plan, approximately 90 percent of the state's 10,000 native species are endemic; in some cases being endemic to a portion of one island making them extremely vulnerable and potentially one wildfire away from extinction (DLNR, DFW 2016). Approximately 38 square miles of parks and reserves and 31 miles of critical habitat are located in high wildfire risk areas for CARs (refer to Table 4.15-13). As noted, the wildfire risk rankings used for analysis are based on the CAR data and focus on communities and developed areas. Therefore, these results are underestimating environmental resources' exposure and vulnerability to wildfire. Refer to Appendix F which summarizes the environmental resources located in the moderate and low wildfire risk areas by county.

Table 4.15-13. Environmental Resources Located in the High Wildfire Risk Hazard Area

Environmental Resource	Statewide		
	Total Square Miles of Resources	Square Miles in High-Risk Area	Percent (%) of Total Resource Area
Critical Habitat [a]	951	31	3.3%
Wetlands	3,637	13	0.3%
Parks and Reserves	2,778	38	1.4%
Reefs [b]	55	0	0.5%
Total [c]	**7,420**	**82**	**1.1%**

Source: *Hawaiʻi Wildfire Management Organization, Division of Forestry and Wildlife; U.S. Fish and Wildlife Service, Pacific Islands Office, 2022a, U.S. Fish and Wildlife Service 2021, 2017; Hawaiʻi State Department of Land and Natural Resources, Division of Forestry and Wildlife 2022; NOAA raster nautical charts 2020; State of Hawaiʻi Department of Land and Natural Resources, Division of State Parks 2021*

Notes:

a. *Critical area mileage includes the combined area of coverage of individual critical habitat areas.*
b. *Reefs include artificial and coral reefs.*
c. *Total square miles includes environmental assets within 3 nautical miles of each county and may be over-reported as some environmental asset areas may overlap.*

Wildfires impact watershed function—they destroy vegetation in watersheds resulting in a diminished capacity of the soils to absorb rainfall and fog drip that replenishes groundwater resources. Watersheds on all islands are subject to frequent tropical downpours, and these brief but intense events can quickly cause erosion and landslides in areas impacted by wildfire. Without vegetation that is resilient to fire and/or does not carry heavy fuel loads, terrestrial plants and animals, fresh and marine water species, and the quality of streams and wetland ecosystems will diminish, and their capacity to function properly will degrade (DLNR 2010).

The watershed areas in high wildfire hazard areas were evaluated by county and are summarized in Table 4.15-14. Approximately 1.5% of the total in these areas is affected by high wildfire risk areas for CARs. Risk rankings have not been developed for most watershed partnership areas.

Table 4.15-14. Watershed Partnership Areas Located in the High Wildfire Risk Hazard Area

Watershed Partnership	Area (in square miles)		
	Total Area	Hazard Area	Hazard Area as % of Total Area
County of Kauaʻi			
Kauaʻi Watershed Alliance	225.61	1.852	0.82%
City and County of Honolulu			
Koʻolau Mountains Watershed Partnership	160.62	4.889	3.04%
Waiʻanae Mountains Watershed Partnership	73.59	7.408	10.07%
County of Hawaiʻi			
Kohala Watershed Partnership	115.81	1.868	1.61%
Mauna Kea Watershed Alliance	400.39	0.384	0.10%
Three Mountain Alliance	1767.20	22.727	1.29%
County of Maui			
East Maui Watershed Partnership	173.01	2.867	1.66%
East Molokaʻi Watershed Partnership	105.27	2.640	2.51%
Leeward Haleakalā Watershed Restoration Partnership	53.56	2.220	4.14%
West Maui Mountains Watershed Partnership	73.94	0.091	0.12%
Lanai Forest and Watershed Partnership	14.84	0.000	0.00%
Overlap East Maui Watershed Partnership and Leeward Haleakalā Watershed Restoration Partnership	13.72	0.000	0.00%
Total	**3177.57**	**46.946**	**1.48%**

Source: Hawaiʻi *Wildfire Management Organization, Division of Forestry and Wildlife; Department of Land & Natural Resources, Division of Forestry and Wildlife 2020*

The DLNR-DOFAW is the primary responder for wildfires on lands it manages. The DOFAW-managed land accounts for 26% of the land statewide. The DOFAW co-responds with county fire departments and federal agencies to wildfires on an additional 32% of statewide lands, as determined by Mutual Aid Agreements and Memoranda of Agreement or Memoranda of Understanding. Therefore, the DOFAW is responsible for fire response on nearly 60% of the lands statewide. The DOFAW-managed lands and the wildfire hazard risk exposure for these lands are listed in Table 4.15-15. Statewide, more than 18 square miles of DOFAW-managed lands are located in high wildfire risk areas for CARs. Risk rankings have not been developed for most DOFAW-managed lands.

Table 4.15-15. DOFAW-Managed Lands Located in High Wildfire Risk Hazard Area

County	Area (in square miles)						
	Total Area	Low Hazard Area	Hazard Area as Percent (%) of Total Area	Moderate Hazard Area	Hazard Area as Percent (%) of Total Area	High Hazard Area	Hazard Area as Percent (%) of Total Area
County of Kauaʻi	166.2	0	0%	0.2	<1%	0.5	<1%
City and County of Honolulu	69.5	1.5	2%	3.1	5%	1.7	2%
County of Maui	217.2	0.1	<1%	0	<1%	5	2%
County of Hawaiʻi	1,124.50	37.8	3%	1.8	0%	11.1	1%
Total	**1,577.40**	**39.5**	**3%**	**5.1**	**<1%**	**18.2**	**1%**

Source: Hawaiʻi Wildfire Management Organization, Division of Forestry and Wildlife

Cultural Assets

Consistent with Native Hawaiian culture, Hawaiian Home Lands include areas from mauka to makai (from the mountain to the ocean). Structures located on Hawaiian Home Lands are considered more vulnerable to wildfire events if located in the categorized high wildfire risk areas (Table 4.15-16). The County of Hawaiʻi has the greatest number of square miles (191.5), and the City of County of Honolulu has the highest percentage (42.1%) of Hawaiian Home Lands located in high wildfire risk hazard areas.

Table 4.15-16. Hawaiian Home Lands Located in the High Wildfire Risk Hazard Area

County	Area (in square miles)		
	Total Area	Hazard Area	Hazard Area as % of Total Area
County of Kauaʻi County	32.1	2.2	6.8%
City and County of Honolulu	10.6	4.5	42.1%
County of Maui	102.6	38.3	37.3%
County of Hawaiʻi	191.5	6.1	3.2%
Total	**336.7**	**51.0**	**15.1%**

Source: Hawaiʻi Wildfire Management Organization, Division of Forestry and Wildlife; Hawaiʻi State Department of Hawaiian Homelands 2021

Table 4.15-17 shows the cultural resources in high wildfire risk hazard areas. The cultural resource type with the largest total area and largest area in the hazard area is the Historic District; however, the district with the largest percentage of area in the high wildfire risk hazard area is the Burial Sensitivity Area.

Table 4.15-17. Cultural Resources Located in the High Wildfire Risk Hazard Area

Cultural Resource Site Type	Area (in square miles)		
	Total Square Miles of Asset	Total Square Miles in the Hazard Area	Percent (%) of Total Asset Area
Archaeology	90.9	11.5	12.7%
Burial Sensitivity Area	2.1	1.1	54.1%
Historic Building	2.7	0.8	28.9%
Historic District	849.4	24.8	2.9%
Historic Object	9.6	0.0	0.1%
Historic Structure	20.7	0.3	1.6%
Total	**975.4**	**38.6**	**4.0%**

Source: Hawaiʻi Wildfire Management Organization, Division of Forestry and Wildlife; Department of Land and Natural Resources, Hawai'i State Historic Preservation Division 2022

Future Changes that May Impact State Vulnerability

Understanding future changes that impact vulnerability in the state can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The state considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

Potential or Projected Development

Non-urban zoned lands throughout the state are being urbanized rapidly. From 2000 to 2030, housing density is projected to substantially increase on approximately 8% (65,000 acres) of Hawaii's private forest land (Stein, et al. 2014). On Oʻahu, the directed growth policy of the City and County of Honolulu encourages growth to occur beyond the primary urban center (City and County of Honolulu 2021). Some new developments have sprawled into dry parts of Oʻahu while encroaching into the WUI. In wildfire-prone areas across the state, new developments would benefit from ensuring that the state fire code, including WUI codes, as well as recommendations are followed. This includes the design of roads (adequate width, fire truck access and turn-arounds, more than one ingress/egress, etc.), layout of structures (spacing), building materials (non-combustible and fire resistant), and maintenance of internal and surrounding vegetation. In other areas where land use changes have occurred due to the removal of active agriculture, fire hazard has increased and would be mitigated if converted and hardened for development. The number of communities rated to be at high risk from wildfire in the state has increased over time due to more people living proximate to wildland areas, unmitigated fuels, limited community engagement, insufficient water and firefighting resources, and under-addressed pre- and post-fire planning and preparedness (HWMO 2015).

Projected Changes in Population

As stated previously, over 98% of wildfires in the State of Hawaiʻi are caused by humans. As the overall resident population increases, there may be an increase in the number of human-caused wildfires as more people move into currently less developed parts of the state and as more people engage in activities that may accidentally spark wildfires. In addition to the resident population, the visitor population coming to the state is also increasing. Visitors may be less familiar with wildfire risk and the precautions that should be taken to prevent or limit wildfire ignition. The increase in both resident and visitor populations may stress existing resources available for wildfire suppression activities as more water will be needed for human use and consumption.

Other Factors of Change

Climate change has the potential to significantly increase vulnerability to wildfire in the state. In the past 30 years, the state has experienced longer droughts, an increase in consecutive dry days, and decrease in the days of intense rainfall, all of which lead to perfect conditions for wildfires throughout the state (HWMO 2017).

As drought conditions become more frequent and as sea level rise "squeezes" land available for development, this will result in development expansion closer to upland forest ecosystems. Increasing temperatures and, in some areas, reduced rainfall will stress native plant and animal populations and species, especially in high-elevation ecosystems, with increased exposure to non-native biological invasions and fire, and with extinctions a likely result (The Pacific Islands Regional Climate Assessment 2012).

Overall, an increase in wildfire events means fewer native forests and drinking water, and more erosion/runoff, coastal brownouts, and communities at risk in the State of Hawaiʻi (HWMO 2017).

Section 4.16 Windstorm

Windstorm

The trade winds that blow across the Pacific are subject to intensification from high pressure cells north of the islands. Windstorms can damage infrastructure, disrupt electrical power due to damaged power lines, destroy buildings, create wind-borne debris missiles, and cause other damages statewide.

CHANGES SINCE 2018

+2 Declared Disasters

+44 Windstorm Events

COUNTIES MOST VULNERABLE

SOCIALLY VULNERABLE POPULATION

22.3% Of Total Population

316,257 Persons

HAZARD RANKING

COMMUNITY LIFELINES

1,369

Total

CLIMATE PROJECTIONS

Change in prevailing winds may shift large-scale pressure and wind patterns

Muggy weather and vog are the result of fewer days of northeast trade winds

Average atmospheric and land surface temperatures may increase due to changing trade wind patterns

6,095 State Buildings

1,104 Miles of State Road

SQUARE MILES

7,420 Environmental Resources

337 Hawaiian Home Lands

975 Cultural Resources

CONTENTS

TABLES

FIGURES

[1] *Section Cover Photo: Wind-whipped palms on Kauaʻi's east shore. Photo by Megan Brotherton*

SECTION 4. RISK ASSESSMENT

4.16 WINDSTORM

2023 SHMP Update Changes

- High windstorm events that occurred in Hawaiʻi from January 1, 2018, through December 31, 2022, were researched for this 2023 SHMP Update.
- This section now includes a discussion of how windstorms impact socially vulnerable populations and community lifelines.
- Six types of cultural resources (archaeology, burial sensitivity area, historic building, historic district, historic object, and historic structure) were added to the vulnerability assessment.

4.16.1 HAZARD PROFILE

Wind is defined as the horizontal component of natural air moving caused by horizontal pressure gradients close to the surface of the earth and at higher levels. This hazard profile and associated vulnerability assessment addresses high windstorms, in general, while Section 4.9 (Hurricane) addresses risk from tropical storms and hurricane-force winds in more detail.

HAZARD DESCRIPTION

Types of Winds

Winds in the State of Hawaiʻi originate from several different sources: trade winds, kona winds, midlatitude fronts and shear lines, and hurricanes/tropical storms. High winds from trade winds (which blow 70% of the time), kona winds, fast-moving cold fronts, and rare winds from hurricanes and tropical storms passing through Hawaiian waters all affect the state. The hazards from hurricanes and tropical storms are discussed in Section 4.9 (Hurricane). This section focuses on the other two wind patterns: trade and kona.

Trade Winds

The trade wind pattern over the Pacific Ocean is one of the largest and most consistent wind fields in the world, and these winds play a major role in defining the climatology of the region. The northeast trade winds prevail over the Hawaiian Islands throughout the year with an average speed of 15.7 mph, with speeds ranging between 10 and 25 mph. Occasional extreme events reach 40 to 50 mph when the subtropical high-pressure cell north of the Hawaiian Islands intensifies (Garza, et al. 2012).

Average wind speeds in the State of Hawaiʻi are the highest during the summer trade wind period (May through September) when trade winds are present 85% to 95% of the time, and wind speeds over the ocean exceed 12 miles per hour (mph) 50% of the time. During the winter (October through April), when trade winds are not as prevalent (present 50% to 80% of the time), wind speeds are in excess of 12 mph about 40% of the time (Western Regional Climate Center 2018).

These persistent winds became known as trade winds long ago when clipper ships carrying cargo depended on the broad belt of easterly winds encircling the globe in the subtropics for fast passage; however, strong, gusty trade winds can cause problems for mariners. Strong trade winds, blowing from the northeast, funnel through the major channels between the islands—Kauaʻi, Kaiwi, Pailolo, Kalohi, ʻAuʻau, and ʻAlenuihāhā Channels—at speeds 5 to 20 knots (about 5.7 to 23.0 miles per hour) faster than the speeds over the open ocean. North Pacific high-pressure systems are responsible for the majority of the gusty trade wind episodes over Hawaiian waters, which commonly persist for several days before tapering off (Pacific Disaster Center 2011).

Kona Winds

Kona winds is a Hawaiian term for the stormy, rain-bearing winds that blow over the islands from the southwest or south-southwest in the opposite direction of trade winds. Kona is the Hawaiian word for leeward. When kona winds blow, the predominant wind pattern is reversed so that the western or leeward sides of the islands become windward. This type of wind is associated with a class of subtropical weather systems known as kona low-pressure systems or kona storms, which develop northwest of the State of Hawaiʻi and move slowly eastward. Kona storms can produce heavy rains, hail, floods, landslides, and other severe weather hazards in addition to the high winds discussed in this hazard profile (Hawaiʻi Life 2012). Strong kona winds can last for a day or for a week or more (Pacific Disaster Center 2011).

Midlatitude fronts and shear lines

Midlatitude cold fronts, which can usually be found to the north of Hawaiʻi in winter, can move very fast, shifting wind from southwesterly ahead of the front to northwesterly behind it. Because of the modification of the cold front by the underlying warm ocean, as it approaches Hawaiʻi, the temperature contrast across a frontal system may not be present. Often a frontal system is recognized as a wind shear line and is accompanied by clouds and/or precipitation (Businger 2013).

Wind Speed and Wind Load

There are several ways to measure the speed at which air is moving or "wind speed". The most commonly used methodologies for measuring wind speed are as follows:

- **The Fastest Mile Wind** – The Fastest Mile Wind speed is the average recorded speed during a time interval in which one mile of wind passes a fixed measuring point. The measurement is taken at an elevation of 33 feet in open terrain. The Fastest Mile Wind speed measurement was historically used in many older building codes and design standards such as the Uniform Building Code (all editions) and the American Society of Civil Engineers (ASCE) Minimum Design Loads for Buildings and Other Structures (until the 1993 edition) (Ghosh 2008).
- **Sustained Wind** – Sustained Wind is the wind speed averaged over 2 minutes. This is the measurement standard used by the National Weather Service (American Meteorological Society 2022).
- **Peak Gusts** – Peak Gusts are the maximum wind gust speeds averaged over a period of two to five seconds (American Meteorological Society 2012). This is the measurement standard used by modern Hawaiian building codes.

It is important to understand that it is wind load, and not wind speed, that causes wind damage. Wind load is the force or pressure that wind exerts on the outside of a structure. Wind exerts three types of forces on a structure:

- **Uplift load** – Wind flow pressures that create a strong lifting effect, much like the effect on airplane wings. Wind flow under a roof will push upward; wind flow over a roof will pull upward.
- **Shear load** – Horizontal wind pressure that could cause racking of walls, making a building tilt.
- Lateral load – Horizontal pushing and pulling pressure on walls that could make a structure slide off the foundation or overturn (Extension Disaster Education Network n.d.).

Location

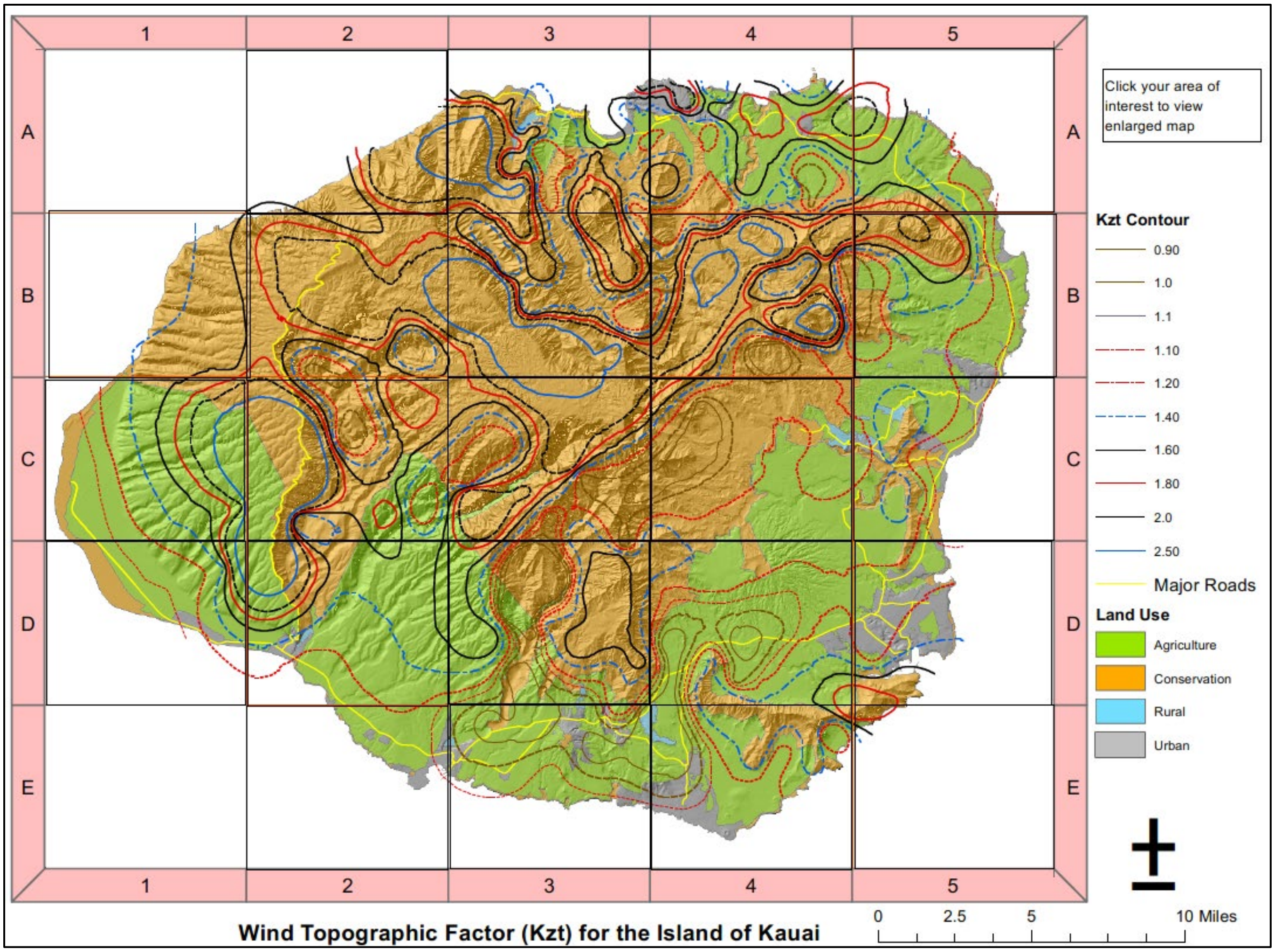
High windstorms can occur anywhere in the State of Hawaiʻi; therefore, the entire state and all its counties are susceptible to the direct and indirect impacts of high windstorms; however, topography plays a significant role in where the impacts of high windstorms are most severe. For example, strong kona storms bring wind and rain and can cause extensive damage to south and southwest-facing shores (NOAA 2021). The Kāneʻohe-Kahaluʻu area, on the windward coast of the Island of Oʻahu (City and County of Honolulu), has had extensive wind damage due to strong kona winds. In the case of the Island of Maui, trade winds appear to be stronger when passing through the isthmus between the West Maui Mountains and Haleakalā, so that wind speeds at locations such as Māʻalaea and north Kīhei may be higher than locations along the island's north shore due to wind channeling that often occurs when wind passes between two mountains or into a valley (USGS 2002). In general, wind speeds vary with height above ground—the higher the elevation, the stronger the wind. As a result, the mountainous areas of the State of Hawaiʻi generally experience the highest wind speeds (Western Regional Climate Center 2018).

Topographic Effects on Windspeed

Wind speed increases over hills, ridges, and escarpments (steep slopes or long cliffs). This phenomenon is known as wind speed-up. Because wind speed is related to wind pressure, structures in wind speed-up areas will experience more severe damages than those located on flat, open terrain if building codes do not take the local topographic factor into consideration (Soleimanian, Kilanehei and Mehdi Memarpour 2019). In the past, the magnitude of wind speed-up caused by topography in the State of Hawaiʻi has not been well understood, and it was not historically considered in any building code used in the state (State of Hawaiʻi 2018).

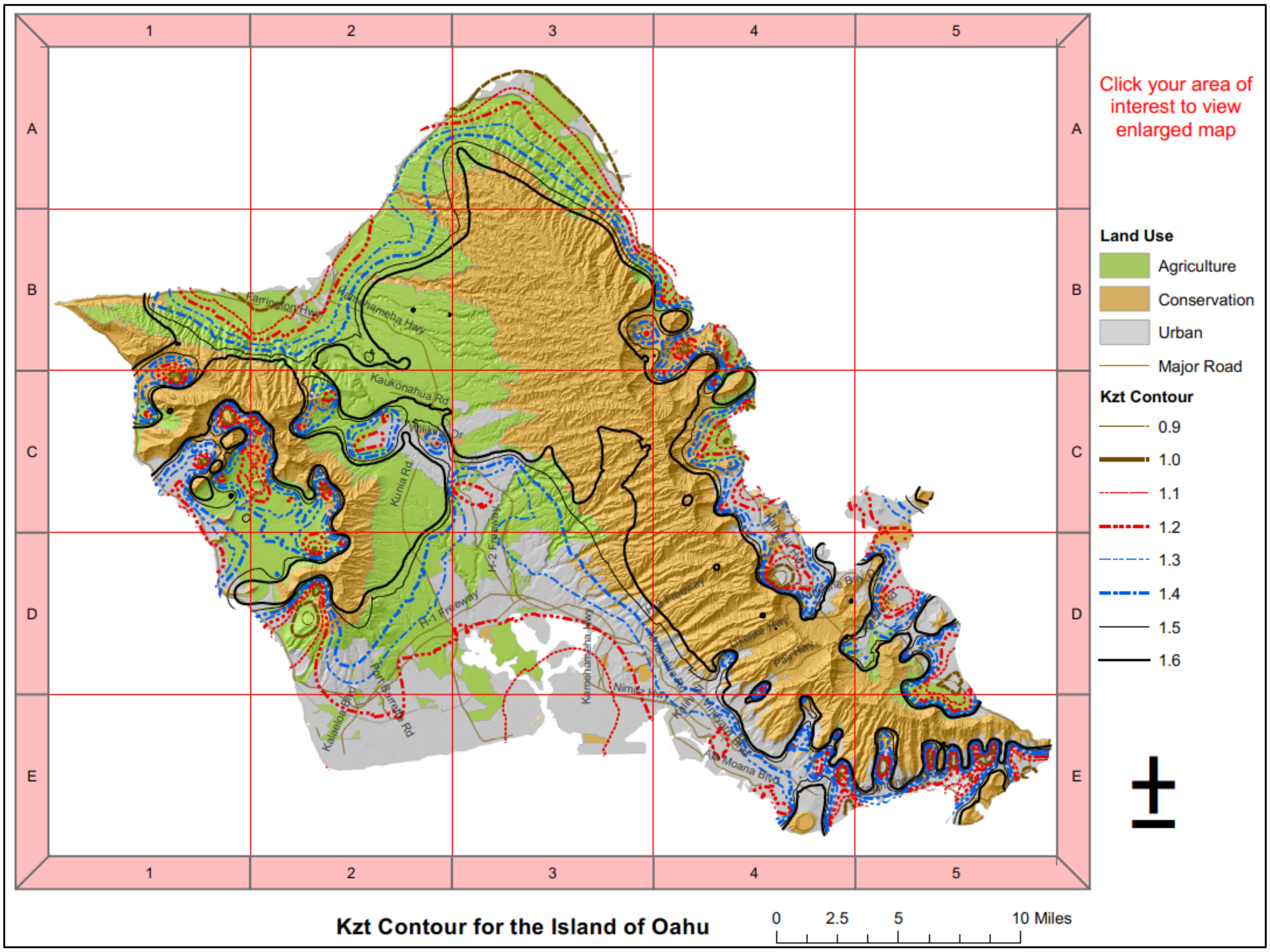
In the early 2000s, an assessment of wind speed-up in the State of Hawaiʻi was conducted, and it was determined that existing mapping and standards were insufficient to adequately determine design wind pressures due to the complex topography in the state (Chock and Cochran 2002). In short, the topography has speed-up effects that cannot be adequately portrayed by a single statewide value of wind speed nor at the macro-scale of a national map. This factor, coupled with the designation of the State of Hawaiʻi as a special wind region in American Society of Civil Engineers (ASCE) standards, resulted in the development of a procedure and associated mapping to determine design wind pressures in the state that could be incorporated into state and county building codes. The State of Hawaiʻi wind design provisions for new construction are included in Appendix W of the Hawaiʻi State Building Code (State of Hawaiʻi 2021). The requirements are complex and include design provisions for windborne debris, ultimate design wind speeds, directionality factors, and exposure categories. Figure 4.16-1 through Figure 4.16-6 show the wind topographic factors for each island that are included in these design requirements.

Figure 4.16-1. Wind Topographic Factor (Kzt) for the Island of Kaua'i (County of Kaua'i)



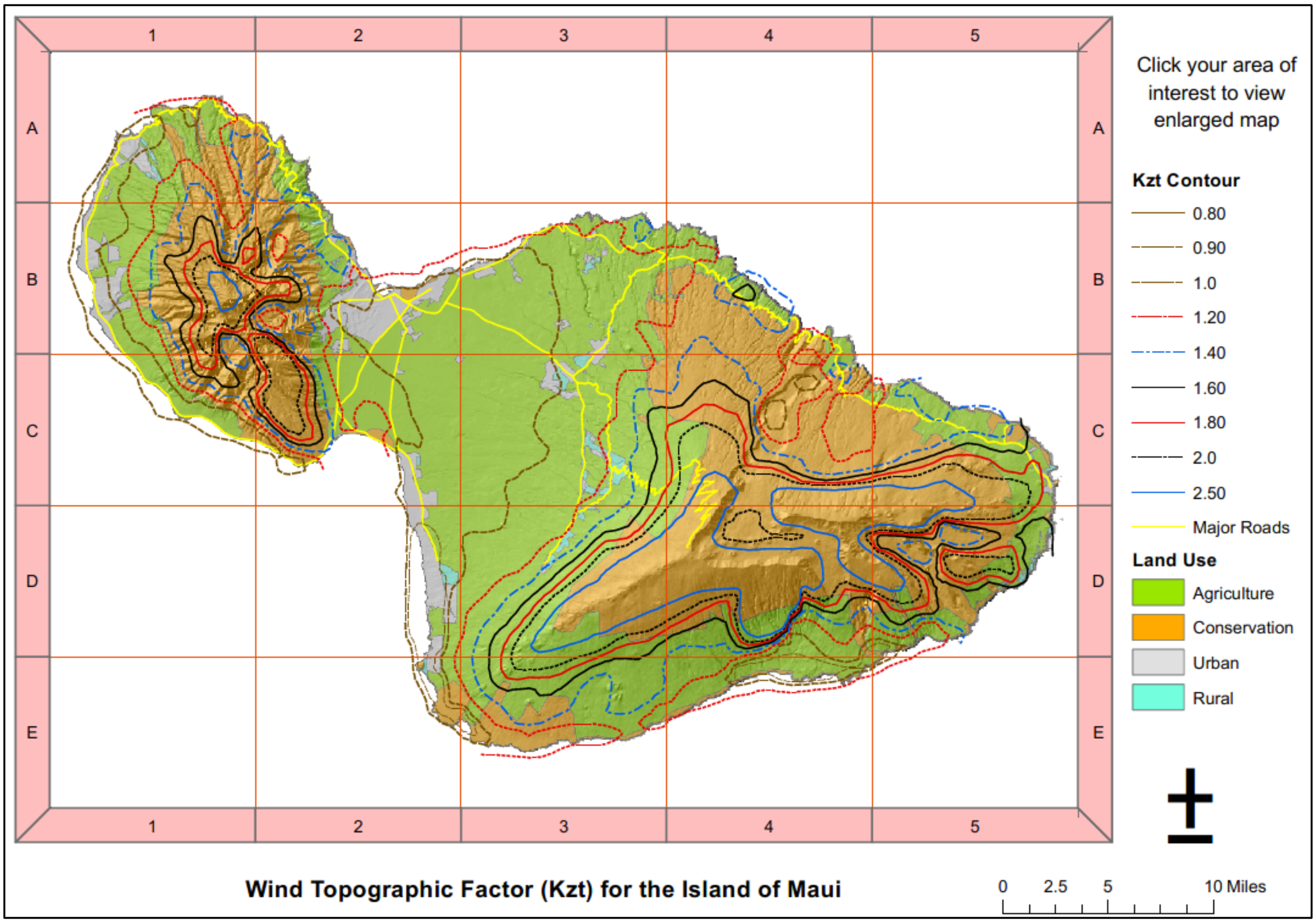
Source: State of Hawai'i Department of Accounting and General Services 2018

Figure 4.16-2. Wind Topographic Factor (Kzt) for the City and County of Honolulu



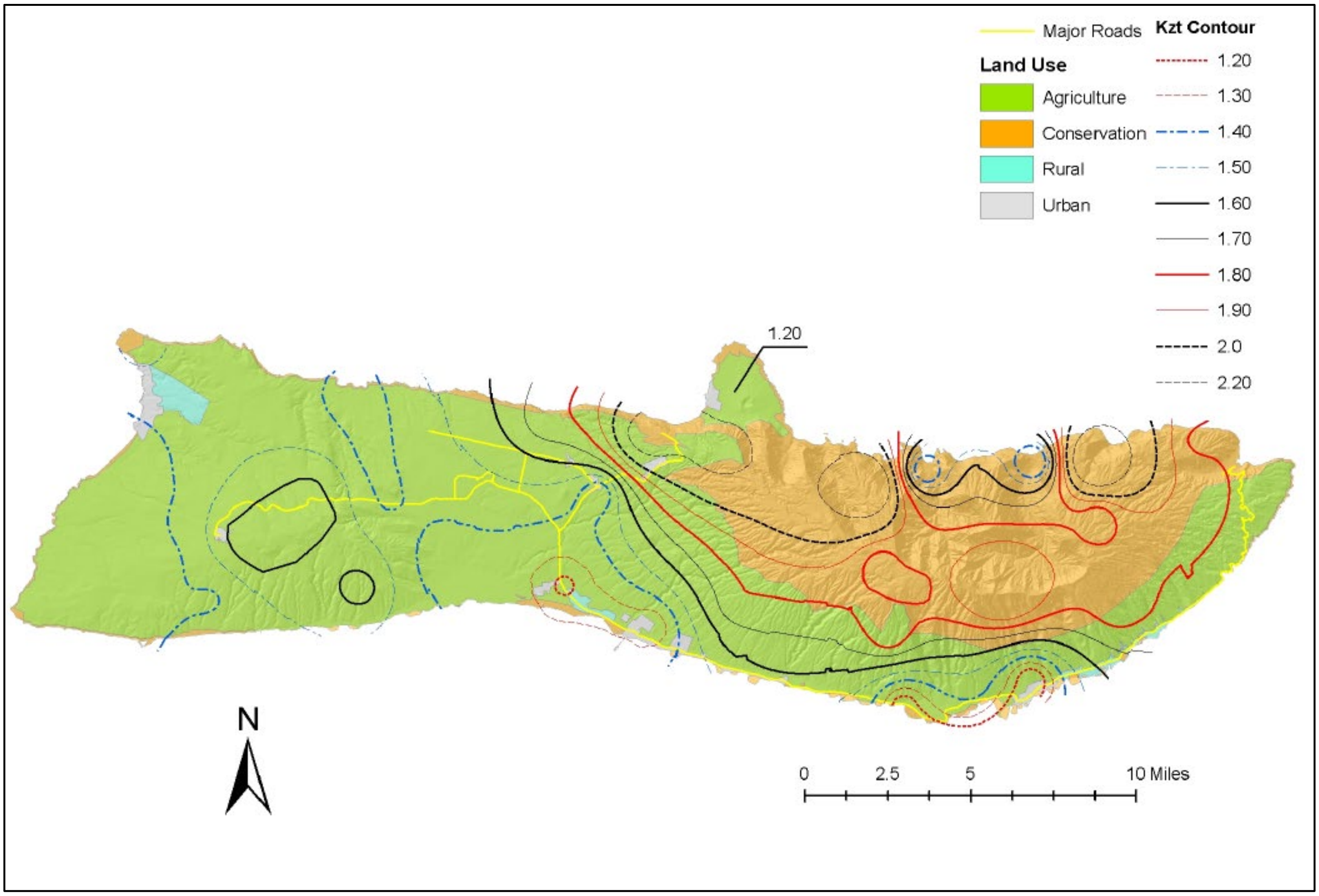
Source: State of Hawai'i Department of Accounting and General Services 2018

Figure 4.16-3. Wind Topographic Factor (Kzt) for the Island of Maui (County of Maui)



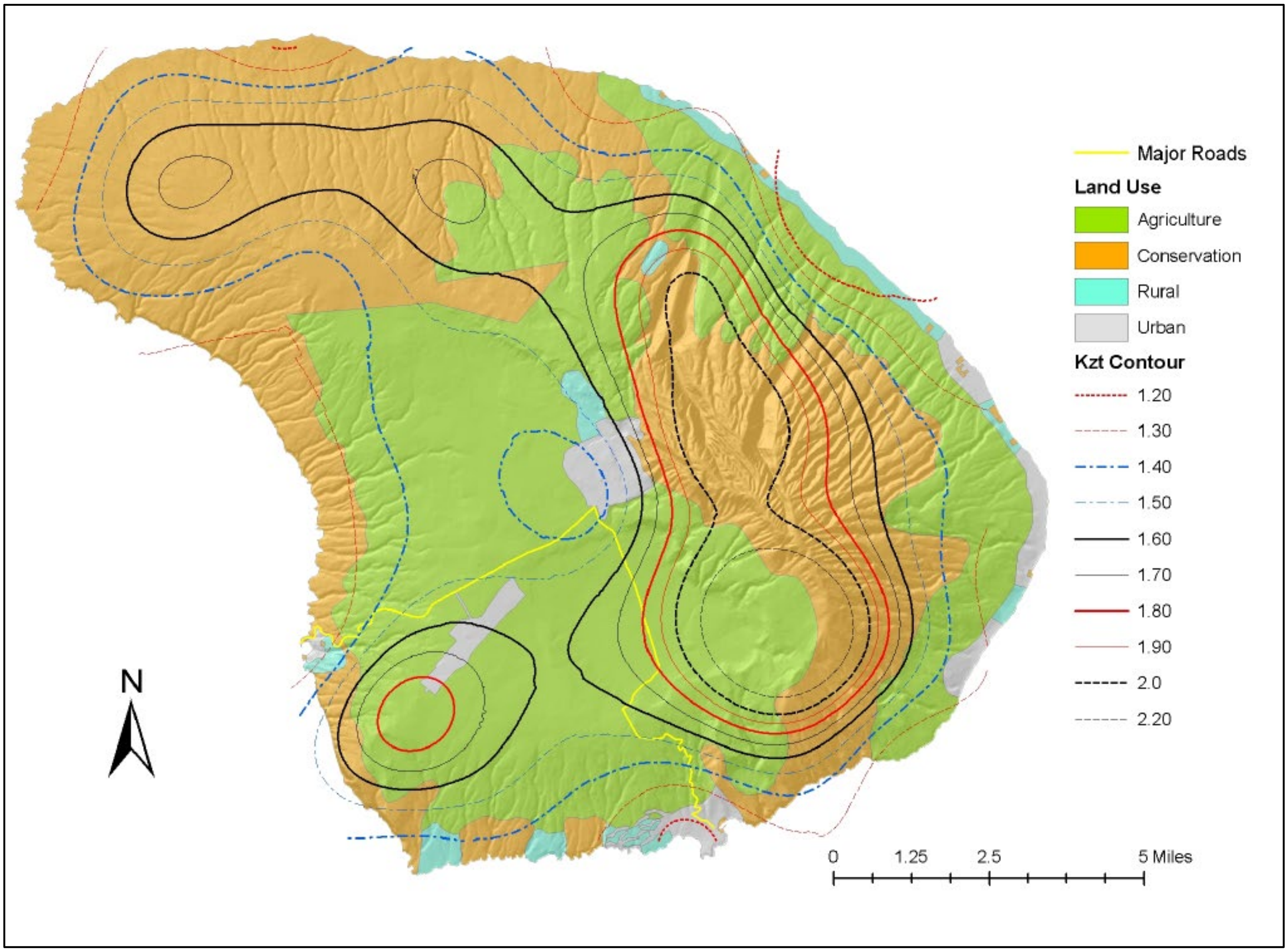
Source: State of Hawai'i Department of Accounting and General Services 2018

Figure 4.16-4. Wind Topographic Factor (Kzt) for the Island of Moloka'i (County of Maui)



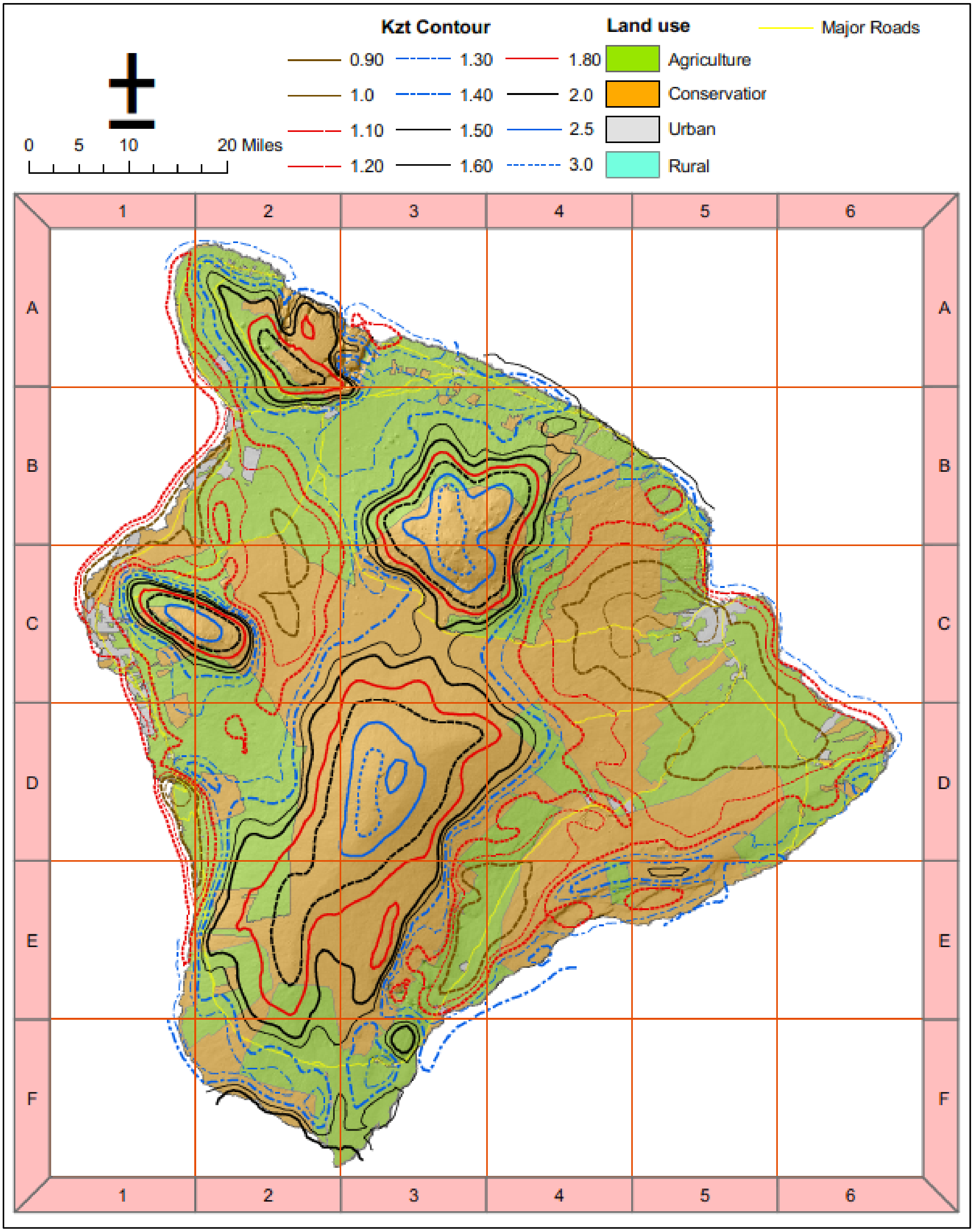
Source: State of Hawai'i Department of Accounting and General Services 2018

Figure 4.16-5. Wind Topographic Factor (Kzt) for the Island of Lānaʻi (County of Maui)



Source: State of Hawaiʻi Department of Accounting and General Services 2018

Figure 4.16-6. Wind Topographic Factor (Kzt) for the County of Hawaiʻi



Source: State of Hawaiʻi Department of Accounting and General Services 2018

The topographic factor (K_{zt}) acts as a multiplier in determining peak gusts relative to mild, flat terrain. As a result, buildings of all types constructed under this code are built to a uniform level of risk, that is, all occurrences of amplified wind are addressed in the design of that building so that no building has disproportionate risk (State of Hawaiʻi 2021, Chock and Cochran 2002).

Extent

The Beaufort wind scale, still in use today, was developed in 1805 to help sailors estimate the wind speed through visual observations. The scale includes a description of winds and specifications for use both at sea and on land (see Table 4.16-1) (National Weather Service 2016).

Table 4.16-1. Beaufort Wind Scale

Force	Speed mph (knots)	Description	Specifications for use at sea	Specifications for use on land
0	0 -1 (0 -1)	Calm	Sea like a mirror.	Calm; smoke rises vertically.
1	1 -3 (1 -3)	Light Air	Ripples with the appearance of scales are formed, but without foam crests.	Direction of wind shown by smoke drift, but not by wind vanes.
2	4 -7 (4 -6)	Light Breeze	Small wavelets, still short, but more pronounced. Crests have a glassy appearance and do not break.	Wind felt on face; leaves rustle; ordinary vanes moved by wind.
3	8 -12 (7 -10)	Gentle Breeze	Large wavelets. Crests begin to break. Foam of glassy appearance. Perhaps scattered white horses.	Leaves and small twigs in constant motion; wind extends light flag.
4	13 -18 (11 -16)	Moderate Breeze	Small waves, becoming larger; fairly frequent white horses.	Raises dust and loose paper; small branches are moved.
5	19 -24 (17 -21)	Fresh Breeze	Moderate waves, taking a more pronounced long form; many white horses are formed.	Small trees in leaf begin to sway; crested wavelets form on inland waters.
6	25 -31 (22 -27)	Strong Breeze	Large waves begin to form; the white foam crests are more extensive everywhere.	Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty.
7	32 -38 (28 -33)	Near Gale	Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind.	Whole trees in motion; inconvenience felt when walking against the wind.
8	39 -46 (34 -40)	Gale	Moderately high waves of greater length; edges of crests begin to break into spindrift. The foam is blown in well-marked streaks along the direction of the wind.	Breaks twigs off trees; generally impedes progress.
9	47 -54 (41 -47)	Severe Gale	High waves. Dense streaks of foam along the direction of the wind. Crests of waves begin to topple, tumble and roll over. Spray may affect visibility.	Slight structural damage occurs (chimney-pots and slates removed).
10	55 -63 (48 -55)	Storm	Very high waves with long overhanging crests. The resulting foam, in great patches, is blown in dense white streaks along the direction of the wind. On the whole, the surface of the sea takes on a white appearance. The tumbling of the sea becomes heavy and shock-like. Visibility affected.	Seldom experienced inland; trees uprooted; considerable structural damage occurs.
11	64 -72 (56 -63)	Violent Storm	Exceptionally high waves (small and medium sized ships might be for a time lost to view behind the waves). The sea is completely covered with long white patches of foam lying along the direction of the wind. Everywhere the edges of the wave crests are blown into froth. Visibility affected.	Very rarely experienced; accompanied by widespread damage.
12	72 -83 (64 -71)	Hurricane	The air is filled with foam and spray. Sea completely white with driving spray; visibility very seriously affected.	Refer to Saffir-Simpson Hurricane Scale in Section 4.9 (Hurricane).

Source: National Weather Service 2016

The average speed of the Trade Winds (15.7 mph) is considered a moderate breeze using this scale. When passing through mountain gaps and over mountains, down-sloped kona wind gusts can reach over 100 mph, which are hurricane-force winds (Pacific Disaster Center 2011).

High windstorms can cause disruptions to power, uproot trees, damage boats, blow roofs off homes and have the potential to damage other structures in the state (National Weather Service 2015). Damage does not typically occur until wind speeds of 40 mph or greater are reached; however, large branches of the invasive Albizia *(Falcataria moluccana)* may break and fall with minor wind gusts of 35 mph. In recent years, utility companies have spent millions of dollars repairing infrastructure after high wind events caused Albizia trees and limbs to fall utility lines and poles (Big Island Invasive Species Committee 2023). The State of Hawaiʻi Building Codes references the ASCE 7 Standard for *Minimum Design Loads for Buildings and Other Structures*, which requires that new buildings in the state be designed to withstand a 120 mph sustained wind or wind gusts of 130 mph. This is equivalent to a Category 3 hurricane (see Section 4.9 Hurricane for more information). In addition, the State of Hawaiʻi building code imposes additional requirements for structures to be designed to account for the topographic factors discussed previously (State of Hawaiʻi 2021).

Warning Time

Meteorologists can often predict the likelihood of a high windstorm event. This can give several days of warning time. However, meteorologists cannot predict the exact time of onset or severity of the storm. Some storms may come on more quickly and have only a few hours of warning time. The predicted wind speed given in wind warnings issued by the National Weather Service is for a one-minute average; gusts may be 25% to 30% higher.

The National Weather Service Honolulu Forecast Office issues specific watches, warnings, and advisories when weather threatens the state. For high windstorms, the following may be issued (NWS 2017):

- **High Wind Watch** is issued when sustained winds exceeding 40 mph and/or frequent gusts over 60 mph are likely to develop in the next 24 to 48 hours. For summit areas, high wind watches are issued when sustained winds are expected to exceed 56 mph and/or frequently gust over 66 mph. If you are in an area for which a High Wind Watch has been issued, you should prepare by securing loose objects outdoors that may blow about and avoiding outdoor activity that exposes you to high winds.
- **High Wind Warning** is issued when sustained winds exceeding 40 mph and/or frequent gusts over 60 mph are occurring or imminent. For summit areas, warnings are issued for winds exceeding 56 mph and/or frequently gusting over 66 mph. Wind warnings may be issued up to 24 hours ahead of the onset of high winds. If you are in an area where a high wind warning is in effect, you should avoid activities that expose you to high winds. Loose objects may be blown around. Tree limbs may break and fall. Power lines may be blown down.
- **Wind Advisory** is issued when sustained winds of 30 to 39 mph and/or frequent gusts to 50 mph or greater are occurring or imminent. For summit areas, the sustained wind range is 45 to 55 mph and/or frequent gusts of 55 to 65 mph. Wind advisories may be in effect for 6 to 12 hours. If you are in an area where a wind advisory is in effect, you should secure loose objects that may be blown about outdoors and limit activity that may expose you to high winds.

- **Small Craft Advisory** is issued for the coastal waters when winds of 28 to 37 mph and seas 10 feet or higher are occurring or forecast.
- A **Gale Warning** is issued for coastal, offshore, and high seas areas when winds of 39 to 54 mph not associated with a tropical cyclone are occurring or forecast.
- A **Storm Warning** is issued for coastal, offshore, and high seas areas when winds of 55 to 73 mph not associated with a tropical cyclone are occurring or forecast.

Previous Occurrences and Losses

High wind events, distinct from tropical cyclones, affect the State of Hawaiʻi on a relatively regular basis. It can be observed from more recent events that the major damage is typically: power outages due to fallen distribution poles; fallen trees, which create debris that often results in damage to structures or other property; and roof damage due to uplift of shingles, tiles, or other types of cladding. Occasionally there are deaths associated with the debris and structural collapses. The storms that produce these high winds often have associated flooding and other hazards that provide further damage and losses.

Many sources provided high windstorm events information regarding previous occurrences and losses throughout the State of Hawaiʻi. The 2018 SHMP discussed specific high windstorm events that occurred in Hawaiʻi through 2017. For this 2023 SHMP Update, high wind events were summarized between January 1, 2018, and December 31, 2022. Table 4.16-2 includes details of major high windstorm events that occurred in the state between 2018 and 2022. Not all events are captured in the table below. Only major events that resulted in injuries or fatalities, as reported by NOAA NCEI, events that resulted in the activation of the state and/or county EOC, and/or events that led to a FEMA disaster declaration are listed. For events prior to 2018, please refer to Appendix E (Hazard Profile Supplement).

Table 4.16-2. Windstorm Events in Hawaiʻi (2018 to 2022)

Date(s) of Event	Event Type	Counties Affected	Description
January 17, 2018	Strong Wind	Honolulu, Hawaiʻi	Strong trade winds caused power outages with downed lines and trees resulting in road closures. No significant injuries were reported. Crop damages totaled $5,000.00.
January 18, 2018	Strong Wind	Honolulu	Strong trade winds caused widespread power outages and traffic delays due to downed lines, utility poles and trees. No significant injuries were reported. Property damages amounted to $25,000.
January 30, 2018	High Wind	Hawaiʻi	Winds from the southwest exceeded 70 mph over the summits of Mauna Kea and Mauna Loa on the Big Island of Hawaiʻi. No serious injuries or property damage were reported.
February 1, 2018	High Wind	Hawaiʻi	Southwest winds strengthened above high wind criteria as an upper air trough moved near the islands. No significant property damage or injuries were reported.
February 5, 2018	High Wind	Hawaiʻi	Middle- to upper-air flow strengthened over Mauna Kea and Mauna Loa on the Big Island of Hawaiʻi. No significant property damage or injuries were reported.
February 8, 2018	High Wind	Hawaiʻi	Middle- to upper-air flow strengthened over Mauna Kea and Mauna Loa on the Big Island of Hawaiʻi. No significant property damage or injuries were reported.
February 15, 2018	High Wind	Hawaiʻi	Southwest winds strengthened above high wind criteria over the summits of Mauna Kea and Mauna Loa on the Big Island. No serious property damage or injuries were reported.

Date(s) of Event	Event Type	Counties Affected	Description
February 19, 2018	High Wind	Hawaiʻi	Southwest winds increased to above high wind criteria over the summits of Mauna Kea and Mauna Loa. There were no reports of serious injuries or property damage.
February 23, 2018	Strong Wind	Hawaiʻi	Heavy showers, including thunderstorms, formed across the area. There were no reports of serious injuries. A roof in Hilo on the Big Island of Hawaiʻl was damaged. Winds gusts were recorded to be 39 knots or 45 mph. Property damages amounted to $10,000.00.
March 7, 2018	High Wind	Hawaiʻi	High winds from the southwest occurred over the summits of Mauna Kea and Mauna Loa on the Big Island of Hawaiʻi. No serious injuries or property damage were reported.
March 12, 2018	High Wind	Hawaiʻi	Winds from the south to southwest increased across the summits of Mauna Kea and Mauna Loa on the Big Island. There were no reports of serious injuries or property damage.
March 20, 2018	High Wind	Hawaiʻi	South to southwest winds accelerated over the summits of Mauna Kea and Mauna Loa on the Big Island. There were no reports of serious injuries or property damage.
March 23, 2018	High Wind	Hawaiʻi	Southwest winds increased above high wind criteria over the summits of Mauna Kea and Mauna Loa on the Big Island of Hawaiʻi. There were no reports of significant property damage or injuries.
April 2, 2018	High Wind	Hawaiʻi	Southwest winds over the summits of Mauna Kea and Mauna Loa on the Big Island of Hawaiʻi increased beyond the high wind threshold. No serious injuries or property damage were reported.
April 27, 2018	High Wind	Hawaiʻi	Winds from the southwest exceeded high wind criteria over the summits of Mauna Kea and Mauna Loa on the Big Island of Hawaiʻi. There were no reports of serious property damage or injuries.
April 29, 2018	High Wind	Hawaiʻi	Southwest winds exceeded high wind criteria over the summits of Mauna Kea and Mauna Loa on the Big Island of Hawaiʻi. No significant property damage or injuries were reported.
May 1, 2018	High Wind	Hawaiʻi	Southwest winds exceeded high wind criteria over the summits of Mauna Kea and Mauna Loa on the Big Island of Hawaiʻi. No significant property damage or injuries were reported.
September 11, 2018 – September 12, 2018	Strong Wind	Honolulu, Maui	As Tropical Storm Olivia approached the islands from the east-northeast and then made a double landfall in Maui County on September 12th, it brought gusty winds and heavy precipitation. Most of its effects were concentrated over Maui, Molokai, and Oʻahu. The system downed trees, closed roads, caused power outages and debris flows, and generated flash flooding. There were no reports of serious injuries. Crop damages totaled $18,000.00.
January 27, 2019	High Wind	Hawaiʻi	Southwest to west winds increased to more than 80 mph over the summits of Mauna Kea and Mauna Loa on the Big Island. No significant injuries or property damage were reported.
January 28, 2019 – January 30, 2019	Strong Wind	Hawaiʻi, Honolulu	A surface trough just east of the island chain, in combination with high pressure north of the state, induced strong north winds across the area. Damages from the winds occurred on the Big Island and Oʻahu, with one individual injured on Oʻahu as well. The tin roof of a building was blown off at the Kona Airport in the leeward part of the Big Island. Six trees were downed near Hilo. On Oʻahu, a house lost its roof due to strong winds. An 89-year-old man was injured. Property damages amounted to $32,000.00.

Date(s) of Event	Event Type	Counties Affected	Description
February 7, 2019 – February 11, 2019	High Wind, Strong Wind	Kaua'i, Honolulu, Maui, Hawai'i	A powerful storm brought fierce winds to most areas of the state, with lower-level winds exceeding 50-knot gusts on Kauaʻi at Port Allen and Barking Sands, and enhanced surf, especially along north- and west-facing shores. Surf heights in some locales reached above 50 feet for north-facing shores and above 30 feet for west-facing shores. The very strong winds at the summits of Mauna Kea and Mauna Loa on the Big Island and the summit of Haleakalā on Maui produced blizzard-type conditions as the feature affected the region. No significant injuries were reported. Winds gusted just over 50 knots at Barking Sands in leeward Kauaʻi. Winds gusted over 55 knots at Port Allen in leeward Kauaʻi. A rooftop was blown off and trees and power poles were downed on Oʻahu, blocking roadways and causing power outages for nearly 10,000 customers. Mainly SW to W winds were sustained from 60 to 135 mph, with gusts as high as 161 mph, at the summits of Mauna Kea and Mauna Loa on the Big Island. Winds were somewhat less at the summit of Haleakalā on Maui. State highways on the Big Island of Hawaiʻi were closed by downed power poles and trees. A downed 100-foot tree crashed through a house, blocking a nearby road and taking down power lines near Honomu in windward Big Island. Property damages amounted to $185,000.00, crop damages totaled $44,000.00.
February 20, 2019	High Wind	Hawaiʻi	Winds from the south to southwest were sustained above 60 mph, with gusts as high as 77 mph. No serious injuries or property damage were reported.
February 27, 2019	High Wind	Hawaiʻi	Mainly south to southwest winds increased to over 60 mph, with gusts as high as 81 mph. No significant injuries or property damage were reported.
March 16, 2019	High Wind	Hawaiʻi	West winds on the summits of Mauna Kea and Mauna Loa on the Big Island gusted above 75 mph. There were no reports of serious injuries or property damage.
May 3, 2019	High Wind	Hawaiʻi	A late-season cold front and strong upper trough generated periods of heavy showers over parts of the state and high winds across the summits of Mauna Kea and Mauna Loa on the Big Island of Hawaiʻi. The precipitation caused ponding on roadways and small stream and drainage ditch flooding. There were no reports of serious injuries or property damage.
November 18, 2019	Strong Wind	Kaua'i, Honolulu, Hawaiʻi	Heavy showers and thunderstorms formed and rainfall affected most of the islands, with flash flooding occurring in Kauaʻi and on the Big Island. However, no serious injuries were reported. Minor property damage occurred on Oʻahu from trees falling on automobiles. There were minor power outages. Property damages amounted to $2,000.00.
December 20, 2019 – December 21, 2019	Strong Wind	Honolulu, Hawaiʻi	Trade winds became breezy to strong over most of the state. Trees and power poles were downed by the winds, especially on Oʻahu. However, no serious injuries were reported. Several trees fell, and a roof was blown off. Strong winds toppled two power poles. Property damages amounted to $25,250.00; crop damages totaled $3,000.00.
December 24, 2019 – December 25, 2019	High Wind, Strong Wind	Kauaʻi, Hawaiʻi, Honolulu	The weather system caused a flash flood and felled trees and power poles, especially on Kauaʻi. No significant injuries were reported. Winds gusted to 63 mph on Oʻahu in Honolulu County. Winds, mainly from the southwest, gusted over 80 mph for a time over the Big Island summits of Mauna Kea and Mauna Loa. Winds downed power lines and poles on Kauaʻi. Roads were closed from downed trees. Property damages amounted to $10,000.00; crop damages totaled $2,000.00.
December 30, 2019	High Wind	Hawaiʻi	Winds from the northeast gusted around 70 to 80 mph over the summits of Mauna Kea and Mauna Loa on the Big Island. No significant injuries or property damage were reported.

Date(s) of Event	Event Type	Counties Affected	Description
January 5, 2020	High Wind	Hawaiʻi	Winds from the northeast gusted above 70 mph over the Big Island summits of Mauna Kea and Mauna Loa. There were no reports of serious property damage or injuries.
January 7, 2020	Strong Wind	Honolulu	Gusty trade winds caused by strong high pressure centered northeast of the islands downed a tree along the H-3 Freeway on Oʻahu. For a time, the tree blocked the Kaneohe-bound lane of the roadway about five miles west of the town. Otherwise, there were no reports of serious property damage or injuries. Crop damages totaled $2,000.00.
January 12, 2020	High Wind	Hawaiʻi	Northeast winds gusted to over 100 mph over the Big Island summits of Mauna Kea and Mauna Loa. No significant injuries or property damage were reported.
February 6, 2020	High Wind	Kauaʻi, Hawaiʻi	A front moving slowly from the northwest triggered showers and downpours across much of the state. The most significant rainfall was over Kauaʻi, where flash flooding occurred over the northern part of the isle. High winds also accompanied the system, mainly over the summits of Mauna Kea and Mauna Loa on the Big Island. There were no significant injuries or property damage. Mainly southwest winds over the summits of Mauna Kea and Mauna Loa on the Big Island of Hawaiʻi were sustained, at times, over 100 mph, with gusts topping 140 mph.
February 13, 2020	Strong Wind	Hawaiʻi	Gusty winds felled several trees along the Old Saddle Road on the Big Island of Hawaiʻi, between the Daniel K. Inouye Highway and the Lower Waikii Ranch Gate. The trees on the roadway forced its closure for a time on the 13th. No serious injuries were reported. Crop damages totaled $20,000.00.
February 20, 2020	Strong Wind	Honolulu, Hawaiʻi	Strong winds caused several trees to on Oʻahu, which closed roadways. Gusty winds brought down a power line on the Big Island, which closed the Old Mamalahoa Highway. There were no reports of serious injuries. Property damages amounted to $2,000.00; crop damages totaled $15,000.00.
February 29, 2020	Strong Wind	Honolulu	Blustery winds toppled a tree onto Waiahole Valley Road in windward Oʻahu. The road was closed for a time due to the tree blocking both lanes of the roadway. No serious injuries were reported. Crop damages totaled $5,000.00.
March 11, 2020	High Wind	Hawaiʻi	An upper trough moving north of the islands produced southwest to west winds over the summits of Mauna Kea and Mauna Loa that gusted near 70 knots. No serious injuries or property damage were reported.
March 18, 2020	High Wind	Hawaiʻi	For a brief time, southwest winds gusted above 65 to 70 knots over the Mauna Kea and Mauna Loa summits on the Big Island. There were no reports of significant property damage or injuries.
March 25, 2020	Strong Wind	Honolulu, Hawaiʻi	Power lines and poles, and several trees, were felled by blustery trade winds on the Big Island and Oʻahu. No serious injuries were reported. Downed tree and power lines blocked Highway 11 near Naalehu, on the Big Island. Kalihi Street was closed for a time in both directions near Umalu Place on Oʻahu due to fallen power poles and trees on the roadway. Property damages amounted to $15,000.00; crop damages totaled $8,000.00.
April 10, 2020	High Wind	Hawaiʻi	Southwest winds briefly gusted above 60 mph over the summits of Mauna Kea and Mauna Loa on the Big Island. No serious injuries or property damage were reported.
November 22, 2020	Strong Wind	Hawaiʻi	Power lines were downed west of Naalehu in Hawaiian Ocean View Estates on the Big Island of Hawaiʻi. This caused a road closure. Property damages amounted to $5,000.00.
February 28, 2021 – March 1, 2021	Strong Wind	Honolulu, Hawaiʻi	Gusty winds toppled a tree near the Mililani Golf Course, injuring one person. Gusty trade winds helped keep showers moving as an upper trough induced downpours from the Big Island to Oʻahu. The precipitation caused ponding on roadways, and small stream and drainage ditch flooding. Two individual hikers lost their lives. A large ironwood tree fell onto a vehicle on Kamehameha Highway near Kahana Bay. Two individuals were injured. Crop damages totaled $3,000.00.

Date(s) of Event	Event Type	Counties Affected	Description
December 4, 2021	High Wind	Honolulu, Hawai'i, Maui	A Kona low, produced heavy and sustained showers and thunderstorms as tropical moisture was pulled north over the dtate. The downpours also led to instances of flash flooding. High winds and wintry conditions affected the mountain summits on the Big Island and Haleakalā on Maui. No significant injuries were reported. The costs of any damages were not available. Winds from various directions gusted over 100 mph during a period that lasted more than one day over the summits of Mauna Kea and Mauna Loa on the Big Island of Hawai'i. Winds also gusted over 90 mph on the Haleakalā Summit on Maui.
May 18, 2022 – May 19, 2022	Strong Wind	Kaua'i	Strong winds associated with a front downed trees over portions of Kaua'i, blocking several roadways on the isle. No serious injuries or property damage were reported. Crop damages totaled $12,000.00.

Source: FEMA 2023; NOAA 2023
Note:
With high windstorm documentation for Hawai'i being so extensive, not all sources have been identified or researched. Additionally, loss and impact information for many events could vary depending on the source. Therefore, this table may not include all events that have occurred in the state and the accuracy of monetary figures discussed is based only on the available information identified during research for this 2023 SHMP update.

Disaster and Emergency Declarations

Known high wind events that have impacted the State of Hawai'i and were declared a FEMA disaster, between January 01, 2018, and December 31, 2022, are identified in Table 4.16-3. For events prior to 2018, please refer to Appendix E (Hazard Profile Supplement). It is recognized that FEMA declarations may not specify the event as a "high windstorm" and may refer to the event type as a severe storm, making it challenging to distinguish the declaration from hurricanes. For details regarding all declared disasters, refer to Section 4.1 (Overview) and Appendix D (Map Atlas).

Table 4.16-3. Windstorm-Related Federal Declarations (2018 to 2022)

Event Type	Date Declared	Federal Declaration Number	Counties Affected
Severe Storms and Flooding	July 9, 2020	DR-4549-HI	Kaua'i
Severe Storms, Flooding, and Landslides	February 15, 2022	DR-4639-HI	Honolulu, Maui

Source: FEMA 2023
Note:
Hurricane and Tropical Storm declarations are included in Section 4.9 Hurricane.

The following disaster declarations or emergency proclamations related to windstorm have been issued for Hawai'i:

- **Federal disaster (DR) or emergency (EM) declarations, 1955 – 2022**: 15 windstorm-related events, classified as severe storms, flooding, and landslides
- **Hawai'i state emergency proclamations, 2018 – 2022**: 2 windstorm-related events, classified as severe storm and flooding
- **USDA agricultural disaster declarations, 2018 – 2022**: 8 windstorm-related events

Probability of Future Hazard Events

Overall Probability

Overall, high wind events will occur regularly as part of severe weather events across the state. Based on historical record, the State of Hawaiʻi has experienced 17 FEMA declarations associated with severe storms since 1954. The state can experience a major event that leads to a FEMA declaration once every five years.

Looking at all high wind events, there have been 611 events between 1954 and 2022. Based on this data, the State of Hawaiʻi may experience between an estimated nine high wind events each year (NOAA 2023). The State of Hawaiʻi can expect a 100% chance of high windstorms occurring annually.

Climate Change Impacts

Although the average atmospheric and land surface temperature are increasing in the State of Hawaiʻi and are projected to continue rising, the rates will vary depending on land uses, topography, and trade wind and precipitation patterns. The effect of climate change on the trade winds, which bring a steady supply of rainfall to the Hawaiian Islands, is a source of uncertainty in local predictions. Winds are changing over the Hawaiian Islands. Changes detected in the prevailing wind over the Hawaiian Islands, the northeast trade wind, may shift large-scale pressure and wind patterns that impact the State of Hawaiʻi in the future (Garza, et al. 2012).

There are fewer days with northeast trade winds than 40 years ago. Fewer days of northeast trade winds leads to more muggy weather and volcanic haze, resulting in longer-term effects for the state (Garza, et al. 2012).

Scientists from the University of Hawaiʻi at Mānoa analyzed wind records from 1973 to 2009 at major airports in the State of Hawaiʻi: Līhuʻe, Honolulu, Kahului, and Hilo. They also collected data from four weather buoys in waters around the islands. The study found for Honolulu, northeast trade winds dropped from 291 days per year to 210 days per year over the 40-year period. The two largest decreases occurred in 1981 and 1997. In 1981, a high-pressure system shut off northeast trade winds, causing a major drought in the state. In 1997, the strongest El Niño event ever recorded weakened the northeasterly trade winds (Garza, et al. 2012) (Live Science 2012).

The anticipated intensity, frequency, and duration of specific windstorm events resulting from climate change impacts is difficult to predict for a particular location in the state. The reduction of trade winds may increase drought conditions on windward sides of the islands, which may subsequently increase the likelihood of extreme heat events, wildfire risk, and air quality impacts from volcanic haze. The increase in kona winds on the leeward sides of the islands could subsequently increase the spread of wildfires exacerbated by drought conditions.

For details regarding climate change as a distinct hazard and its unique impacts to the State of Hawaiʻi, refer to Section 4.2 (Climate Change and Sea Level Rise).

4.16.2 VULNERABILITY ASSESSMENT

High windstorms can occur anywhere in the State of Hawaiʻi; however, as previously discussed, topography plays a significant role in where the impacts are most severe. Terrain-related amplification of wind speeds have led to significant losses in the state. Kona storm events not only bring high winds, but also large amounts of rain that result in flash flooding, snow at high altitudes, hail, and severe thunderstorms. For further discussion on flooding and surge impacts, refer to Sections 4.6 (Flood) and Section 4.9 (Hurricane). This vulnerability assessment focuses on the high wind component to these storm events. No spatial data was available for the high windstorm vulnerability assessment. Therefore, a qualitative assessment was conducted and is presented below.

Assessment of State Vulnerability and Potential Losses

This section discusses statewide vulnerability of exposed state assets (state buildings and roads) and critical facilities to high windstorm events.

State Assets

As noted earlier, the Hawaiʻi State Building Code requires new structures to be built to withstand a Category 3 hurricane wind speed. Any state buildings that were built before the building code incorporated provisions for wind load and topographic factor are particularly vulnerable. Depending on the severity and duration of the storm, a high windstorm, as described earlier, can cause windows and doors to be blown out, roofs to be ripped off, and walls to collapse. Although it is unlikely that high winds would directly damage state roads, debris has blocked roads, isolating areas and putting already vulnerable populations at even greater risk.

Community Lifelines and Critical Facilities

All community lifelines and critical facilities in the state are vulnerable to high windstorms. Loss of utilities is the most common issue with high windstorms. High winds can severely impact power transmission lines as high winds are funneled through changes in terrain, causing widespread power outages. For example, on December 26, 2008, the entire electrical grid on the island of Oʻahu (City and County of Honolulu) was blacked out for around 12 hours due to a kona storm (Bachmeiere 2008). The interruption of power, water, wastewater. as well as critical services such as hospitals and other emergency services has cascading impacts on residents, visitors, and all forms of economic activity.

As summarized in Section 4.2 (Climate Change and Sea Level Rise), the primary transportation arteries for the entry of people and goods to the state is the Daniel K. Inouye International Airport and Honolulu Harbor. In addition, each island has critical points of entry for people and goods located along the coast. Ports, harbors, and airports are especially vulnerable to the high windstorm hazard. Damages and closures to these critical facilities will likely be long-term and have cascading economic impacts statewide.

Kona wind events, such as the January 1980 storm, have caused the closure of airports. The 1980 storm produced sustained winds of 40 to 50 mph gusting over 100 mph in certain regions due to topographical features. According to the Hawaiʻi Department of Transportation, anchorage for deep-draft vessels exist outside the Honolulu Harbor in Mamala Bay off Sand Island and west of the Main Channel (also known as Fort Armstrong Channel). However, anchorage is not possible during kona wind conditions (World Port Source 2013).

In February 2017, the HI-EMA conducted a series of workshops to continue its ongoing efforts to address temporary emergency power planning requirements outlined in the 2015 *Hawaiʻi Catastrophic Hurricane Plan*. As a result, the state identified critical facilities within each county and developed a method to prioritize the allocation of limited generator resources. The critical facilities identified through this process were used in the risk assessment for the 2018 SHMP Update and this 2023 SHMP Update. Exposure and potential impacts to these critical facilities resulting from natural hazard events are reported throughout Section 4 (Risk Assessment).

Economic (monetary) losses due to high windstorms on critical infrastructure such as airports, harbors, water, sewer, and power utilities were not calculated due to the variable cost of such infrastructure and the complexity and uncertainty involved based on design, siting, and construction. However, estimated costs for the resiliency and hardening of electric power systems are available through the efforts being made after Puerto Rico was struck by Hurricanes Irma and Maria in 2017. These two hurricanes resulted in catastrophic damage to the island and a complete failure of Puerto Rico's power grid. Similar to the State of Hawaiʻi, Puerto Rico also experiences wind speed-up due to the differences in terrain across the island. As reported in *Build Back Better: Reimagining and Strengthening the Power Grid of Puerto Rico*, the estimated cost per mile for hardening is $1.25 to $7 million, depending upon if low or high voltage lines are used (Puerto Rico Energy Resiliency Working Group and Navigant Consulting 2017).

Assessment of Local Vulnerability and Potential Losses

Overall, high windstorms can occur anywhere in the State of Hawaiʻi. In terms of vulnerability, the strong kona storms and associated wind, rain, and wave heights can cause extensive damage to the south- and west-facing shores of the islands. This section provides a summary of vulnerability and potential losses to population, general building stock, and environmental/cultural assets by county.

The local HMPs were reviewed to integrate risk assessment results into the 2023 SHMP Update; a summary of information available is below.

- **County of Kauaʻi** –The County HMP includes windstorms as part of their Tropical Cyclone and Other High Winds hazard. The county includes an overview of wind types experienced in the plan area, including Trade Winds, Tropical Cyclones, and Kona Winds. The county performed a Level 2 Hazus analysis which found that 14,102 residents would be displaced by Category 4 hurricane wind; 288 critical facilities would be impacted by Category 4 hurricane wind (County of Kauaʻi 2020).
- **City and County of Honolulu** – The City and County discusses Strong Winds in place of a Windstorm hazard. The HMP includes an overview of different types of wind pressure and wind types relevant for the county, including Trade Winds, Tropical Cyclones, and Kona Winds (Tropical Cyclones are explored as a separate hazard) (City and County of Honolulu 2020).
- **County of Maui** – The Maui County HMP provides a qualitative overview of windstorm risk within the county. Maui County is classified as a Zone II wind zone, capable of experiencing winds up to 160 miles per hour. Areas at greatest risk to wind events are south-facing shorelines and communities along the northern slopes of Haleakalā. Additionally, the HMP lists residents who are most vulnerable to flood risk, including single parent and dependent households, residents living below the poverty line, residents without adequate communication infrastructure and/or limited English proficiency, residents living in properties built prior to the 1950s, and residents with limited mobility (County of Maui 2020).
- **County of Hawaiʻi** – The HMP includes an overview of different types of wind pressure and wind types relevant for the county, including Trade Winds, Tropicaly Cyclones, and Kona Winds (Tropical Cyclones are explored as a separate hazard). Hawaiʻi County is located in FEMA's Wind Zone II, with speeds up to 160 miles per hour. The HMP discusses populations particularly at risk to windstorms, including the elderly,

low income or linguistically isolated populations, and people with life-threatening illnesses (County of Hawaiʻi 2020).

Socially Vulnerable and Total Population

Because the entire population of the state is exposed and vulnerable to windstorms, the exposed population in socially vulnerable communities is equal to the total population. Vulnerable populations are the elderly, low income or linguistically isolated populations, people with life threatening illnesses, and residents living in areas that are isolated from major roads. Power outages from windstorms can be life-threatening to those dependent on electricity for life support and is a significant concern. These populations face isolation and exposure during windstorm events and could suffer more secondary effects of the hazard.

Certain areas are more vulnerable because of their geographic location and local weather patterns. For example, people living at higher elevations with large stands of trees or nearby powerlines may be more susceptible to wind damage and loss of power. Kona winds that accelerate down the slopes of mountains, hills, and escarpments, historically reaching up to 100 miles per hour, can be very destructive when they reach populated low-lying areas. It is common for trees to be uprooted, signs and utility poles to be overturned, debris to be carried by the winds and for residential roofs to be blown off. Damage can be inflicted on boats caught in the open ocean or anchored in the southwest-exposed anchorages (Pacific Disaster Center 2011).

Kona winds can also bring volcanic smog (vog) from Kīlauea in the County of Hawaiʻi up the island chain reaching the County of Maui and City and County of Honolulu (Tofte, Chu and Barnes 2017). This makes visibility poor and causes eye and respiratory irritation. Refer to Section 4.14 (Volcanic Hazards) for a more detailed discussion of vog and human health impacts.

After high wind events, residents may be displaced or require temporary to long-term sheltering. Vulnerable populations, such as the elderly, low-income and linguistically isolated populations, are most susceptible to high windstorms. This vulnerability is based on several factors, including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Other risk factors include that power outages can be life-threatening to people dependent on electricity for life support. Because these vulnerable populations face various forms of isolation, they are more at risk for secondary effects from the high wind hazard.

General Building Stock

As noted earlier, the Hawaiʻi State Building Code requires new structures to be built to withstand a Category 3 hurricane wind speed. Any structures that were built before the building code incorporated provisions for wind load and topographic factor are particularly vulnerable. More vulnerable locations include those at higher elevations, on leeward sides of islands during Kona winds, on ridge lines, under or near powerlines, or near large trees. Depending on the severity and duration of the storm, a high windstorm can cause windows and doors to be blown out, roofs to be ripped off, and walls to collapse.

Spatial data was not available to conduct an exposure analysis based on wind speed zones. When estimating the potential impact to individual structures, the structural integrity, mitigation measures in place, building construction and date of construction should be considered. Because of differences in building construction, residential structures are generally more susceptible to wind damage than commercial and industrial structures. Wood and masonry buildings in general, regardless of their occupancy class, tend to experience more damage than concrete or steel buildings. Refer to Section 4.9 (Hurricane) for further discussion on impacts resulting from high wind speeds associated with tropical cyclone events for all counties in the state.

Environmental Resources and Cultural Assets

Natural habitats such as forests and waterways are vulnerable to damage from high windstorms. Major damage can occur from downed or uprooted trees, other debris, as well as rivers and streams blocked by various types of debris. Agricultural losses have been reported due to historic kona wind events; for example, macadamia, coffee, foliage, and flower farms incurred losses as a result of the January 1980 event in the County of Hawaiʻi. In general, forest trees on the leeward side of each island are sheltered from the prevalent trade winds, but strong kona winds blow from the opposite direction and can topple trees that are not accustomed to that wind direction and intensity.

A kona storm can bring large amounts of rain in a short period of time to the leeward side of the islands that tend to be drier. In addition, major kona storm events can bring large wave heights and resulting shoreline change which may impact environmental and cultural assets along the shore (Rooney and Fletcher III 2005).

Future Changes that May Impact State Vulnerability

Understanding factors of change that impact vulnerability in the state can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The state considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

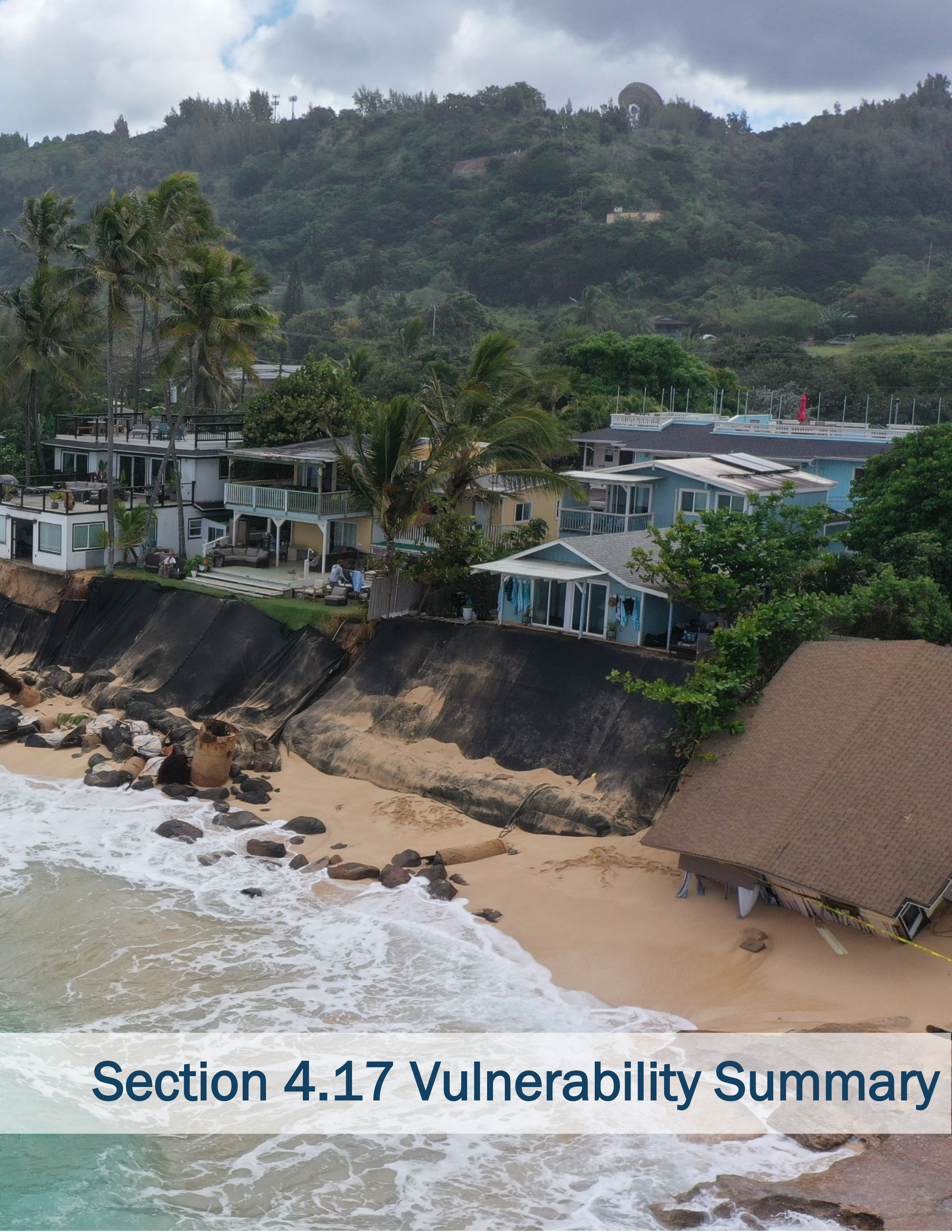
All future development in each county and statewide is vulnerable to high wind hazards. However, the ability to withstand impacts from high winds is based in appropriate land use practices and consistent enforcement of codes and regulations for new construction. As older structures are replaced with new structures built to modern building codes, overall vulnerability to the high windstorm hazard will decrease.

It is possible to use global climate models and a regional high-resolution climate model to assess future high wind hazards and flooding events for the State of Hawaiʻi. This approach, known as dynamical downscaling, promises to yield more detailed spatial distribution and temporal variability of meteorological hazards in the future. This approach is particularly amenable for Hawaiʻi because of its complex terrain, high mountains, and rugged coastlines. Refer to the 2023 mitigation action plan in Section 6 (Mitigation Strategy) for new actions to further evaluate this hazard.

Windstorm Hazard Mitigation Success Story

Credit: HI-EMA

The Honolulu Board of Water Supply and the Hawaiʻi County Department of Water Supply each received federal grant funding to protect the water supply of Honolulu and Hawaiʻi Counties. Funding include the purchase of mobile generators and transfer switches to provide redundant power at key pumping facilities when the primary power supply is interrupted due to adverse weather conditions, including windstorms.



Section 4.17 Vulnerability Summary

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TABLES

[1] *Section Cover Photo: House collapsed from coastal erosion on O'ahu's north shore. Photo courtesy of DLNR*

SECTION 4. RISK ASSESSMENT

4.17 VULNERABILITY SUMMARY

2023 SHMP Update Changes

- The 2023 SHMP Update uses the same hazard ranking methodology as the 2018 plan, but the hazard categories are now aligned with the HI-EMA Hazards and Vulnerabilities Overview document.

Element S6 and 44 CFR §201.4(c)(2)(ii) and 201.4(c)(2)(iii): The risk assessment shall include an overview and analysis of jurisdictions' vulnerability to the identified hazards and the potential losses, including jurisdictions most threatened by the identified hazards and most vulnerable to damage and loss from hazard events with respect to populations, structures, infrastructure, and community lifelines. Additionally, potential losses to the identified vulnerable structures based on estimates in the local risk assessments as well as the state risk assessment should be included.

2023 Hazard Ranking

- The purpose is to summarize statewide vulnerability and guide the updated mitigation strategy.
- The hazard ranking is provisional. It may change with time as additional data and analyses become available, capabilities in the State change, and changes associated with climate change become realized and fully predictable.
- Overall, the 2023 hazard ranking represents a snapshot in time based upon best available data.

At the conclusion of the risk assessment update documented in Sections 4.2 through 4.16, the 15 hazards of concern were ranked to summarize statewide vulnerability. The results of the hazard ranking were presented at the Forum and public meetings held in March and April 2023 to collect feedback (refer to Section 2 – Planning Process and Appendix A – Planning Process Documentation). The results were carefully reviewed by HI-EMA and the Forum, and adjusted as needed and appropriate, to ensure the hazard ranking aligned with the perceived statewide hazard risk.

The following summarizes the methodology and results of the State of Hawaiʻi's hazard ranking. Refer to Appendix F (State Profile and Risk Assessment Supplement) for the hazard ranking results developed for each county using the same methodology.

It is important to emphasize that all hazards evaluated in the 2023 SHMP Update are considered hazards of concern. Medium- and low-ranked hazards are of concern to the State of Hawaiʻi, and potential future losses resulting from these hazard events should be mitigated. Mitigation strategies are included in Section 6 (Mitigation Strategy).

4.17.1 2023 SHMP UPDATE HAZARD RANKING

The 2023 SHMP Update utilizes the same hazard risk ranking methodology as the 2018 SHMP. Numerical values allow identified hazards to be ranked against one another; the higher the relative risk factor calculated, the greater the hazard risk.

METHODOLOGY

The hazard ranking methodology designed for the State of Hawaiʻi includes risk factor categories that align with FEMA's State Mitigation Planning Key Topic Bulletin on Risk Assessment and FEMA's Comprehensive Preparedness Guide (CPG 101) risk analysis process. In addition, the methodology integrates the Threat and Hazard Identification and Risk Assessment (THIRA), the Hazards and Vulnerabilities Overview, and State of Hawaii's capabilities into the evaluation.

It is recognized that certain hazards have undergone more detailed analyses than others based upon the available data and hazard modeling methodologies available and/or conducted over the course of the 2023 SHMP Update. Therefore, for some hazards, qualitative assessments, and professional judgment were used to assign the most appropriate numeric value for each category evaluated.

As described in Section 4.1 (Risk Assessment Overview) and summarized in Table 4.1-7, three different levels of analysis were used to estimate potential impacts: (1) historic loss/qualitative analysis, (2) exposure analysis, and (3) loss estimation. All three levels of analysis are suitable for planning purposes; however, with any risk analysis, there is underlying uncertainty resulting from assumptions used to describe and assess vulnerability and the methodologies available to model impacts. Impacts from any hazard event within the state will vary from the analysis presented here based on the factors described for each hazard of concern, namely location, extent, warning time, and mitigation measures in place at the time of an event. The hazard ranking methodology for some hazards of concern is based on a scenario event, while others are based on the potential vulnerability to the state as a whole. In order to account for these differences, the quantitative hazard ranking methodology was adjusted using professional judgment and subject matter expert input and assumptions are included, as appropriate, in the following sections. The limitations of this analysis are recognized given that all scenarios do not have the same likelihood of occurrence; nonetheless, there is value in summarizing and comparing the hazards using a standardized approach to evaluate relative risk. The following categories were considered when evaluating the relative risk of the hazards of concern.

- **Probability of Occurrence**—The probability of occurrence of the scenario evaluated was estimated by examining the historic record and/or calculating the likelihood of annual occurrence. When no scenario was assessed, an examination of the historic record and judgment was used to estimate the probability of occurrence of an event that will impact the state.
- **Impact**—The following three hazard impact subcategories were considered: impact to people; impact to assets and the economy; and impact to environmental resources and cultural assets. The results of the 2023 SHMP Update risk assessment and/or professional judgment were used to assign the numeric values for these three impact subcategories. For the statewide ranking, the impact to state assets and the overall state economy and resilience were considered. For the county-specific ranking, the impact to the general

building stock, community lifelines that affect state resilience, and county economy were considered. A factor was applied to each subcategory, giving impact on population the greatest weight.

- Population (total and socially vulnerable)—Numeric value x 3
- Assets/Economy—Numeric value x 2
- Environment Resources/Cultural Assets—Numeric value x 1

- **Spatial Extent**—The area of impact was calculated in GIS for the hazards with a delineated spatial extent. For hazards that do not have a geographic extent, it was determined whether the hazard event would have local, regional, island-wide or statewide impacts. Refer to Section 4.1 (Overview), which describes the spatial data sets used.
- **Warning Time**—The lead time associated with the hazard event was researched, and the warning measures/systems in place to alert the state in advance of the event occurring were considered. Warning time is discussed in each hazard profile (refer to Sections 4.2 to 4.16).
- **Duration**—The duration was estimated by determining the approximate length a hazard event may last and time until full recovery. An examination of the historic record was used as a point of reference.
- **Adaptive Capacity**—Adaptive capacity describes the state's current ability to protect from or withstand a hazard event. The state develops an annual Stakeholder Preparedness Review (SPR) that rates core capabilities across five elements: planning, organization, equipment, training, and exercises. The three-step self-assessment of capability levels is based on capability targets in the THIRA. These ratings, conducted by the HI-EMA and supporting stakeholders, form the basis for the adaptive capacity assessment for each hazard of concern for the 2023 SHMP Update.

Adaptive Capacity Defined

Adaptive capacity describes the State's current ability to protect from or withstand a hazard event.

- **Changing Future Conditions**—Current climate change projections were considered as part of the hazard ranking to ensure the potential for an increase in severity/frequency of the hazard was factored into the hazard ranking. This was important to the HI-EMA to include because the hazard ranking helps guide and prioritize the mitigation strategy development, which should have a long-term future vision to mitigate the hazards of concern. The potential impacts climate change may have on each hazard of concern is discussed in Sections 4.2 through 4.16. The benchmark values in the methodology are similar to confidence levels outlined in the National Climate Assessment 2017.

Table 4.17-1 summarizes the categories, benchmark values, and weights used to calculate the risk factor for each hazard. The relative hazard risk score was calculated for each hazard using the following formula. Using the weighting applied, the highest possible risk factor value is 6.75. The higher the number, the greater the relative risk.

Table 4.17-1. Summary of Hazard Ranking Approach and Associated Criteria

Category		Level	Degree of Risk/Benchmark Value	Numeric Value	Weight
Probability of Occurrence		Unlikely	Hazard event is unlikely to occur with less than a 1% annual chance probability	0	25%
		Rare	Between 1 and 10% annual probability	1	
		Occasional	Between 10 and 100% annual probability	2	
		Frequent	100% annual probability; may occur multiple times per year	3	
Impact *(Sum of all 3)*	**Population (Numeric value x3)**	None	No anticipated displacement or injuries; minimal disruption on quality of life.	0	25%
		Low	Potential for measurable life safety impacts (displacement, injuries, fatalities) is less than 10% of the total and socially vulnerable population	1	
		Medium	Potential for measurable life safety impacts (displacement, injuries, fatalities) is 10-25% or less of the total and socially vulnerable population	2	
		High	Potential for measurable life safety impacts (displacement, injuries, fatalities) is greater than 25% of the total and socially vulnerable population	3	
	Assets (including Community Lifelines)/Economy (Numeric value x2)	None	No impact to minimal anticipated potential loss to property/assets; no anticipated economic impacts (interruption of services, businesses, jobs).	0	
		Low	Potential loss to property/assets is more than 10% of the total of all assets; impacts are localized affecting only a relatively small or isolated area; no interruption of services or business continuity.	1	
		Medium	Potential loss to property/assets is more than 25% of the total of all assets; impacts are local and regional; temporary shutdown of critical facilities, businesses/delivery of services/jobs	2	
		High	Potential loss to property/assets is greater than 50% of the total of all assets; impacts are regional/multiple counties; shutdown of critical facilities; interruption of business continuity/delivery of services/jobs	3	
	Environment Resources/ Cultural Assets [a] (Numeric value x1)	None	No loss is estimated from the hazard	0	
		Low	Potential loss to environmental resources/cultural assets is less than 10% of total of all assets.	1	
		Medium	Potential loss to environmental resources/cultural assets is 10-20% of total of all assets.	2	
		High	Potential loss to environmental resources/cultural assets is greater than 20% of total of all assets.	3	
Spatial Extent		None	No spatially delineated hazard area	0	15%
		Small	A portion of one island	1	
		Medium	2 to 3 islands	2	
		Large	Entire state (all islands)	3	
Warning Time		More than 24 hours	Warning time is more than 24 hours	0	5%
		12 to 24 hours	Warning time is 12 to 24 hours	1	
		6 to 12 hours	Warning time is 6 to 12 hours	2	
		less than 6 hours	Warning time is 0 to 6 hours	3	

Category	Level	Degree of Risk/Benchmark Value	Numeric Value	Weight
Duration of Event	Minimal	Less than 6 hours	0	10%
	Low	Less than 24 hours	1	
	Medium	Less than 1 week	2	
	High	Greater than 1 week	3	
Adaptive Capacity	Complete	The state has mitigated all hazard risk through mitigation measures and in-house capabilities.	0	10%
	High	Plans, policies, codes/ordinances in place and exceed minimum requirements; mitigation/protective measures in place; state has ability to recover quickly because resources are readily available and capabilities are high	1	
	Medium	Plans, policies, codes/ordinances in place and meet minimum requirements; mitigation strategies identified but not implemented on a widespread scale; state can recover but needs outside resources; moderate state capabilities	2	
	Low	Weak/outdated/inconsistent plans, policies, codes/ordinances in place; no redundancies; limited to no deployable resources; limited capabilities to respond; long recovery	3	
Changing Future Conditions [b]	No Change	Studies and modeling projections indicate there is no evidence at this time to indicate conditions may change in the future	0	10%
	Uncertain	No local data is available; modeling projects are uncertain on whether there is increased future risk; confidence level is low (inconclusive evidence)	1	
	Likely	Studies and modeling projections indicate a potential for exacerbated conditions due to climate change; confidence level is medium to high (suggestive to moderate evidence)	2	
	Highly Likely	Studies and modeling projections indicate exacerbated conditions/increased future risk due to climate change; very high confidence level (strong evidence, well documented and acceptable methods)	3	

Notes:

a. *The potential loss to environmental resources (critical habitat, wetlands, parks and reserves, reefs) and cultural assets (Hawaiian Home Lands and Cultural Resources) could not be estimated or monetized; therefore, the exposure analysis results in Sections 4.2 through 4.16 support this evaluation. It is recognized additional environmental resources and cultural assets may be impacted that were not included as part of the risk assessment.*

b. *Similar to confidence levels outlined in the National Climate Assessment 2017*

Relative Risk Schema

Relative Risk = [(**Probability** × 0.25) + (**Impact** × 0.25) + (**Spatial Extent** × 0.15) + (**Warning Time** × 0.05) + (**Duration** × 0.1) + (**Adaptive Capacity** × 0.1) + (**Changing Future Conditions** × 0.1)]

In an attempt to summarize the confidence level regarding the input utilized to populate the hazard ranking, a gradient of certainty was developed. A certainty factor of high, medium, or low was selected and assigned to each hazard to provide a level of transparency and increased understanding of the data utilized to support the resulting ranking. The following scale was used to assign a certainty factor to each hazard:

- High—Defined scenario/event to evaluate; probability calculated; evidenced-based/quantitative assessment to estimate potential impacts through hazard modeling.
- Moderate—Defined scenario/event or only a hazard area to evaluate; estimated probability; combination of quantitative (exposure analysis, no hazard modeling) and qualitative data to estimate potential impacts.
- Low—Scenario or hazard area is undefined; there is a degree of uncertainty regarding event probability; majority of potential impacts are qualitative.

Table 4.17-2 summarizes the hazard scenario or hazard area evaluated; highlights key impacts to population, state assets, and environmental resources/cultural assets; and lists the associated certainty factor assigned for each hazard to convey the level of confidence in the data used. This table is not intended to be a complete and comprehensive list of all hazard impacts determined in the risk assessment and considered for the hazard ranking exercise. Refer to Sections 4.2 to 4.16 for a complete summary of all estimated statewide impacts for each hazard.

Table 4.17-2. Overview of the Hazard Scenario and Associated Estimated Impacts Considered in the Hazard Ranking

Hazard	Category				Certainty Factor
		Estimated Statewide Impacts			
	Hazard Scenario/ Area Evaluated	Population [b]	State Assets	Environment Resources/ Cultural Assets	
Climate Change and Sea Level Rise	Sea Level Rise Exposure Area (SLR-XA) 3.2ft (future chronic coastal flooding) 1%-Annual-Chance Coastal Flood Zone (1%CFZ) + 3.2ft SLR (event-based coastal flooding plus SLR)	SLR-XA-3.2: 19,830 people displaced 1%CFZ-3.2: 138,448 people exposed, including 23,830 socially vulnerable people	SLR-XA-3.2: 54 state buildings ($57.5M), 38.8 miles of state roads and 33 community lifelines ($4.9B) lost 1%CFZ-3.2: 638 state buildings ($2.4B), 100.9 miles of state roads and 218 community lifelines exposed	SLR-XA-3.2: 32 sq.mi. of environmental resource areas, 14.1 sq. mi. of cultural resources and 1.2 sq.mi. of HHL lost 1%CFZ-3.2: 1,148 sq.mi. of environmental resource areas, 155.4 sq. mi. of cultural resources and 3.98 sq.mi. HHL exposed	High
Cyber Threat	Statewide	Entire state population exposed; impacts to health and safety of individuals are estimated to be minimal	All state assets exposed	All environmental/cultural assets exposed	Moderate
Drought	Drought event	Entire state population exposed; impacts to health and safety of individuals are estimated to be minimal	Community lifeline and critical facility functionality may be impacted (e.g., water source for fire services); overall impacts to structures are low	Environmental damages; increased wildfire risk; agricultural losses ($564M market value exposed)	High

Hazard		Category				Certainty Factor
		Hazard Scenario/ Area Evaluated	Estimated Statewide Impacts			
			Population [b]	State Assets	Environment Resources/ Cultural Assets	
Earthquake		100-year probabilistic earthquake event 4 USGS ShakeMap scenarios: Kalapana 1975 M7.7 Ka'ū M8.0 Lāna'i M7.0 NE Maui M7.0	Entire population exposed; 1,758 displaced households; 1,244 people need short-term sheltering	$358.8M state building damages; $529.5M community lifeline and critical facility damages	Impacts to environment from hazardous materials release; induced flooding/landslides; poor water quality	High
Flood	Event-Based	1% Annual Chance Flood	91,462 people exposed, including 15,800 socially vulnerable people	$87.9M state building damages; 85.5 miles of state roads exposed; $441M community lifeline and critical facility damages	147 sq.mi. environmental resource areas, 47.7 sq. mi. cultural resources and 4.3 sq.mi. HHL exposed	High
	Chronic Coastal	SLR-XA-1.1ft	4,160 people displaced	8 state buildings ($31.9M), 15 miles of state roads and 8 community lifelines ($2.9B) lost	22.3 sq.mi. of environmental resource areas, 9.4 sq. mi. of cultural resources and <1 sq.mi. of HHL exposed	High
Hazardous Materials [a]		Release at a National Priorities List site	Population impacted will depend on the type of material and scale of the incident. May include population within small radii of site	The degree of damages to state asset depends on the scale of the incident.	The degree of damages depends on the scale of the incident.	Low
Health Risks		Statewide	Entire state population exposed	Loss of state services; Potential temporary closure of ports of entry impacting import/export of goods and vital resources	Livestock and poultry may become infected; impacts to food supply and water supply	High
Hurricane		Wind (500-year event) *buildings only* Category 4 storm surge (SLOSH)	142,622 people exposed to storm surge (Category 4), including 30,320 socially people; all exposed to wind	654 state buildings ($3.2B); 77.7 miles of state roads; 207 community lifelines ($7.5) exposed	33 sq.mi. environmental resource areas, 21.8 cultural resources sq.mi. and 2.5 sq.mi. HHL exposed	High
Infrastructure Failure		Inundation area for all high hazard dams	34,324 people exposed, including 12,510 socially vulnerable people	197 state buildings ($1.2B), 25.6 miles of state roads and 84 community lifelines ($4.8B) exposed	9 sq.mi. of environmental resources areas, 3.2 sq.mi. cultural resources and 1.9 sq.mi. of HHL exposed	Moderate
Landslide and Rockfall		High landslide susceptibility areas	65,049 people exposed, including 14,823 socially vulnerable people	357 state buildings ($2B); 150.6 miles of state roads; 95 community lifelines ($2.29B) exposed	642 sq.mi. environmental resource areas, 89 sq.mi. cultural resources and 119.4 sq.mi. HHL exposed	Moderate
Terrorism		Statewide	Entire state population exposed	All state assets exposed	All environmental/cultural assets exposed	Low

Hazard	Category					Certainty Factor
	Hazard Scenario/ Area Evaluated	Estimated Statewide Impacts				
		Population [b]	State Assets	Environment Resources/ Cultural Assets		
Tsunami	School of Ocean & Earth Science & Technology (SOEST) Historic (200-yr) Great Aleutian Tsunami (GAT) (1,500-yr) American Society of Civil Engineers (ASCE) Design Inundation Mapping (3,500-yr)	54,429 people exposed, including 13,442 socially vulnerable people	420 state buildings ($1.5B); 88.7 miles of state roads; 193 community lifelines ($10.2B) exposed	29 sq.mi. environmental resources areas; 10.8 sq.mi. cultural resources and 1 sq.mi. HHL exposed		High
Volcanic Hazards	Hawaiʻi County lava zones 1-4 Maui County lava zones 1-2	181,731 people exposed, including 36,475 socially vulnerable people	1,115 state buildings ($3.28B); 240.8 miles of state roads; 201 community lifelines exposed ($4.9B)	1,938 sq.mi. environmental resource areas, 404.4 sq.mi. cultural resources and 70.8 sq.mi. HHL exposed		High
Wildfire	Communities at Risk from Wildfire (CAR) high wildfire risk areas	568,401 exposed, including 139,125 socially vulnerable people	2,895 state buildings($7.3B); 335.3 miles of state roads; 694 community lifelines and critical facilities ($36B) exposed	82 sq.mi. environmental resource areas, 18.2 sq.mi. of DOFAW-managed land; 46.9 sq.mi. watershed partnership area; 38.6 sq.mi. cultural resources and 51 sq.mi. HHL exposed		Moderate
Windstorm	100-Year wind event	Entire state population exposed	All state buildings, community lifelines and critical facilities exposed; utility outages may cause disruption in services	All environmental resources and HHL exposed; potential agricultural losses and debris		Low

Notes:

State building values are based on structure replacement cost; for SLR-XA-1.1 and SLR-XA-3.2 losses do not include land value.

a. *The impacts and vulnerability from a hazardous materials event are greatly dependent on the material and its physical and chemical properties, the quantity released, weather conditions, micro-meteorological effects of buildings and terrain, maintenance/mechanical failures, and distance and related response time for emergency response teams.*
b. *All population estimates do not include visitors.*

Exposed = This refers to the number of assets located in the hazard area, all of which may not incur losses as a result of the event.

Table 4.17-3 summarizes the projected changes in hazard event occurrences in terms of location, extent or intensity, and frequency and/or duration. In addition, it lists the associated value assigned to each hazard in the risk factor calculation (i.e., confidence in changing future conditions). Refer to Sections 4.2 to 4.16 for a more detailed discussion of all factors of change discussed for each hazard of concern.

Table 4.17-3. Overview of Projected Future Changes for each Hazard of Concern

Hazard	Projected Change			Confidence in Changing Future Conditions [a]
	Location	Extent/ Intensity	Frequency/ Duration	
Climate Change and Sea Level Rise	↑	↑	↑	Highly Likely
Cyber Threat	—	—	—	No Change
Drought	↑	↑	↑	Highly Likely
Earthquake	—	—	—	Uncertain
Flood	↑	↑	↑	Highly Likely
Hazardous Materials	—	—	—	No Change
Health Risks	—	—	—	No Change
Hurricane	↑	↑	↑	Highly Likely
Infrastructure Failure	— [b]	— [b]	↑ [b]	Likely
Landslide and Rockfall	—	—	↑	Highly Likely
Terrorism	—	—	—	No Change
Tsunami	↑	↑	—	Highly Likely
Volcanic Hazards	— [d]	— [d]	— [d]	Uncertain
Wildfire	↑	↑	↑	Highly Likely
Windstorm	—	—	↓ [c]	Likely

Notes:
Arrow direction indicates a projected increase or decrease based on literature review as described in Sections 4.2 through 4.16
— *Straight line indicates uncertain and/or no change known at this time.*

a. Similar to confidence levels outlined in the National Climate Assessment 2017
b. Increased rainfall, flooding, and sediment runoff may lead to an increase risk of a dam failure as some dams may not be designed to withstand an increase in rain totals. However, the probable maximum flood used to design each dam may be able to accommodate changes in climate.
c. Historic records indicate a decrease in northeast trade winds
d. Vog dispersion may be altered based on changes in wind patterns

Highly Likely = Studies and modeling projections indicate exacerbated conditions/increased future risk due to climate change; very high confidence level (strong evidence, well documented and acceptable methods).
Likely = Studies and modeling projections indicate a potential for exacerbated conditions due to climate change; confidence level is medium to high (suggestive to moderate evidence).
Uncertain = No local data is available; modeling projects are uncertain on whether there is increased future risk; confidence level is low (inconclusive evidence).
No Change = Studies and modeling projections indicate there is no evidence at this time to indicate conditions may change in the future.

Hazard Ranking Results

State Hazard Ranking

Table 4.17-4 provides the statewide hazard ranking for the 2023 SHMP Update.

Table 4.17-4. 2023 SHMP Update Hazard Ranking Results

Hazard Rank	Hazard	Category									Relative Risk Factor
		Probability	Impact			Spatial Extent	Warning Time	Duration	Adaptive Capacity	Changing Future Conditions	
			Population	Assets/ Economy	Environmental Resources/ Cultural Assets						
High	Wildfire	3	3	3	3	3	3	2	2	3	6.6
High	Health Risks	3	3	3	0	3	3	3	2	0	5.6
High	Climate Change and Sea Level Rise	3	1	3	2	2	0	3	2	3	4.6
High	Hurricane	2	2	2	1	3	0	3	2	3	4.5
High	Tsunami	1	2	2	1	2	3	3	2	3	4.3
High	Earthquake	1	2	2	1	3	3	3	2	1	4.2
High	Volcanic Hazards	3	1	2	3	2	1	3	2	1	4.2
Medium	Flood	3	1	2	1	2	1	3	2	3	3.9
Medium	Landslide and Rockfall	2	1	1	3	2	3	3	2	3	3.8
Medium	Drought	3	1	1	1	3	0	3	2	3	3.5
Medium	Windstorm	2	1	1	1	3	0	3	2	2	3.2
Medium	Cyber Threat	2	1	1	1	3	3	1	3	0	3.0
Low	Infrastructure Failure	1	1	1	1	2	2	3	1	2	2.8
Low	Terrorism	1	1	1	1	3	3	1	2	0	2.7
Low	Hazardous Materials	2	1	1	1	1	3	1	2	0	2.6

Note: Relative Risk Factor Scores - High: > 4.0; Medium: 3.0 to 4.0; Low < 3.0

The highest-ranked hazards for the State of Hawaiʻi when examining statewide risk are:

- Wildfire
- Health Risks
- Climate Change and Sea Level Rise
- Hurricane
- Tsunami
- Earthquake
- Volcanic Hazard

Table 4.17-5 compares the 2018 high-ranked hazards to the 2023 high-ranked hazards using the total Risk Factors. Wildfire became a high-ranked hazard due to the devastating August 2023 wildfire events. Health Risks also became a high-ranked hazard due to their increased probability and economic impacts. Volcanic Hazards increased in risk ranking due to increased probability.

Table 4.17-5. Comparison Between the 2018 and 2023 SHMP Update Statewide High Hazard Rankings

Numeric Rank	2018 High-Ranked Hazard Rank Order [a]	2023 High-Ranked Hazard Rank Order
1	Climate Change and Sea Level Rise	Wildfire
2	Hurricane	Health Risks
3	Tsunami	Climate Change and Sea Level Rise
4	Earthquake	Hurricane
5		Tsunami
6		Earthquake
7		Volcanic Hazards

Note:
a. *The 2018 SHMP only had four high-ranked hazards*

Counties Most Threatened and Vulnerable to the Identified Hazards

An updated hazard ranking was also conducted for each county using the same ranking process as for the statewide ranking (relative risk schema). The ranking considers the location of potential hazard impacts and the intensity of each hazard. For example, the hurricane storm surge hazard is analyzed with four intensities (Categories 1-4 SLOSH inundation areas). Each hazard is also analyzed by each county's adaptive capacity and takes into consideration future hazard impacts based on changing climate. Both the total population and socially vulnerable populations are considered in the risk ranking. Community lifelines and additional critical facilities are included when analyzing assets and economic impacts. Refer to Appendix F (State Profile and Risk Assessment Supplement) for each county's results. Table 4.17-6 lists the high-ranked hazards for each county based on the potential impacts presented in Sections 4.2 through 4.16. The same risk ranking criteria used for the state hazard ranking was also used for the county ranking including:

- Probability of occurrence
- Impact to socially vulnerable and total populations
- Impact to the economy and assets including community lifelines
- Impact to environmental and cultural assets

- Spatial extent
- Warning time
- Duration of event
- Adaptive capacity
- Changing future conditions

See Table 4.17-1 for additional risk ranking criteria details that were used in the county and state risk ranking.

Table 4.17-6. Summary of High-Ranked Hazards for Each County

County	Highest Threat Hazards	Total and Socially Vulnerable Population Potentially Impacted	Community Lifelines and Critical Facilities Potentially Impacted	Risk Factor	Hazard Risk
Kauaʻi	Health Risks	The entire population, including 11,149 socially vulnerable people	127 community lifelines 11 additional critical facilities	5.6	High
	Wildfire [a]	27,604 people; 725 socially vulnerable people	94 community lifelines 8 additional critical facilities	5.6	High
	Hurricane [d]	2,462 people; 126 socially vulnerable people	23 community lifelines 2 additional critical facilities	5.0	High
	Climate Change and Sea Level Rise [b]	1,007 people; 189 socially vulnerable people	32 community lifelines 4 additional critical facilities	4.5	High
	Tsunami [e]	4,490 people; 532 socially vulnerable people	33 community lifelines 4 additional critical facilities	4.3	High
Honolulu	Wildfire [a]	427,293 people; 117,049 socially vulnerable people	323 community lifelines 12 additional critical facilities	5.7	High
	Health Risks	The entire population, including 224,567 socially vulnerable people	750 community lifelines 33 additional critical facilities	5.6	High
	Hurricane [d]	135,313 people; 29,010 socially vulnerable people	129 community lifelines 5 additional critical facilities	5.1	High
	Climate Change and Sea Level Rise [b]	26,681 people; 6,469 socially vulnerable people	115 community lifelines 4 additional critical facilities	5.0	High
	Flood [c]	73,711 people; 13,226 socially vulnerable people	65 community lifelines 3 additional critical facilities	4.7	High
	Tsunami [e]	126,570 people; 27,767 socially vulnerable people	185 community lifelines 9 additional critical facilities	4.6	High
	Earthquake [f]	N/A [g]	750 community lifelines 33 additional critical facilities	4.2	High
Maui	Wildfire [a]	81,424 people; 20,679 socially vulnerable people	172 community lifelines 20 additional critical facilities	5.8	High
	Health Risks	The entire population, including 35,284 socially vulnerable people	250 community lifelines 34 additional critical facilities	5.6	High
	Hurricane [d]	3,755 people; 812 socially vulnerable people	37 community lifelines 1 additional critical facility	5.1	High
	Flood [c]	9,206 people; 1,225 socially vulnerable people	40 community lifelines 2 additional critical facilities	4.7	High
	Tsunami [e]	21,784 people; 4,077 socially vulnerable people	89 community lifelines 9 additional critical facilities	4.4	High
	Earthquake [f]	80,507 people; 2,764 socially vulnerable people [g]	250 community lifelines 34 additional critical facilities	4.3	High
	Climate Change and Sea Level Rise [b]	2,930 people; 484 socially vulnerable people	43 community lifelines 0 additional critical facilities	4.2	High

County	Highest Threat Hazards	Total and Socially Vulnerable Population Potentially Impacted	Community Lifelines and Critical Facilities Potentially Impacted	Risk Factor	Hazard Risk
Hawaiʻi	Volcanic Hazards [h]	161,698 people; 36,475 socially vulnerable people	185 community lifelines 16 additional critical facilities	6.2	High
	Health Risks	The entire population, including 45,257 socially vulnerable people	242 community lifelines 28 additional critical facilities	5.6	High
	Hurricane [d]	1,092 people; 309 socially vulnerable people	18 community lifelines 2 additional critical facilities	5.0	High
	Landslide and Rockfall [i]	52,256 people; 12,031 socially vulnerable people	74 community lifelines 17 additional critical facilities	5.0	High
	Wildfire [a]	32,080 people; 672 socially vulnerable people	60 community lifelines 5 additional critical facilities	4.6	High
	Tsunami [e]	9,098 people; 7,325 socially vulnerable people	53 community lifelines 4 additional critical facilities	4.3	High
	Earthquake [f]	6,681 people; 20,783 socially vulnerable people [g]	242 community lifelines 28 additional critical facilities	4.2	High

Notes:

a. High wildfire risk hazard area
b. Sea Level Rise Exposure Area (SLR-XA) 3.2ft
c. 1% annual chance flood event
d. Category 4 SLOSH inundation areas
e. Great Aleutian Tsunami (GAT) inundation areas
f. 100-year probabilistic earthquake
g. Based on population located on the NEHRP Class D and E soils
h. Lava flow hazard areas
i. High landslide susceptibility areas

It is important to note that there is a difference in thought process when evaluating statewide risk and risk for an individual county. Due to the state's geography, some hazards are contained by island; therefore, their statewide risk is lower compared to the risk presented to a specific county. For example, the hurricane hazard may be ranked high for all counties and the state because a hurricane event may impact all islands as a result of the same event, leading to a potential disaster declaration. In contrast, a volcanic event may be isolated to one island and not impact the state as a whole at the same time. Therefore, each county may have a different volcanic hazard ranking because impacts are measured relative to their individual county.

Refer to Table 4.17-7 for the comparison between 2018 and 2023 SHMP county high hazard rankings.

Table 4.17-7. Comparison Between the 2018 and 2023 SHMP Update County High Hazard Rankings

Numeric Rank	2018 High-Ranked Hazard Rank Order	2023 High-Ranked Hazard Rank Order
County of Kauaʻi		
1	Wildfire	Health Risks
2	Climate Change and Sea Level Rise	Wildfire
3	Hurricane	Hurricane
4	Tsunami	Climate Change and Sea Level Rise
5	Earthquake	Tsunami
City and County of Honolulu [a]		
1	Wildfire	Wildfire
2	Hurricane	Health Risks
3	Climate Change and Sea Level Rise	Hurricane
4	Tsunami	Climate Change and Sea Level Rise
5	Earthquake	Flood
6		Tsunami
7		Earthquake
County of Maui [b]		
1	Wildfire	Wildfire
2	Hurricane	Health Risks
3	Chronic Coastal Flooding	Hurricane
4	Tsunami	Flood
5	Earthquake	Tsunami
6	Climate Change and Sea Level Rise	Earthquake
7		Climate Change and Sea Level Rise
County of Hawaiʻi		
1	Volcanic Hazards	Volcanic Hazards
2	Hurricane	Health Risks
3	Landslide and Rockfall	Hurricane
4	Wildfire	Landslide and Rockfall
5	Tsunami	Wildfire
6	Earthquake	Tsunami
7	Climate Change and Sea Level Rise	Earthquake

Source: State of Hawaiʻi HMP 2018
Notes:
a. The 2018 SHMP only had five high-ranked hazards for the City and County of Honolulu
b. The 2018 SHMP only had six high-ranked hazards for the County of Maui

Community Lifeline Mitigation Success Story

Credit: HI-EMA

The Maui Food Bank is one of the food, water, and shelter community lifelines in the county. A federally funded project received nearly $94,000 to purchase and install an emergency redundant power supply. When the primary power supply is interrupted due to hazard events, generated power will allow the food bank to continue providing essential services to the most vulnerable members of the community.

Section 5. Capability Assessment

CONTENTS

TABLES

[1] *Section Cover Photo: Waves crashing on lava cliffs. Photo by Megan Brotherton*

SECTION 5. CAPABILITY ASSESSMENT

2023 SHMP Update Changes

- State and local capabilities have been comprehensively reviewed, updated, and reformatted.
- Discussion of the processes utilized by the state to support and promote mitigation planning at the County level and processes to help counties obtain funding and technical assistance for mitigation planning have been reviewed and updated to reflect current procedures.
- State and local capabilities for building codes and standards are summarized.
- Mitigation capability challenges and barriers to implement mitigation and build resilience were identified in collaboration with plan stakeholders. These challenges and associated opportunities to overcome these barriers are summarized.
- The state agency/department hazard mitigation capability summaries in Appendix C were expanded to include the following new elements: capability category, effect on future mitigation, equitable outcomes, community lifelines, and 2023 SHMP goal(s) met.
- An expanded detailed scoring methodology to prioritize planning and project grants was developed in an effort to make the prioritization process easier to understand for the subapplicants and reviewers.

This section provides a comprehensive review and evaluation of state and local capabilities used to support and facilitate mitigation activities and describes the process utilized by the State of Hawaiʻi to support, promote, and coordinate mitigation planning at the County level.

5.1 ADMINISTRATION OF HAZARD MITIGATION PROGRAMS IN THE STATE

The Governor has the overall responsibility for emergency management activities in the State of Hawaiʻi. Emergency management functions at the state level are coordinated by the HI-EMA and its five branches: Preparedness, Operations, Telecommunications, Logistics, and Finance Administration. HI-EMA is located within the Department of Defense, and the Adjunct General serves as its Director. A civilian Administrator is appointed by the Director and maintains the day-to-day operations of the agency. HRS §127-A (Emergency Management) was revised in June 2014 updating the state's emergency management statutes, moving from an outdated civil defense framework to the current emergency management structure. The revisions led to a number of changes intended to ensure coordination of the state and its counties to the maximum extent possible with the comparable functions of the federal government.

HI-EMA serves as the coordinating agency for the four County emergency management agencies and as State Warning Point. HI-EMA administers the state's hazard mitigation program with the State Hazard Mitigation Officer (SHMO) serving as the official point of contact.

5.2 IDENTIFICATION AND EVALUATION OF STATE PRE- AND POST-DISASTER CAPABILITIES

Element S8 and 44 CFR § 201.4(c)(3)(ii): The state plan must include a discussion of the evaluation of the state's hazard management policies, programs, capabilities, and funding sources to mitigate the hazards identified in the risk assessment. This includes an evaluation of state laws, regulations, policies, and programs related to hazard mitigation; state funding capabilities for mitigation actions and projects; and obstacles, challenges, and proposed solutions.

This section identifies and evaluates the state pre- and post-disaster capabilities including legal, regulatory, and programmatic capabilities, participation in national programs, and funding capabilities. County capabilities are discussed in Section 5.3 (Summary of Effectiveness of Local Mitigation Capabilities).

Key Term

Mitigation Capabilities provide the means to accomplish desired mitigation outcomes. Capabilities include laws, regulations, policies, programs, administrative and technical staffing and resources, funding, and people-powered capabilities, such as volunteer groups.

5.2.1 LEGAL, REGULATORY, PLANNING, AND PROGRAMMATIC CAPABILITIES

State departments and agencies, in coordination with the HI-EMA, conducted a thorough review of laws, rules, plans, and programs to identify and evaluate their hazard mitigation-related capabilities, including those related to development in hazard-prone areas. Each identified capability was described, significant changes that occurred during the performance period of the 2018 SHMP were noted, and opportunities or challenges in enhancing capability effectiveness or minimizing conflicts with mitigation goals were discussed. In addition, the hazard(s) of concern that the capability helps to mitigate, the type of hazard management capability (pre- and/or post-disaster), and the effect on loss reduction were identified. While some funding capabilities were identified in this discussion, funding is discussed in more detail in Section 5.2.3. Table 5-1 summarizes the full range of identified capabilities and the hazards which they mitigate. The detailed information evaluating the mitigation capabilities of state laws, regulations, policies, and programs upon which this summary table is based is in Appendix C (Capability Assessment Supplement). Detailed information in the appendix also includes the areas of strength or deficiency of the capabilities for impacting resilience to climate change and supporting vulnerable populations.

Table 5-1. Summary of the State of Hawaii's Hazard Mitigation Capabilities by Hazard of Concern

Capability [a]	Climate Change and Sea Level Rise	Cyber Threat	Drought	Earthquake	Flood	Hazardous Materials	Health Risks	Hurricane	Infrastructure Failure	Landslide and Rockfall	Terrorism	Tsunami	Volcanic Hazards	Wildfire	Windstorm
Aircraft Alert System (HI-EMA)												◆			
Building Code Committee (SEAOH)				◆	◆			◆		◆		◆	◆	◆	◆
Building Code Council (DAGS)				◆	◆			◆		◆		◆	◆	◆	◆
Bridge Inspection Program				◆	◆				◆	◆		◆			
Capital Improvements Budget (DBF)	◆		◆	◆	◆	◆		◆	◆	◆		◆	◆	◆	◆
Clean Water Act Section 401 Water Quality Certifications (DOH EHA)					◆	◆	◆								
Climate 21C (OCCL)	◆				◆				◆						
Coastal Lands Program (OCCL)					◆			◆							
Coastal Zone Management Program (OPSD)	◆		◆	◆	◆	◆	◆	◆	◆	◆		◆	◆		◆
Commission on Water Resources Management (CWRM)			◆											◆	
Community Development District Program (HCDA)	◆		◆	◆	◆	◆	◆	◆	◆	◆		◆	◆		◆
Critical Infrastructure Security and Resilience Program (OHS)		◆									◆				
Critical Infrastructure Vulnerability Assessment (OHS)		◆									◆				
Critical Systems Vulnerability Assessment (HI-EMA)				◆				◆				◆			
Cybersecurity Program (OHS)		◆									◆				
Dam Safety Program (Engineering)									◆						
Damage Assessments (DAGS)				◆			◆								
Department Emergency Operations Plan Template (HI-EMA)	◆		◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆
Department of Hawaiian Home Lands Land Trust (DHHL)	◆		◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆
Department of Health All-Hazards Training and Exercise Program (DOH HRA)	◆		◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆
Department Operations Center (HI-EMA) Planning Guidance and Resources (HI-EMA)	◆		◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆
Disaster Response Committee (SEAOH)				◆	◆			◆	◆	◆		◆	◆	◆	
Energy Assurance Program (HSEO)	◆			◆	◆			◆	◆	◆		◆	◆	◆	◆
Epidemiological Surveillance (DOH HRA)							◆								

Capability [a]	Hazards of Concern														
	Climate Change and Sea Level Rise	Cyber Threat	Drought	Earthquake	Flood	Hazardous Materials	Health Risks	Hurricane	Infrastructure Failure	Landslide and Rockfall	Terrorism	Tsunami	Volcanic Hazards	Wildfire	Windstorm
Fire Program (DOFAW)			◆					◆						◆	
Flood Hazard Assessment Tool (DLNR)					◆				◆			◆			
Forestry Program (DOFAW)	◆		◆		◆			◆		◆		◆		◆	◆
Geography Department (UH)					◆										
Get Ready Website (HI-EMA)				◆	◆			◆				◆	◆		
GoHawaiʻi Mobile App (HTA)				◆	◆		◆	◆		◆		◆			
Hawaiʻi Advisory Council on Emergency Management (HI-EMA)	◆		◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆
Hawaiʻi Catastrophic Hurricane Plan (HI-EMA)								◆							
Hawaiʻi Earthquake & Tsunami Advisory Committee (HI-EMA)				◆								◆			
Hawaiʻi Emergency Planning and Community Right to Know Act (DOH EHA)						◆									
Hawaiʻi Environmental Policy Act (DOH OEQC)				◆	◆					◆		◆	◆	◆	
Hawaiʻi Hazards Awareness and Resilience Program (HI-EMA)	◆		◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆
Hawaiʻi Homeland Security Strategy and its Implementation Plan (OHS)		◆									◆				
Hawaiʻi Institute of Geophysics and Planetology (UH)	◆		◆		◆		◆	◆	◆			◆	◆		◆
Hawaiʻi Invasive Species Council (HISC)	◆		◆		◆		◆	◆						◆	◆
Hawaiʻi State Legislature Grant-in-Aid Program (HSL)	◆		◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆
Hawaiʻi State Legislature Senate Resolution 35 (HSL)	◆				◆			◆				◆			
Hawaiʻi State Planning Act (OPSD)	◆		◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆
Hawaiʻi Statewide Geographic Information System Program (OPSD)	◆		◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆
Hawaiʻi Targeted Violence Prevention Strategy (OHS)											◆				
Hawaiʻi Tree Canopy Viewer (DLNR)	◆		◆		◆			◆						◆	◆
Hazardous Materials Risk Management Program (HDOT)						◆									
Hazardous Waste Section Regulations (DOH EHA)						◆									

Capability [a]	Hazards of Concern														
	Climate Change and Sea Level Rise	Cyber Threat	Drought	Earthquake	Flood	Hazardous Materials	Health Risks	Hurricane	Infrastructure Failure	Landslide and Rockfall	Terrorism	Tsunami	Volcanic Hazards	Wildfire	Windstorm
Hazus Risk Assessment Program (HI-EMA)				◆	◆			◆				◆			
Homeland Security Executive Advisory Council (OHS)		◆									◆				
Homeland Security Grant Program Subcommittee (OHS)		◆									◆				
Hospital Preparedness Program (DOH HRA)							◆								
Immunization Programs (DOH HRA)							◆								
Laboratory Preparedness and Response Program (DOH HRA)						◆	◆								
Land Acquisition Program (DAGS)	◆		◆		◆										
Makani Pahili 2017 Emergency Power Prioritization Workshop Series (HI-EMA)				◆	◆			◆	◆			◆	◆		◆
Mandatory Seller Disclosures in Real Estate Transactions (DCCA)					◆							◆			
Mass Feeding Operations (DOH EHA)							◆								
Medical Countermeasure Points of Distribution (DOH HRA)							◆								
National Disaster Preparedness Training Center (UH)	◆		◆	◆	◆	◆	◆	◆	◆	◆		◆	◆		◆
National Flood Insurance Program (Engineering)	◆		◆		◆			◆	◆			◆			
Native Ecosystems Protection and Management (DOFAW)	◆		◆		◆			◆							
Natural Disaster Economic Recovery Strategy (HI-EMA)	◆		◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆
NPDES Wastewater Discharge Permits (DOH EHA)					◆	◆	◆								
Pacific Disaster Center Technical Capabilities (PDC)	◆		◆	◆	◆	◆	◆	◆	◆	◆		◆	◆		◆
Pacific RISA (Pacific RISA)	◆		◆												
Polluted Runoff Control Program (DOH EHA)			◆		◆										
Pacific Risk Management ‘Ohana (PRiMO)	◆		◆	◆	◆	◆	◆	◆	◆	◆		◆	◆		◆
Radiation Section - Radiation Assessment Team (DOH EHA)						◆	◆								
Risk MAP (Engineering)				◆	◆			◆				◆			

Capability [a]	Climate Change and Sea Level Rise	Cyber Threat	Drought	Earthquake	Flood	Hazardous Materials	Health Risks	Hurricane	Infrastructure Failure	Landslide and Rockfall	Terrorism	Tsunami	Volcanic Hazards	Wildfire	Windstorm
Roadside Fuel Reduction Program (HDOT)														◆	
Safe Drinking Water Emergency FAQs (DOH EHA)							◆								
School of Ocean and Earth Science Technology (UH)	◆		◆		◆			◆					◆		◆
Shelter Upgrade Program (DAGS)							◆								
Shoreline Certification (Land Division)	◆				◆										
Silver Jackets (Engineering)	◆				◆			◆	◆			◆			
State and Local Cybersecurity Grant Program Subcommittee (OHS)		◆													
State Board of Land and Natural Resources (BLNR)	◆		◆		◆										
State Cyber Disruption Response Plan (OHS)		◆													
State Fire Council (SFC)														◆	
State Land Use Law (OPSD)	◆		◆	◆	◆			◆	◆	◆		◆	◆	◆	◆
State Mitigation Forum (HI-EMA)	◆		◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆
State of Hawaiʻi Emergency Operations Plan (HI-EMA)	◆		◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆
State-owned Building Insurance (DAGS)				◆	◆			◆	◆	◆		◆	◆	◆	◆
State Preparedness Report (HI-EMA)	◆		◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆
Statewide Highway Shoreline Protection Study (HDOT)	◆				◆			◆							
Strategic Plan (HI-EMA)	◆		◆	◆	◆	◆	◆	◆	◆	◆		◆	◆		◆
Terrorism and Targeted Violence Incident Annex (OHS)											◆				
Terrorism and Targeted Violence Program (OHS)											◆				
The Center for the Study of Active Volcanoes (UH)				◆	◆			◆				◆	◆		
Threat Hazard Identification and Risk Assessment (HI-EMA)				◆	◆		◆	◆				◆	◆		
Training & Exercise Plan (HI-EMA)	◆		◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆
Transportation Asset Climate Change Risk Assessment Project (Oʻahu MPO)	◆														
Underground Storage Tank Section Regulations (DOH EHA)			◆		◆										
Vector Control Program (DOH EHA)							◆								

Capability [a]	Hazards of Concern														
	Climate Change and Sea Level Rise	Cyber Threat	Drought	Earthquake	Flood	Hazardous Materials	Health Risks	Hurricane	Infrastructure Failure	Landslide and Rockfall	Terrorism	Tsunami	Volcanic Hazards	Wildfire	Windstorm
Weatherization Assistance Program (OCS)			◆												
Western States Seismic Policy Council (HI-EMA)				◆								◆			

a. Acronym in parenthesis refers to the state department detail table under which the capability is discussed (see Appendix C [Capability Assessment Supplement]). Listing under a particular department or agency should not be construed to imply that the department is the sole administrator of the capability. Additionally, in some instances the capability is associated with the duties of the department but the department does not have administrative authority over the capability.

In order to support program and plan integration, each capability was also assessed to determine the mitigation mission area core capability that each supports. Core capabilities are identified in the National Preparedness Goal and are used in other emergency management programs, including the THIRA and State Preparedness Report. The mitigation mission includes seven core capabilities: (1) Threats and Hazards Identification, (2) Risk and Disaster Resilient Assessment, (3) Planning, (4) Community Resilience, (5) Public Information and Warning, (6) Long-Term Vulnerability Reduction, and (7) Operational Coordination. These core capabilities and the results of the assessment are available in Appendix C (Capability Assessment Supplement).

Planning and Regulatory Challenges and Opportunities

Throughout the stakeholder engagement process for the 2023 SHMP Update, stakeholders noted gaps and challenges in existing state capabilities to implement hazard mitigation actions and build resilience. Outcomes of the capability workshops held in February 2023 acknowledged the following:

- There is a need to coordinate economic development planning and hazard mitigation planning. As a result of this discussion, new mitigation actions that tie priorities established by the economic sector more closely with emergency management were included in the mitigation strategy (Action 2023-004).
- There is a lack of coordination between government agencies and community-based organizations which will be addressed when implementing numerous mitigation actions that align with the new objective in the SHMP to "establish and maintain public-private partnerships among all levels of government, community groups, the private sector, and institutions of higher learning …" (i.e., Actions 2023-013, 2023-16).
- Legal challenges hinder managed retreat efforts to mitigate the sea level rise hazard (Action 2023-14).
- To address challenges related to protecting coastal areas including natural and cultural resources, the "Hawaiʻi Digital Coastal Atlas" is being developed by OPSD for planning and permitting purposes (Action 2023-15).

Land Use

The Hawai'i State Planning Act was adopted in 1978 and sets policy for all activities, programs, and decisions made by local and state agencies. Current priorities are planning for climate change impacts, ensuring the sustainable and economic use of ocean and coastal resources, and supporting scientific and cultural knowledge to better manage natural resources (OPSD 2022). All lands in the state are classified into four categories as required by HRS 205; the four categories are urban, rural, agricultural, and conservation. The classification of lands is required to be reviewed every five years in accordance with HRS 205-18.ag

In 2021, land use and environmental policy functions of different agencies were consolidated to form the Office of Planning and Sustainable Development. The Office is responsible for the following activities:

- Comprehensive planning and program coordination
- Strategic planning
- Planning coordination and cooperation
- Statewide planning and GIS
- Land use planning
- Coastal and ocean policy management
- Regional planning studies
- Regional, national, and international planning

The Hawai'i State Plan establishes overall themes, goals, objectives, and policies for the state. The State Plan is composed of a statewide planning system, which includes County general plans that align with the State Plan. In addition to the State Plan, OPSD also develops the Hawai'i Sustainability Plan and Ocean Resource Management Plan.

State Building Code

The State Building Code Council (SBCC), housed within the Department of Accounting and General Services, is responsible for establishing a State Building Code through timely adaption of national building codes; the SBCC must include the latest fire code as adopted by the State Fire Council, the latest edition of the International Building Code, the latest edition of the Uniform Plumbing Code, and Hawai'i design standards to implement Act 5, Special Session Laws, 2005 as applicable to emergency shelters and essential government facilities (State Building Code Council 2022).

On April 20, 2021, Hawai'i adopted the 2018 International Building Code with amendments and Wind Topographic Factor Maps for use with the State Building Code. Each County is required to amend and adopt the code by April 20, 2023, in accordance with HRS 107-28(a). Additionally, all design of state building construction must comply with the code by April 20, 2022, in accordance with HRS 107-27.

In addition to the Hawai'i State Building Code, the state also adopts an Energy Conservation Code.

State Building-Code Related Challenges and Opportunities

Feedback during the Building Codes and Standards Focus Group meeting in September 2022 and the capabilities workshops in February 2023 included the following:

- There is a lack of funding for the State Building Code Council. The State Building Code Council members serve on a voluntary basis. There are ongoing discussions to build capacity with paid staff support.

- The state has not adopted the most current IBC. The delay exists due to the lack of funding and capacity as noted above. As a result, the state is not competitive on a national level when applying for FEMA BRIC funding.
- The coordination between building code departments and floodplain managers at the county level needs to increase. The counties may include mitigation actions to address this need in future local HMP updates.
- There is a need to promote the importance of building codes among the general population. Soliciting their support would require targeted outreach and education.

5.2.2 PARTICIPATION IN NATIONAL MITIGATION-RELATED PROGRAMS

There are several national programs that incentivize or support mitigation activities including the National Flood Insurance Program (NFIP), Community Rating System (CRS), Risk Mapping Assessment and Planning (Risk MAP), and the National Incident Management System (NIMS). These programs are a key component of state hazard mitigation capabilities. The following sections discuss the administration and application of these programs in the State of Hawaiʻi.

National Flood Insurance Program and Community Rating System

The NFIP is a federal program established to allow property owners in participating communities to purchase insurance protections against losses from flooding. Participation in the NFIP is based on an agreement between local communities and the federal government that states if a community will adopt and enforce a floodplain management ordinance to reduce future flood risks to new construction and substantial improvements in Special Flood Hazard Areas (SFHAs), the federal government will make flood insurance available within the community (DLNR 2022).

The NFIP is administered by the Federal Insurance and Mitigation Administration (FIMA) and the Mitigation Directorate, components of FEMA. The DLNR has been designated as the State Coordinating Agency responsible for assisting the coordination of the program between the federal and County agencies in the State of Hawaiʻi. All four of the counties are participating communities in the NFIP, and each community has a representative County floodplain manager (see Table 5.3-2 in Section 5.3.2 for information on County floodplain management programs). According to FEMA records, as of September 30, 2022, there are 55,797 flood insurance policies in force within the state totaling more than $14.4 billion in insurance and more than $38.5 million in annual premiums.

The CRS is a voluntary program within the NFIP that encourages floodplain management activities that exceed the minimum NFIP requirements. For participating communities, flood insurance premium rates are discounted in increments of 5%. For example, a Class 1 community would receive a 45% premium discount, and a Class 9 community would receive a 5% discount. Class 10 communities are those that do not participate in the CRS; they receive no discount. CRS activities can help to save lives and reduce property damage. More information on their participation is available in Section 5.3.2.

Key Capability

Community Rating System—Hawaiʻi is the first state in the nation in which all the counties participate in the CRS program.

- **Kauaʻi County**—Class 8
- **City and County of Honolulu**—Class 8
- **Maui County**—Class 7
- **Hawaiʻi County**—Class 7

NFIP Staffing, Resources, and General Administration of Program

The state NFIP Coordinator sits in the Engineering Division of DLNR. There are three employees that generally administer the program, including the state NFIP Coordinator, State General Flood Control Plan Administrator, and an Engineering Technician. Although resources are adequate, staff resources would be improved by the addition of staff with a focus on grant management and information technology skills, such as GIS and website development.

Although the State of Hawaiʻi no longer participates in FEMA's Community Assistance Program State Support Services Element (CAP-SSSE) program, DLNR still serves as the State Coordinating Agency for the NFIP with emphasis on providing technical assistance to NFIP stakeholders across the state and to periodically conduct audits of each County's floodplain management program administration and enforcement. Activities include:

- **Attending National and Regional NFIP Related Conferences**—State floodplain management staff host an annual conference for floodplain managers, and staff can travel to Flood Mitigation Association (FMA) or Association of State Floodplain Manager (ASFPM) conferences.
- **Providing Technical Assistance to Community Officials and the Public—**Technical assistance is provided by reviewing CRS standing/feasibility with counties; attending CRS/NFIP audit and compliance meetings with FEMA or contractor staff, meeting with the Building Code Council, and providing other technical assistance as requested.

NFIP and CRS Implementation Challenges and Opportunities

The following NFIP and CRS implementation challenges and opportunities gathered during the planning process are summarized below.

- Each County has island-specific challenges in administering their floodplain management regulations. Coordination between the counties and state agencies is challenging, especially regarding data availability and sharing. Higher resolution imagery data would allow state and county floodplain managers to produce more useable and practical data to support flood modeling (i.e., Actions 2023-005, 2023-2018-007)
- Funding and resource availability is a challenge at the County level. The state is interested in ways to increase collaboration on CRS by creating a statewide Hawaiʻi CRS user group. This effort would focus on

creating tools and opportunities for each County to leverage to maintain CRS eligibility and improve class rating and premium discounts.

- Drainage and other flood control facilities are frequently located on privately-owned lands. This complicates access and identification of funding to support flood control and drainage maintenance. Efforts to address these and other issues are ongoing at the local level.

Risk Mapping, Assessment, and Planning Program

FEMA works with federal, state, tribal, and local partners across the nation to identify flood risk and promote informed planning and development practices to help reduce that risk through the Risk MAP program. Risk MAP provides high quality flood maps and information, tools to better assess the risk from flooding and planning and outreach support to communities to help them take action to reduce (or mitigate) flood risk. Each Risk MAP flood risk project is tailored to the needs of each community and may involve different products and services.

According to the Risk MAP Progress interactive map available online, at the time of this plan update there no active projects in the state. FEMA coordinates and works directly with County floodplain managers during the Risk MAP project process. The state NFIP Coordinator is kept apprised of project activities and consults as needed. The state (DLNR and HI-EMA) continues to be involved in mitigation planning and hazard identification but does not currently have the resources to lead mapping projects under the Cooperating Technical Partner program; however, DLNR is a Cooperating Technical Partner and is undertaking special projects.

DLNR maintains the Flood Hazard Assessment Tool (FHAT), an informational mapping viewer that displays flood zone information from FEMA's Digital Flood Insurance Rate Maps (FIRMs). The FHAT can be used to inform mitigation planning and strategies and community planning decisions across state and local partners.

National Risk Management System

The National Incident Management System (NIMS) guides all levels of government, nongovernmental organizations and the private sector to work together to prevent, protect against, mitigate, respond to and recover from incidents. NIMS defines operational systems that guide how personnel work together during incidents. Hawaiʻi strives to maintain NIMS compliance with the state's Emergency Operations Plan.

5.2.3 PRE- AND POST-DISASTER FUNDING CAPABILITIES

Element S11 and 44 CFR § 201.4(c)(3)(iv): The state plan must identify current and potential sources of funding to implement mitigation actions and activities, including the identification of current and/or potential sources of federal, state, local, or private funding for implementation. At a minimum, the plan must identify FEMA mitigation funding sources.

For the 2023 SHMP Update, the federal and state programs that provide funding were reviewed and updated. This section discusses FEMA and other federal funding sources available to support mitigation, and evaluates the state's funding capabilities, including a summary of funding resources that the state has access to or is eligible to use, a description of how the state has used its own funding for hazard mitigation, and how FEMA funds have been used.

FEMA Funding for Mitigation Activities

FEMA's hazard mitigation assistance provides funding for eligible mitigation measures that reduce disaster losses. Table 5-2 summarizes these FEMA grant funding programs, their purpose, and applicability of pre- or post-disaster requirements.

Table 5-2. Summary of FEMA Mitigation Funding

Hazard Mitigation Grant Program (HMGP)
Purpose: To provide funds to states, territories, Indian tribal governments, and local communities to significantly reduce or permanently eliminate future risk to lives and property from natural hazards. HMGP funds projects in accordance with priorities identified in state or local hazard mitigation plans and enables mitigation measures to be implemented during the recovery from a disaster. **Availability:** Post-Disaster. When authorized under a Presidential major disaster declaration in areas of the state requested by the Governor.
Building Resilient Infrastructure and Communities (BRIC)
Purpose: To provide funds to states, local communities, tribes and territories as they undertake hazard mitigation projects, reducing the risks they face from disasters and natural hazards. The BRIC program guiding principles are supporting communities through capability- and capacity-building; encouraging and enabling innovation; promoting partnerships; enabling large projects; maintaining flexibility; and providing consistency. **Availability:** Pre-Disaster
Pre-Disaster Mitigation (PDM)
Purpose: Makes federal funds available to state, local, tribal, and territorial governments to plan for and implement sustainable cost-effective measures. These mitigation efforts are designed to reduce the risk to individuals and property from future natural hazards, while also reducing reliance on federal funding from future disasters. This funding is offered in addition to funds provided through other FEMA grant programs for projects that will support growing mitigation needs nationwide. **Availability:** Pre-Disaster
Flood Mitigation Assistance (FMA)
Purpose: To implement cost-effective measures that reduce or eliminate the long-term risk of flood damages to buildings, manufactured homes and other structures insured under the National Flood Insurance Program (NFIP). As noted, the FMA combines the previous Repetitive Flood Claims and Severe Repetitive Loss grants into one grant program. **Availability:** Pre-Disaster
HMGP Post-Disaster Fire Assistance
Purpose: Provides assistant to help communities implement hazard mitigation measures after wildfire disasters. **Availability:** Post-Disaster
HHPD
Purpose: Provides technical, planning, design and construction assistance in the form of grants for rehabilitation of eligible high hazard potential dams. **Availability:** Pre- and Post-Disaster
Public Assistance
Purpose: Provides federal assistance to government organizations and certain private non-profit organizations following a Presidential Disaster Declaration so that communities can quickly respond to and recover from major disasters or emergencies. Provides assistance to supplement federal disaster grants for debris removal, life-saving emergency protective measures, and the repair, replacement, or restoration of disaster-damaged publicly owned facilities and the facilities of certain private non-profit organizations. Supports local communities with opportunities to strengthen infrastructure that has been proven to fail under disaster conditions. **Availability:** Post-Disaster

Source: (FEMA 2023)

FEMA’s Safeguarding Tomorrow Revolving Loan Fund Program provides hazard mitigation assistance to reduce risks from natural hazards and disasters. Hawaiʻi has not yet used this funding program but may in the future.

In 2022, the Community Disaster Resilience Zones Act was signed that amends the Robert T. Stafford Act and applies FEMA's National Risk Index to identify communities most vulnerable to natural hazards. Designated zones will receive targeted federal support for FEMA grant programs. Hawai'i is currently working on identifying Community Disaster Resilience Zones (CDRZ) to support disadvantaged communities that are most at risk to natural hazards.

Leveraging FEMA Funding for Mitigation Activities

The state has historically utilized HMGP and pre-disaster funding to the greatest degree. The HMGP funds are typically used for project implementation, while BRIC funding is typically used to support mitigation planning activities at the state and county level.

It is important to note that HMGP funding is determined as a percentage of the funds spent on public and individual assistance for a Presidentially declared disaster. The State of Hawai'i has historically received less than $1 million in HMGP funds following declared disasters. The BRIC monies are determined by congressional allocation and fluctuate from year-to-year. The FMA and Section 406 funding has historically been underutilized by the state. No FMA or Section 406 funds were used for mitigation activities during the performance period of the 2018 SHMP.

Table 5-3 summarizes key information on the location and the types of FEMA-funded mitigation projects during the performance period of the 2018 SHMP. In total, 60 projects were identified, 13 are closed, 27 are ongoing, and 20 have been submitted for grant funding consideration.

Table 5-3. FEMA-Funded Mitigation Projects During Performance Period of 2018 SHMP

Criterion		Project Costs
Project Costs by FEMA Grant Program	Hazard Mitigation Grant Program (HMGP)	$14,977,604.88
	HMGP Management Costs	$1,817,712
	Pre-Disaster Mitigation (PDM)	$13,181,667
	PDM Management Costs	$626,616.04
	BRIC FY 2020	$600,000
	Flood Mitigation Assistance (FMA)	$0
	Public Assistance (PA) Category C-G (Section 406 funds)	$0
Project Costs by Location	Statewide	$1,988,970
	County of Kaua'i	$35,000
	City & County of Honolulu	$5,133,084
	County of Maui	$1,273,375
	County of Hawai'i	$7,325,952.88
Project Costs by Activity Type	Hardening/Retrofit	$1,811,164.88
	Management Costs	$1,817,712
	Local Mitigation Planning (Including 5% Initiative)	$1,973,271
	State Mitigation Planning (Including 7% planning grant)	$1,408,738

Source: Data provided by HI-EMA as of December 2022

These funds were used to reduce risk and increase resilience across the state in a variety of ways:

- **Critical Facility Hardening**—Critical facilities were hardened, including the Waikiki Fire Station in the City and County of Honolulu and the Maui County Highways Division Base Yard.

- **Backup Power**—Several projects were completed to provide emergency backup power to community lifelines, including an emergency standby power connection generator for the Department of Water Supply in the County of Hawaiʻi, an emergency generator at the Maui Food Bank in Maui County, and generators at Wilcox Memorial Center in the County of Kauaʻi.
- **Focus on Planning**—Planning efforts were supported by FEMA grant funds, including updates to all four County HMPs.

State Funding for Mitigation Activities

The state uses its own funding for a variety of mitigation activities. This use of funds includes earmarking resources for mitigation projects, providing grant monies to the counties and non-governmental organizations, supporting ongoing programs that further mitigation goals, and using state monies or in-kind contributions as matching funds for federal grants. The programmatic and regulatory programs summarized in Table 5.2-1 and outlined in detail in Appendix C (Capability Assessment Supplement) are supported, at least in part, by state general funds and the operating budgets of the various state departments and agencies. The detailed state capability tables for each agency in Appendix C include a column that indicates if the agency provides funding for mitigation. The following lists the state funding sources as specified by each contributing agency/department in Appendix C:

- Department of Accounting and General Services Capabilities
  - Land Acquisition Program
  - Shelter Upgrade Program
- Department of Budget and Finance
  - Capital Improvements Budgets
- Department of Health
  - Department of Health All-Hazards Training and Exercise Program
  - Hospital Preparedness Program
- Department of Land and Natural Resources
  - Fire Management Program
  - Legacy Lands Conservation Program
  - Watershed Partnership Program
  - Natural Area Partnership Program
  - Natural Area Reserves System
- Hawaiʻi Emergency Management Agency
  - Western States Seismic Policy Council
- Hawaiʻi State Legislature
  - Hawaiʻi State Legislature Grant-in-Aid (GIA) Program
  - Hawaiʻi Revised Statutes for Hazard Mitigation Funding

The progress update on the actions identified in the 2018 SHMP is included in Appendix G (Mitigation Strategy Supplement). It includes a list of activities that the state undertook during the performance period of the plan and indicates those actions that were accomplished using state funds. In total, 11 of the 16 actions (69%) identified as completed during the performance period of the 2018 SHMP used state funds (exclusively or in part) to support the completion of the action.

Other Funding for Mitigation Activities

A wide array of funding is available to support mitigation activities within the State of Hawaiʻi. Non-state and non-FEMA funding resources that state departments and agencies have indicated that are actively being used or pursued to support mitigation activities include the following:

- America the Beautiful Challenge (ATBC), National Fish and Wildlife Foundation
- Clean Water Act Section 319 Funding, U.S. EPA
- Corps Continuing Authorities (CCA) program, USACE
- State Response Plan Grant Funding, U.S. EPA
- Coastal and Estuarine Land Program, NOAA
- Coastal Resiliency Grant Funding, NOAA
- Coastal Zone Enhancement Program (Section 309) Funding, NOAA
- Community Development Block Grant – Mitigation (CDBG-MIT), HUD
- Community Wildfire Defense Grant, U.S. Forest Service
- Conservation Reserve Enhancement Program, Farm Service Agency
- Economic Development Administration Grants, EDA
- Emergency Management Performance Grant (FEMA Preparedness Grant)
- Forest Legacy Program, U.S. Forest Service
- Forest Stewardship Program, U.S. Forest Service
- Homeland Security Grant Program (prevention, protection, and response)
- Hospital Preparedness Program, U.S. Department of Health & Human Services
- Infrastructure Investment and Jobs Act (IIJA)
- National Coastal Resilience Fund (NCRF), NOAA
- National Earthquake Hazards Reduction Program
- National Tsunami Hazard Mitigation Program, NOAA
- Silver Jackets Interagency Program, U.S. Army Corps of Engineers
- State and Local Cybersecurity Grant Program (prevention, protection, and response)
- State and Private Forestry Branch, U.S. Forest Service
- Weatherization Assistance Program, U.S. Department of Energy
- Wildland Urban Interface Grant Program, U.S. Forest Service

More detailed information on how these funds are being used is available in Appendix C (Capability Assessment Supplement) and Appendix G (Mitigation Strategy Supplement).

Challenges and Opportunities to Access Mitigation Funding

There were several conversations throughout the planning process centered on the challenges to access funding to implement mitigation activities. The following summarizes these the challenges and opportunities to overcome these challenges identified by the Forum and stakeholders participating in the February 2023 workshops.

Local-level challenges and opportunities:

- There is a lengthy time period between grant application submittal and award, leaving people/property/ environment at risk.
- Socially vulnerability communities are challenged to meet the ranking criteria for HMA grants and need assistance to develop competitive grant applications.
- Technical assistance is needed from FEMA on how to develop competitive hazard mitigation grants on the national level. This is being addressed in consultations with FEMA.
- Grant writers and administrators need to be hired at the county level to increase capacity. The counties may include this gap in a mitigation action during the next local HMP update.

State-level challenges and opportunities:

- There have been significant changes and reductions in staff at HI-EMA who oversee funding and the application process. HI-EMA is in the process of filling this gap in capacity through hiring and training.
- There was a shift in oversight of FMA funding from DLNR to HI-EMA in 2020. This occurred at a time when capacity at HI-EMA for overseeing funding was already diminished.
- There is a lack of capacity at DLNR to apply for and manage HHPD grants.

5.2.4 SUMMARY OF CHANGES IN STATE CAPABILITIES AND PROGRESS ON INTEGRATION

The State of Hawaiʻi has strengthened and enhanced its capabilities over the performance period of the 2018 HMP and has continued to make progress on integration. The following sections provide a summary of the detailed information available in Appendix C (Capability Assessment Supplement).

Summary of Changes in State Capabilities

The following are a selection of notable changes that have influenced or impacted state capabilities over the performance period of the 2018 HMP:

- **Public Education and Information**
    - The Ocean Resources Management Plan (ORMP) Dashboard, built on Esri HUB technology, was launched, which provides information on the progress of implementing the ORMP.
    - The Hawaiʻi Hazards Awareness and Resilience Program (HHARP) was established in 2014 and, as of March 2023, seven communities have reached recognition level in the program. Six additional communities are engaged in HHARP (Hawaiʻi Emergency Management Agency 2023).

- **Staffing and Technical Resources**
  - The HI-EMA Mitigation Section, who led the state mitigation program, experienced significant challenges to adequately staff all the responsibilities for which they are charged during regular operations. This challenge is exacerbated when staff is deployed for special occurrences, such as disaster events.
- **New and Updated Planning Resources**
  - One (1) Community Wildfire Protection Plan was developed in 2021
  - The HI-EMA Strategic Plan was updated in March 2022
  - The Hazards and Vulnerabilities Overview was developed in 2022
  - The Hawaiʻi 2050 Sustainability Plan was developed in 2021
  - The Hawaiʻi Highways Climate Adaptation Action Plan was developed in 2021
  - The County of Hawaiʻi Volcanic Risk Assessment was developed in 2020
- **New Collaborative Approaches**
  - The Hawaiʻi Climate Change Mitigation & Adaptation Commission was formed and has adopted the *Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report*, with an updated report expected in 2023.
  - The Hawaiʻi Tree Canopy Viewer was developed in 2020, which facilitates awareness of the extent of impervious surfaces to promote clear stormwater runoff and urban heat sensitivity mapping.

PROGRESS ON INTEGRATION INTO STATE PROGRAMS

The state has used the update of the 2023 SHMP Update as an opportunity to further promote integration:

- **Resource for County Local HMPs**—HI-EMA envisions the 2023 HMP Update as a reference for local HMPs to integrate risk assessment results to reduce work and focus on strengthening other areas of plans, including general plans and emergency operations plans.
- **Goal Development**—Goals identified in local HMPs were used to inform the development of goals for the 2023 SHMP Update. County leaders worked with the state in goal development and all aspects of plan development through their involvement on the State Hazard Mitigation Forum.
- **THIRA**—HI-EMA intends to leverage the 2023 SHMP Update for the next THIRA update. The 2023 SHMP Update risk and capability assessments will be integrated into the updated document.
- **Stakeholder Preparedness Review**—HI-EMA will more fully integrate the updated mitigation goals into the next Stakeholder Preparedness Review.
- **Hawaiʻi Mitigation Program Consultation**—The results of the mitigation program consultation conducted with FEMA Region 9 mitigation staff and HI-EMA were used to identify challenges and opportunities to mitigation within the state and will be used in the future to help monitor progress on addressing challenges and identifying emerging issues.
- **Homeland Security**
  - Hawaiʻi has established several foundational strategies and plans in the Homeland Security mission space:

- Hawaiʻi Homeland Security Strategy and its Implementation Plan
- Hawaiʻi Targeted Violence Prevention Strategy
- Cyber Incident Response Plan (for state executive agencies)
- State Cyber Disruption Response Plan
- Terrorism and Targeted Violence Incident Annex

- Hawaiʻi inaugurated its Homeland Security Exercise Program in 2022, completing four large-scale exercises:

  - State Cyber Disruption Response Plan (led)
  - Hawaiʻi County Election Security (led)
  - Hawaiʻi State Election Security (led)
  - TSA/USCG Cyber Challenge 22 (support)

- Homeland Security planning activities underway include:

  - Terrorism and Targeted Violence Incident Annex annual review and incorporation of State Mass Violence Response Plan
  - Targeted Violence Prevention Strategy Implementation Plan
  - Critical Infrastructure Security and Resilience Strategy, Planning Framework, and Implementation Guide

- Hawaiʻi is in the process of establishing its Homeland Security Executive Advisory Council, along with two grant program-focused subcommittees (Homeland Security and State and Local Cybersecurity) and relevant working groups.
- Hawaiʻi is also in the progress of establishing its Statewide Cybersecurity Program with significant support provided through the State and Local Cybersecurity Grant Program, initially focused on:

  - Statewide Cybersecurity Strategy and Implementation Plan(s)
  - Subrecipient Cyber Incident Response Plans and related exercises
  - Statewide Cyber Workforce Development Strategy and County/Entity-Level Implementation Plans

Additional components of program integration are discussed in Section 2 (Planning Process – Program Integration). Opportunities for additional integration have been identified and are included in the Action Plan in Section 6 (Mitigation Strategy).

5.3 SUMMARY OF EFFECTIVENESS OF LOCAL MITIGATION CAPABILITIES

Disasters are inherently local events; therefore, the assessment of state capabilities would not be complete without an examination of local (County) capabilities. This review and examination was used to inform and influence the state's mitigation priorities as discussed in Section 6 (Mitigation Strategy). The review was conducted by examining the local hazard mitigation plans (local HMPs) of the four counties.

Element S13, HHPD6, and 44 CFR § 201.4(c)(3)(ii): The state plan must include a general description and analysis of the effectiveness of local government mitigation policies, programs, and capabilities. The plan must include a summary of current local government policies, programs, and capabilities. The plan must identify challenges to implementing these mitigation policies, programs, and capabilities; these should include gaps and disparities in serving underserved communities and challenges resulting from the impacts of climate change. If the state is interested in HHPD funding, the plan must generally describe and analyze the effectiveness of local mitigation policies, programs, and capabilities that address high hazard potential dams.

This review focused on the following aspects of the local HMPs:

- **Foundational Capabilities**—A list of foundational capabilities relevant for hazard mitigation in the state was developed, and local HMPs were reviewed to determine if these capabilities were identified and discussed. It should be noted that this list is not intended to be a comprehensive assessment of all capabilities identified in local HMPs.
- **Floodplain Management Capabilities**—The local HMPs were reviewed for discussion of County floodplain management capabilities. including adoption of higher standards; general information on effectiveness and process; and efforts to address repetitive loss and severe repetitive loss properties.
- **Land Use Planning**—The local HMPs were reviewed for discussion on General Plans and Community Plans and for information on integrating hazard mitigation into land use planning (i.e., plan integration).
- **Evaluation and Effectiveness**—The local HMPs were reviewed to determine challenges and opportunities, unique sources of funding, mitigation successes, and determinations on effectiveness of mitigation actions.

The local HMPs, like state HMPs, are required by FEMA to be updated every five years. The counties' local HMPs are midway through their performance periods; therefore, the 2023 SHMP Update includes discussion on emerging capabilities that have arisen in the counties during their performance period that are not reflected in those plans. The following sections summarize the results of the review of the local HMPs and emerging capabilities identified during the 2023 SHMP Update.

5.3.1 LOCAL FOUNDATIONAL CAPABILITIES FOR HAZARD MITIGATION

County policies, programs, funding, and other capabilities are used to support and accomplish hazard mitigation goals and objectives. The County local HMPs identify and evaluate County capabilities for implementing hazard mitigation. In order to summarize these capabilities for the 2023 SHMP Update, a list of foundational capabilities for accomplishing hazard mitigation was developed based on FEMA local mitigation planning guidance, professional judgement, and suggestions from the State Hazard Mitigation Forum. This list was not intended to be inclusive of every capability discussed in the local HMPs or every capability that may be used to support hazard mitigation at the County level. Table 5-4 includes a summary of foundational capabilities relevant for hazard mitigation in the state and if these capabilities were identified and discussed in the County local HMPs.

Table 5-4. Foundational Capabilities as Reflected in County Local Hazard Mitigation Plans

Foundational Capabilities	County of Kauaʻi	City and County of Honolulu	County of Maui	County of Hawaiʻi
Building Code [a]	◆	◆	◆	◆
Capital Improvement Program	◆	◆	◆	◆
Climate Action/Resilience Plan [b]	◆	◆	◆	◆
Community Development Plans	◆	◆	◆	◆
Community Wildfire Protection Plan [c]	◆	◆	◆	◆
Emergency Operations Plan	◆	◆	◆	◆
Continuity of Operations Plan	◆			◆
County Owned Building Insurance				
Economic Development Plan	◆		◆	◆
Firewise USA™ [d]		◆	◆	◆
Flood Damage Prevention Ordinance	◆	◆	◆	◆
General Plan	◆	◆	◆	◆
Get Ready Website				
Hawaiʻi Hazards Awareness and Resilience Program			◆	
Hawaiʻi State Legislature Grant-in-Aid Program			◆	
Legacy Lands Conservation Program				
Land Acquisition Plan / Willing Seller Program		◆	◆	◆
Post-Disaster Recovery	◆		◆	◆
Public Health Preparedness Plan [e]	◆			◆
Real Estate Disclosure [f]	◆	◆	◆	◆
Rehabilitation of High Hazard Potential Dams (HHPD) [g]				◆
Resilience Officer		◆		
Risk MAP Program				
Sea Level Rise Study/Plan [h]	◆	◆	◆	◆
Shoreline Setbacks	◆	◆	◆	◆
Site Plan Review	◆	◆	◆	◆
Special Management Area Permits [i]	◆	◆		◆
State Hazard Mitigation Forum	◆	◆	◆	◆
StormReady®	◆	◆	◆	◆
TsunamiReady®	◆	◆	◆	◆
Stormwater Management / Low Impact Development	◆	◆	◆	◆
Subdivision Requirements	◆	◆	◆	◆
Threat & Hazard Identification & Risk Assessment [j]	◆	◆	◆	◆
Water Management Plan		◆		◆
Zoning Code or Land Use Ordinance [k]	◆	◆	◆	◆

Notes:

◆ *= Capability discussed in hazard mitigation plan; Information presented in this table reflects information as it is presented in the County hazard mitigation plans unless otherwise noted. Codes, regulations, and/or plans may have been updated since the time of their publication.*

a. *The State Building Code is included in HAR §3-180 State Building Code; Counties may make local amendments; At the time of the 2023 SHMP Update, counties had until April 20, 2023, to adopt the current version of the State Building Code.*

b. *Progress on the development of Climate Action/Adaptation Plans has occurred since the last updates of the County hazard mitigation plans. One new plan (Maui County Climate Action & Resiliency Plan) was completed in 2022. One plan for Hawaiʻi County will be completed in June 2023.*

c. *Progress on the development of Community Wildfire Protection Plans has occurred since the last updates of the County hazard mitigation plans. One new plan (North Shore Oʻahu) was completed in 2021 in the City and County of Honolulu.*

d. As of March 2023 there are 13 Firewise USA recognized sites in County of Hawaiʻi (9), County of Maui (3), and City and County of Honolulu (1).
e. There are no County equivalent public health agencies within the state; however, plans have been developed for all counties either directly by the Department of Health (for Oʻahu) or via the District Health Offices of the Neighbor Islands (County of Kauaʻi, County of Maui, and County of Hawaiʻi). In addition, the State of Hawaiʻi Health Risk and Vulnerability Assessment (2014) pertains to the entire state.
f. Disclosure of hazard risk is required in some real estate transactions by state law (see HRS 508D, Mandatory Seller Disclosures in Real Estate Transactions).
g. All counties rely solely on DLRN for HHPD policies, programs, and capabilities. Hawaiʻi County included one HHPD mitigation in the local HMP.
h. All counties are included in the statewide Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report.
i. Special Management Area Permits are part of the State Coastal Zone Management Program and are administered at the County level.
j. State law includes requirements as part of the Uniform Land Sales Practices Act (HRS Chapter 484)j. County representatives have participated in the development of the state THIRA.
k. County government have regulatory authority over Urban District lands and shared authority over Agricultural and Rural District Lands. Conservation District lands are reserved for the state.

The text included provides details on how the capability was discussed/addressed in the local plan and does not account for inaccuracies in this discussion. It is important to note that the absence of a capability does not mean that the capability does not exist in the county. It simply means that no discussion was found describing or identifying the capability in the local HMP. This suggests that the capability may not be used to its full potential to support mitigation within the county, or it may suggest that the department or agency responsible for implementing the capability may not have been fully involved in the local HMP planning process.

It is important to note that codes, regulations, and/or plans may have been updated or developed since the time of the local HMP publication (see Table 5-6). Notes are provided below the table on some such updates. In addition, please note that some of the capabilities included are local level capabilities, while others are state programs and/or regulations. A table with more detailed information on the foundational capabilities summarized below can be found in Appendix C (Capability Assessment Supplement). In addition, many aspects of these foundational capabilities and changes that may have occurred over the last several years are discussed in the detailed tables supporting the state capability assessment described above (see Appendix C [Capability Assessment Supplement]).

5.3.2 COUNTY LAND USE PLANNING

As indicated in Table 5.3-1 all Hawaiʻi counties have general plans, community plans, and zoning ordinances (referred to as the land use ordinance in some counties) and all three of these capabilities are discussed in the four County local HMPs. All of the counties have recognized the importance of land use planning and have identified actions to integrate the local HMPs into these plans. An example of actions included in the local HMPs addressing this integration are as follows:

- **County of Kauaʻi**—Integrate community-based disaster resilience plans into future community plan updates.
- **City and County of Honolulu**—Integrate natural hazard policies into the General Plan & Community Development Plans.
- **County of Maui**—Integrate the hazard mitigation plan into other plans, ordinances, and programs that dictate land use decisions in the community, including capital improvement programs, the general plan, recovery plans, and strategic plans.

- **County of Hawaiʻi**—Integrate the hazard mitigation plan into other plans, ordinances, and programs that dictate land use decisions in the community, including capital improvement programs, the general plan, recovery plans, and strategic plans.

Current and future development trends are discussed in more detail in Section 3 (State Profile) and in Section 4 (Risk Assessment).

5.3.3 COUNTY FLOODPLAIN MANAGEMENT

All counties are in good standing in the NFIP program at the time of this plan update. Each county is responsible to conduct floodplain management within their jurisdiction. The local HMPs were reviewed for discussion of county floodplain management capabilities including, adoption of higher standards; general information on effectiveness and process; and efforts to address repetitive loss and severe repetitive loss properties. Table 5-5 includes a summary of each county's floodplain management programs.

Table 5-5. County NFIP and CRS Participation

Criterion	County of Kauaʻi	City & County of Honolulu	County of Maui	County of Hawaiʻi
County Department That Is Responsible for Floodplain Management	Department of Public Works, Engineering Division	Department of Planning and Permitting	Department of Planning	Department of Public Works, Engineering Division
Floodplain Administrator	Floodplain Manager	Floodplain Manager	Floodplain Manager	Floodplain Manager
Date of Entry into the NFIP Program [a]	11/04/81	09/03/80	06/01/81	05/03/82
Current Effective FIRM Date	02/26/21	11/05/14	11/04/15	09/29/17
Date That Flood Damage Prevention Ordinance Was Last Modified [b]	2005	2016	2017	2018
Floodplain Management Program Higher Regulatory Standards [c]	Definition and development standards added for repetitive loss structures disallowing grandfathered unsubstantial improvement 10-year cumulative substantial improvement	Not discussed in local HMP	Not discussed in local HMP	3-year cumulative substantial improvements
Most Recent Community Assistance Visit or Community Assistance Contact [c]	2012	2007	2015	2019
Known Outstanding NFIP Compliance Violations That Need to be Addressed [c]	No; Issues identified during 2012 CAV were addressed in 2015	Various issues with administrative and enforcement procedures including improperly completed elevation certificates	No	No

Criterion	County of Kauaʻi	City & County of Honolulu	County of Maui	County of Hawaiʻi
Community Rating System (CRS) Participant	Yes	Yes	Yes	Yes
Date of Entry into the CRS Program	04/01/23	04/01/22	10/1/95	05/1/11
Current CRS Classification	8	8	7	7
Flood Insurance Policies in Force in the County [d]	3,835	38,122	11,787	4,201
Insurance in Force[d]	$992,835,100	$9,412,190,700	$2,836,571,500	$1,091,948,400
Premium in Force [d]	$3,396,276	$23,314,743	$7,803,520	$3,476,834
Total Loss Claims Filed in the County [d]	1,454	2,735	598	754
Total Payments for Losses [d]	$44,614,711	$55,893,849	$9,336,888	$19,756,781
Total Number of Repetitive Loss Properties [e]	46	132	38	46
Severe Repetitive Loss Properties [e]	2	13	6	32
Repetitive Loss Properties That Have Been Mitigated [e]	0	1	3	0
Repetitive Loss Properties That Are NFIP Insured [e]	23	40	14	4
Repetitive Loss Properties Located Outside the Special [e] Flood Hazard Area (SFHA)	12	54	11	10
Total Repetitive Loss Occurrences [e]	96	347	97	163
Total Cumulative Repetitive Loss Property Losses [e]	$6,906,758	$11,392,049	$2,436,353	$4,100,237
Total Average Repetitive Loss Property Losses [e]	$71,945	$32,830	$25,117	$25,155

Notes:

a. Date indicates entry into the Regular Program.
b. There is no state-level model flood damage prevention ordinance.
c. As discussed and described in the County's Local Hazard Mitigation Plan.
d. According to FEMA statistics as of September 30, 2022.
e. Provided by FEMA PIVOT Database, August 31, 2022; See Section 4.6 (Flood) for more information.

5.3.4 COUNTY BUILDING CODES

In 2007, the State Legislature created a State Building Code Council, composed of subject matter experts and government agency representatives, with the authority to establish a comprehensive suite of codes applicable to all construction in the State of Hawaiʻi. The statute governing this process is Hawaiʻi Revised Statues Chapter 107 Part II, State Building Code and Design Standards. The State Building Code Council is the technical body with the background expertise to evaluate model building codes and develop amendments necessary to make the codes appropriate for Hawaiʻi conditions. Under the present statute, once the Council develops and approves a Hawaiʻi code, it is then legally adopted into the Hawaiʻi Administrative Rules (HAR) of the Department of Accounting and General Services (DAGS).

Counties have two years from the date of establishment of the HAR State Building Code to adopt the Hawaiʻi State Building Code as the local County building code, including the addition of any locally approved County amendments. While having any code in effect to govern how structures are constructed considering the impacts from natural hazards is beneficial, this “2-year” lag process for code adoption has created some challenges for the State of Hawai'i as it pertains to meeting FEMA's goals for “consensus-based codes”. Consensus-based codes are the latest published editions of codes from nationally recognized authorities such as the International Code Council. FEMA Policy 104-009-11 has established minimum requirements for consensus-based codes for certain eligibilities under its Public Assistance (PA) and BRIC programs. The State of Hawai'i and its counties have not been successful pursuing grant funding under the BRIC program because of this limitation.

FEMA has developed a program to tracking the adoption of consensus-based codes in response to directives from the Disaster Recovery Reform Act of 2018 (Building Code Adoption Tracking Program (BCAT), https://www.fema.gov/emergency-managers/risk-management/building-science/bcat). The BCAT program tracks code adoption by each state and then categorizes each state into the following two categories:

- Higher Resistance: State has adopted the hazard-resistant codes of 2018 or later International Building Code (IBC) and International Residential Code (IRC), without weakening of any resilience provisions related to any of the five tracked hazards for which the jurisdiction is at high risk.
- Lower Resistance: State has not adopted hazard-resistant codes as defined under the higher resistance category.

The BCAT program has identified the State of Hawaiʻi as a lower resistance state based on its failure to adopt consensus-based codes as defined by FEMA.

5.3.5 EVALUATION OF LOCAL HAZARD MITIGATION PLANS

All counties in the state have identified, leveraged, and developed capabilities that are effective in mitigating risk from natural hazards. These capabilities are discussed in their local HMPs and serve as the basis for the implementation of many successful actions. A review of the County local HMPs was conducted to achieve the following:

- Determine how the counties are evaluating the effectiveness of their plans.
- Determine challenges, barriers, and unmet needs the counties had identified in reaching their mitigation goals.
- Identify opportunities to address challenges and leverage existing capabilities.

A review of the County local HMPs reveals that there is limited discussion of the effectiveness of mitigation actions and overall plan effectiveness. A summary of the results of the review are provided in the sections that follow. The results of this assessment were used by the state to develop its mitigation strategy for the 2023 SHMP Update.

Rehabilitation of High Hazard Potential Dams (HHPD) Program

The County local HMPs do not include discussions of the HHPD program. Each county relies solely on the policies, programs, and capabilities of DLNR for mitigation of high hazard potential dams. Challenges and opportunities are discussed in the following section.

5.4 CHALLENGES AND OPPORTUNITIES TO EFFECTIVE STATE AND LOCAL HAZARD MITIGATION

5.4.1 CHALLENGES AND BARRIERS

A number of challenges and barriers to implementing effective state and local mitigation actions have been identified during the update process for the 2023 SHMP. A summary of these challenges and barriers follows.

- **Sources of Funding Impact Implementation**—Activities and actions that required outside sources of funding for implementation were less likely to be implemented over the performance period of plans due to economic fluctuations and budget delays.
- **Social Factors Influence Mitigation Strategy Effectiveness**—Effective disaster mitigation goes beyond scientific and technical data. Social factors, such as poverty, social justice, and high costs of living, must be considered in the development and implementation of effective mitigation actions and strategies.
- **Coordination and Collaboration are Needed**—Additional coordination and collaboration among and between state, local and non-government agencies is needed to successfully implement many mitigation activities. An example of this is provided by the need for strong coordination and collaboration as well as clear policies for coordinating information and responses to landslides and rockfalls on critical highway areas and the trifurcation of jurisdiction in coastal areas of the state.
- **High Hazard Potential Dam Program Coordination and Hazard Awareness**—Each county relies solely on the capabilities, programs, and policies of DLNR for dam safety, but has not developed local mitigation capabilities to fully implement the HHPD program. The Hawaiʻi County HMP is the only local plan that includes a mitigation action to specifically address a high hazard potential dam. DLNR currently has a dam failure awareness program but focuses on dams impacted by storm events. There is a local and state data gap for how climate change, especially increased intense precipitation, may exacerbate dam failure.
- **Floodplain Management Presents Challenges for Counties**—A few counties have experienced challenges with effectively administering floodplain management regulations. In addition, updated FIRMs have resulted in more properties falling within SFHA boundaries and properties that do not conform to current flood damage prevention standards. Older levees are subject to failure or do not meet current building practices for flood protection. Issues with levee accreditation have emerged in the past few years.
- **Data Sharing and Information Management could be Improved**—Data sharing and information management for hazard mitigation has been a challenge and is a priority concern. A sustained effort to gather historical damage data, such as high-water marks on structures and damage reports, would be useful in measuring the cost-effectiveness of future mitigation projects.
- **Funding for Critical Facility and Infrastructure Mitigation is Needed**—Funding is needed to upgrade and retrofit public facilities and shelters as well as communication infrastructure. In addition, detailed assessments on some critical facilities, such as major health care centers, need to be conducted to determine appropriate mitigation measures.
- **Public Awareness of Risk could be Improved**—Increased awareness and better understanding of risks and impacts is needed across stakeholder groups including the general public and decision makers. Isolated population centers especially need information on sheltering in place and instructions on developing a personal emergency plan.

- **Visitors Present Special Challenges**—Visitors present a special challenge for disaster planning activities, especially education and awareness campaigns, warning, and planning for accommodations post-event.
- **Capabilities Could be Enhanced/Updated**—Some county and state plans, such as community plans and drainage plans, have not been updated regularly. Development codes could be improved to better account for hazard risk, such as requiring defensible space in new subdivisions and increasing the design capacity of stormwater systems. Coastal AE zones may be subject to wave action that would cause damage to structures. Current flood damage prevention ordinances in the counties do not include standards that account for this risk. Present building codes and guidelines do not adequately address the impacts of tsunamis on structures, and current tsunami hazard mapping is not appropriate for code enforcement. It should be noted; however, that the State Coastal Zone Management program has identified tsunami mapping in its five-year coastal hazards strategy and initial mapping is underway.
- **Conditions are Changing**—Guidance on effective approaches and time horizons for planning for sea level rise and other climate change considerations are needed. Increases in impervious surfaces due to growth and development are altering historical drainage patterns and amounts. Coastal erosion and beach loss are significant causes of concern and are expected to be exasperated by sea level rise.
- **Pre-Event Planning Could be Improved**—There are a number of planning and administrative activities that can be conducted before a hazard event to reduce post-event recovery times. For example, post-storm debris management is a significant issue on the islands and many counties have not conducted appropriate planning efforts. In addition, redundancy of power supply, especially for critical facilities, is a significant issue of concern.
- **Structures are Vulnerable**—Many structures across the state were constructed before modern building codes were widely adopted and enforced. Mechanisms for bringing these structures into compliance are limited and may be cost prohibitive to owners.
- **Development Pressures Can Increase Risk**—There is continued pressure to convert floodplain compatible uses, such as agricultural lands, to more intensive uses during periods of growth. This pressure may intensify as sea levels rise.

5.4.2 OPPORTUNITIES TO ADDRESS AND LEVERAGE CAPABILITIES

The following are some of the opportunities identified during the update process for the 2023 SHMP and documented in local hazard mitigation plans to address challenges and leverage capabilities:

- **Building Code Effectiveness**—Coordination between the state and counties to adopt building codes within similar timeframes will allow grant applications to become more competitive.
- **Resiliency Efforts Have Gained Momentum**—Community interest and political support for resiliency planning provides an opportunity to engage stakeholders and integrate hazard mitigation into a number of policies and programs.
- **Opportunities for Partnerships are Available**—Forming partnerships with community and non-profit organizations can maximize limited financial resources. Several working groups have formed to determine protocols for data sharing, transfer, and use.
- **Counties are Poised to Capture Funding**—The last round of local hazard planning efforts resulted in risk assessment and modeling efforts that provide enough detail for identification of specific vulnerabilities at

the structure and infrastructure level and support the submission to FEMA grant programs. In addition, the counties have sought and received funding for mitigation activities such as beach warning and tsunami evacuation signage (NOAA, FEMA, and NIST funding).

- **Natural Resources can be Harnessed for Mitigation Goals**—Maintenance, restoration, and management programs can be developed for natural mitigation features, such as coral reefs, wetlands, beaches, and dunes.
- **State Resources and Assistance Support County Efforts**—The state provides technical resources and programs that support the counties in their hazard mitigation activities, including assistance in applying for grant funding opportunities.
- **Coordination with DLNR on the HHPD Program**— Additional coordination between local jurisdiction and DLNR will help effectively implement the HHPD program. Each county has unique needs that may need to be addressed by developing local capabilities, programs, and policies that align with oversight from DLNR. Implementation of mitigation action 2023-003 will allow HI-EMA, DLNR, and local jurisdictions to coordinate outreach and awareness activities. Implementation of mitigation action 2023-005 will increase state and local understanding of the dam risk and assist with identifying and prioritizing future dam failure mitigation actions.

5.4.3 EMERGING LOCAL CAPABILITIES

Appendix C (Capability Assessment Supplement) provides a detailed record of state mitigation capabilities, including those that have emerged over the past five years. The following section (Emerging Local Capabilities) discusses progress on addressing the challenges in the years since the counties' local hazard mitigation plans have been developed. There have been advances in the understanding and development of strategies to address community resilience and climate change. A few emerging capabilities in these areas include:

- **Pre-Disaster Recovery Plan**—At the time of this 2023 SHMP Update, the County of Kauaʻi is starting to build on existing County planning efforts to work with County departments, external stakeholders, and community members in vulnerable and underserved communities to plan for expedited recovery after a catastrophic natural disaster.
- **Resiliency Work in the City and County of Honolulu**—In May 2016, the City and County of Honolulu was selected as a member of the 100 Resilient Cities Network. The City & County of Honolulu Office of Climate Change and Resilience was established in the City Charter in 2017, increasing institutional capacity for coordinating actions and policies to improve community resilience to climate change and sea level rise impacts and integrating sustainable and environmental values into City plans, programs, and policies.
- **Resiliency Work in the County of Maui**—The County of Maui established an Office of Climate Change, Resiliency, and Sustainability in 2022 to increase capacity including through the ongoing development of a Climate Action and Resiliency Plan and Resilient Housing Guide.
- **Climate Action Resiliency Plan in the County of Maui**—This is the first climate action plan for Maui County and includes 22 resilience strategies and 84 supporting actions to prepare for, and strengthen resilience to, potential climate threats.
- **County of Maui Beach Parks Vulnerability and Adaptation Study**—In 2020, the County of Maui Department of Parks and Recreation initiated a project to assess the vulnerability of its beach parks to a

variety of coastal threats and to prepare adaptation strategies. It includes an adaptation and mapping tool built on the County's GIS platform.

These capabilities and others identified during the course of the 2023 SHMP Update performance period will be monitored to determine their effectiveness at achieving hazard mitigation goals.

5.5 STATE PROCESS TO SUPPORT DEVELOPMENT OF LOCAL PLANS, PROJECTS, AND CONTINUED PLANNING

The State of Hawaiʻi recognizes that reducing the impact of hazards occurs at many levels in many categories, and therefore needs to involve multiple sectors, organizations, government agencies, and communities in mitigation. HI-EMA is the state agency responsible for mitigation throughout the state. HI-EMA works closely with the State Hazard Mitigation Forum, which includes participants from state and county agencies with mitigation responsibilities and public and private interests and serves an important role in local mitigation plan monitoring.

Element S14 and 44 CFR § 201.3(c)(5) and 201.4(c)(4)(i): The state plan must include a discussion of the process to support the development of approvable local government mitigation plans. This includes providing technical assistance, training, and funding. The plan must provide a summary of barriers to developing or updating, adopting, and implementing FEMA-approved local government mitigation plans and steps to remove barriers to help local governments advance mitigation planning.

This section:

- Indicates the current status of County local Hazard Mitigation Plans (local HMPs)
- Evaluates the prior plan's approach to local assistance and coordination
- Describes the state's process for supporting the update of local plans
- Describes the process by which the state reviews, coordinates, and links with local mitigation plans.

5.5.1 COUNTY LOCAL HAZARD MITIGATION PLAN STATUS

The four counties in Hawaiʻi are participating in the hazard mitigation planning program through the development and update of local hazard mitigation plans. Table 5.4-1 lists the status of the local mitigation plans and plan adoption dates.

Table 5-6. Status of the State of Hawaiʻi Local Hazard Mitigation Plans

County	Approval Date	Expiration Date
County of Kauaʻi	04/29/2021	04/28/2026
City and County of Honolulu	02/17/2020	02/16/2025
County of Maui	11/18/2020	11/17/2025
County of Hawaiʻi	9/14/2020	9/13/2025

Note:
Status as of January 1, 2023

5.5.2 EVALUATION OF PRIOR APPROACH TO LOCAL ASSISTANCE AND COORDINATION

In the 2018 SHMP, HI-EMA identified and prioritized the need for the development of a formalized approach to local assistance. The process was structured so that the plan could be the foundation and resource for the next round of local HMPs. In addition, a new mitigation action was identified to ensure effective assistance and coordination moving forward. HI-EMA, in coordination with the State Hazard Mitigation Forum, worked to start developing and documenting standard operating procedures regarding local assistance for supporting the update of local hazard mitigation plans and their implementation, including documentation of the grants management process, application packets for grants management, and procedures for encouraging counties to update local HMPs following major disasters. Some technical assistance and training sessions were completed in 2022, including training for project and grant application development. Lack of Mitigation Staffing and complications from the COVID-19 pandemic prevented full development and implementation of the standard operating procedures. HI-EMA is coordinating with the FEMA Pacific Area Office on delivering additional training in 2023, and the mitigation action is carried over to the 2023 SHMP Update.

5.5.3 STATE SUPPORT FOR THE UPDATE OF LOCAL HAZARD MITIGATION PLANS

HI-EMA is committed to a comprehensive mitigation program that actively supports local mitigation planning by providing technical assistance such as workshops and training for both planning and post-disaster activities. The following sections describe how the State of Hawaiʻi supports the development and update of FEMA-approvable local mitigation plans through planning support, funding opportunity education and outreach, training programs, and technical assistance.

Planning Support and Technical Assistance

HI-EMA provides guidance and technical assistance to counties upon request to support the update of their local HMP through the assistance of state planners, as needed and as resources are available. The SHMO or representative from HI-EMA sends an email notification to the Counties with plans expiring within 24 months of upcoming funding cycles. HI-EMA is committed to the continued funding of local HMPs through its state allocation of Building Resilient Communities and Infrastructure (BRIC) monies. Local plan status is also regularly discussed at State Hazard Mitigation Forum meetings held quarterly. Each of the four County mayors, or their designated official representatives, are members of the State Hazard Mitigation Forum, which allows County officials to stay informed about mitigation planning. The type of technical assistance is flexible; it is based on the particular needs and resources available to the County requesting the assistance.

HI-EMA is committed to this close level of support for County plan development and intends to continue to participate in County plan development over the performance period of the 2023 SHMP Update. HI-EMA also intends to coordinate with FEMA Region 9 mitigation staff to encourage their participation in plan development whenever possible.

As discussed in Section 7 (Plan Maintenance), HI-EMA plans to continue meeting the Forum which includes county representatives on a quarterly basis. These meetings will include discussion topics including the sharing of risk assessment data and mitigation actions across the state and local plans. In addition, this SHMP Update included a robust risk assessment inclusive of not only state-owned and leased assets, but also all buildings statewide. HI-EMA will share this geospatial data with the counties to assist with their future local HMP updates.

Funding Opportunity Outreach and Technical Assistance

HI-EMA is committed to educating its counties on grant availability, grant applications, and managing mitigation funds. When funding opportunities become available, HI-EMA places notifications in local newspapers, notifies appropriate state and county agencies via email and other means, and communicates opportunities through networks via word of mouth. In addition, HI-EMA has provided training in groups and/or one-on-one on benefit-cost analysis (BCA), the E-Grants system, the environmental and historic preservation (EHP) review process, the Hazard Mitigation Assistance (HMA) program, and applicant briefings and trainings for the HMGP after declared disasters. Over the performance period of the 2018 SHMP, education related to funding has been focused on the FEMA mitigation grant programs and other programs that provide funds for mitigation activities. Additional information on trainings is provided in the Training Program and Offerings section below.

Training Program and Offerings

HI-EMA administers a standard training and exercise program similar to other states, which includes full-scale and tabletop exercises that follow a National Incident Management System (NIMS) protocol. The Training and Exercise Plan (TEP) establishes training, exercise, and planning priorities for the State of Hawaiʻi. The TEP is updated annually by HI-EMA and is informed by the Training and Exercise Planning Workshop (TEPW), hosted by HI-EMA and attended by stakeholders from all levels of government, non-profit, and private sectors. The TEPW is generally held in the latter half of each year. In general, the exercise program tends to focus on the predominant hazards of concern for the state (e.g., hurricane, tsunami, event-based flood, and volcanic hazards). Given the risk posed to the state by hurricanes, an annual statewide hurricane exercise (Makani Pahili) is conducted. After action reports are developed after each exercise allowing the state and other stakeholders to capture lessons learned on how best to build capabilities.

Table 5-7 outlines the hazard mitigation-related trainings offered over the performance period of the 2018 SHMP. Counties may direct ad hoc requests for trainings not addressed in the TEP to the SHMO, and they will be conducted as time and resources allow. During the performance period of the 2018 SHMP, there have not been any issues with providing trainings that have been requested. Mitigation-related trainings overlap to some extent with trainings offered by the State of Hawaiʻi Homeland Security Office, and between the two agencies, all mitigation-related requested trainings have been addressed. HI-EMA is committed to continue to offer regular trainings to improve County capabilities for hazard mitigation and will coordinate with the counties through their participation in the State Hazard Mitigation Forum over the performance period of the 2023 SHMP Update to ensure responsiveness to ongoing County training needs and emerging training issues.

Table 5-7. HI-EMA Offered Mitigation-Related Trainings during the 2018 SHMP Performance Period

Training	Comment
Benefit-Cost Analysis	Offered though the FEMA to various counties
Environmental and Historic Preservation	Offered though FEMA to the Hawai’i Emergency Management Agency (HI-EMA)
Extreme Tsunami Evacuation Zone	None provided

Training	Comment
FEMA E-74 Reducing the Risks for Nonstructural Earthquake Damage	None provided
FEMA L-320 Hurricane Preparedness for Decision Makers	None provided
FEMA L-705 Fundamentals of Grants Management	None provided
FEMA P-767 Earthquake Mitigation for Hospitals	None provided
HMA Grants	• City and County of Honolulu Board of Water Supply and Honolulu Fire Department • Department of Hawaiian Homelands • County of Hawaiʻi Civil Defense Agency and Department of Water Supply • Kauaʻi Emergency Management Agency • Maui Emergency Management Agency
HURREVAC Training	Offered through the National Hurricane Program, multiple years.
Mitigation Grants Training and Workshop	Offered through FEMA and HI-EMA for various counties
NOAA Storm Surge Modeling (SLOSH)	None provided
Storm Surge Modeling/NOAA National Hurricane Center	None provided
Wind Design Provisions of the Hawaiʻi State Building Code	None provided

Source: HI-EMA

In addition to the trainings provided by the HI-EMA, several other agencies have reported mitigation-related trainings:

- All-Hazards Training and Exercise Program, Department of Health
- Crisis Response Training Program, Department of Geology and Geophysics, UH
- Dam Safety Program Training Events and Materials, Engineering Division, DLNR
- FEMA Certified Training Courses, NDPTC
- NFIP Community Assistance Program, Engineering Division, DLNR
- Ready Set Go! Wildfire Training, HWMO
- Special Management Area Training, CZM Program OPSD
- Teacher Training Workshops, CSAV, UH
- Training and Exercise Support, PDC.

Additional information on these trainings can be found in the detailed tables in Appendix C (Capability Assessment Supplement).

5.5.4 STATE REVIEW, COORDINATION, AND LINKAGE WITH LOCAL PLANS

Element S16 and 44 CFR § 201.3(c)(6), 201.4(c)(2)(ii), 2014.4(c)(3)(iii), and 201.4(c)(4)(ii): The state plan must include a description of the state process and timeframe to review, coordinate, and link local mitigation plans with the state mitigation plan. If the state is unable to consistently submit approvable plans to FEMA or submit adoption resolutions from participating jurisdictions the plan must describe actions planned to improve state and local mitigation planning capabilities. The plan must describe the state's process and timeframe to share risk assessment data and mitigation priorities with local governments.

HI-EMA is committed to building its hazard mitigation program to support a coordinated approach to mitigation within the State of Hawaiʻi. This will occur through coordinated and linked state and county local hazard mitigation plans. The following sections describe the process for County local HMP review and the process to coordinate and link state and county plans, identifies barriers for County local HMP development and suggested solutions, describes the criteria for prioritizing mitigation planning and project grants, and outlines the strategy for continued planning.

Process for County Local HMP Plan Review and Submission to FEMA

As discussed in Section 5.4.3, HI-EMA works closely with the counties to develop and update the County local hazard mitigation plans and is committed to continuing this close working relationship. This commitment includes early and ongoing technical assistance before and during the plan development process. The state is positioned to provide informal reviews as well as a formal review prior to submittal to FEMA. This level of involvement reduces the uncertainty in the plan review process when local plans are submitted to the state for review and ultimately reduces the number of plan revisions required to achieve approval pending adoption notification from FEMA.

The state has not developed any additional planning requirements for local HMPs, so the FEMA Region 9 Plan Review Tool provides the complete set of plan requirements. Typically, plan reviews are conducted by the state in less than 45 days, and HI-EMA will continue to strive for a shorter review period whenever staffing and resources allow. Occasionally, the state and FEMA reviews are conducted concurrently. It is the preference of HI-EMA that concurrent reviews occur whenever feasible to reduce the amount of time that County plans are undergoing review.

There is currently no defined, formalized process for a plan that does not meet all requirements after state review. This process will be documented as part of the operating procedure documentation discussed in Section 5.4.2. At the time of the 2023 SHMP Update, HI-EMA is committed to developing, documenting and implementing an established protocol, including a local HMP update schedule, to work together with the counties in a coordinated manner. HI-EMA envisions that this protocol will involve:

- A memorandum of understanding with defined roles and responsibilities signed at the beginning of a plan update process.
- Formal transmission of the plan to the state for review.
- In the event that there are any requirements determined to have not been met, HI-EMA will formally transmit the plans back to the County with required changes noted.
- When all requirements are met to the satisfaction of HI-EMA, HI-EMA will transmit the local HMP to FEMA Region 9.

The SHMO serves as the lead plan reviewer at the time of this plan update. The counties and FEMA Region 9 will be notified via writing if the lead plan reviewer changes.

Process to Coordinate and Link State and Local Plans

During the performance period of the 2018 SHMP, some coordination and linkage occurred as a result of HI-EMA's participation in local plan updates, the State Hazard Mitigation Forum, and the 2018 SHMP serving as a resource for local plan development. Linkage also occurred during the 2018 SHMP development process through the risk assessment and its methodology. Because the state worked with the four counties in developing their risk and vulnerability assessments for their local HMPs, the counties included the state's critical facilities and lifeline infrastructure in their risk and vulnerability assessments.

The state recognizes the benefits of developing the 2023 SHMP Update and local mitigation plans in a more integrated manner, which ultimately can result in building a more resilient state. The 2018 SHMP Update strives to continue developing a framework upon which local HMPs can build upon their update. HI-EMA has developed the 2023 SHMP Update to be a resource for the development of local HMPs to improve their overall effectiveness. The 2023 SHMP Update coordinates risk assessment and mitigation strategy information as follows:

- Includes an enhanced risk assessment that:
    - Conducted extensive hazard subject matter expert (SME) outreach to ensure best-available data, methodologies, and science were utilized
    - Assessed local vulnerability and conducted local hazard ranking utilizing a holistic approach to prioritize the updated mitigation strategy
- Included enhanced coordination among sectors as part of the planning process to maximize planning efforts and to inspire continued collaboration and implementation beyond the 2023 SHMP Update
- Includes high priority mitigation actions identified at the County level in the state mitigation strategy (see Section 6 [Mitigation Strategy])

The 2023 SHMP Update will serve as a catalyst for all County local HMPs to be updated. HI-EMA envisions that this will allow for wise use of resources and better coordination of risk assessment and mitigation strategies among the counties and with the state. In addition, it is the intention of HI-EMA to continue the annual reviews coordinated with and through the annual mitigation program consultation with FEMA Region 9. During this consultation methods and progress on linking the 2023 SHMP Update and local HMPs will be discussed and evaluated.

Challenges and Opportunities For Local Plan Development

At the time of this plan update, all four counties have adopted and approved local hazard mitigation plans; therefore, no insurmountable challenges or barriers to local plan development have been identified.

If funding resources currently being used for plan updates are no longer available or are significantly delayed, this may be a challenge for local plan development in the future. HI-EMA is committed to supporting local plan updates via BRIC grant support as long as these funds remain available. The 2018 SHMP stated that it was HI-EMA's goal to align all four County plans on the same planning cycle. However, due to persistent staffing shortages and the overlap of subject matter experts and stakeholders involved in both state and county HMP updates, aligning planning cycles is no longer HI-EMA's goal.

Criteria for Prioritizing Planning and Project Grants

Element S15, HHPD7, and 44 CFR § 201.4(c)(4)(iii): The state plan must include criteria for prioritizing jurisdictions to receive planning and project grants under available federal and non-federal programs. A principal criterion for prioritizing grants will be the degree to which benefits are maximized. Areas of coordination should include communities at the highest risk with the highest vulnerability, including underserved communities and socially vulnerable populations; high-risk properties, including repetitive loss and severe repetitive loss; areas under intense development pressures; and areas that may experience increasingly severe impacts from climate change. If the state is interested in HHPD funding, the plan must describe criteria for prioritizing funding for high hazard potential dams.

HI-EMA administers the state's hazard mitigation program; however, hazard mitigation is a shared responsibility between state agencies; County governments; private companies; and non-governmental groups and organizations within the State of Hawaiʻi, including local residents. Recognizing this, the State of Hawaiʻi has formed the Forum Forum with representatives from a broad spectrum of state and county agencies and the non-governmental sector, which serves as an advisory body to HI-EMA on mitigation matters. Two of the most important roles of the Forum are to assist in the development of the SHMP and to make mitigation project recommendations to the HI-EMA Director. The HI-EMA Director makes the ultimate determination on which projects will be submitted for grant funding consideration.

The Hawaiʻi State Hazard Mitigation Forum reviews, ranks, and prioritizes project proposals submitted by the state and its counties for FEMA grant funding programs. The ranking criteria evolved over the performance period of the 2018 SHMP and varied with each grant program. HI-EMA recognized the need to provide a consistent ranking methodology that would be easily accessible to those who reviewed and ranked the project proposals and to the subapplicants who submitted them. The updated funding prioritization method includes a baseline evaluation and scoring for all subapplications, and additional criteria and associated scoring depending upon the HMA program being applied. A summary of the criteria and scoring are presented in Table 5-8 below and outlined in further detail in Appendix C (Capability Assessment).The consistent ranking criteria that will be used for project prioritization during the performance period of the 2023 SHMP. HI-EMA looks forward to working with the Forum to implement the criteria and to formalize the process to best meet the needs of the state and its subapplicants.

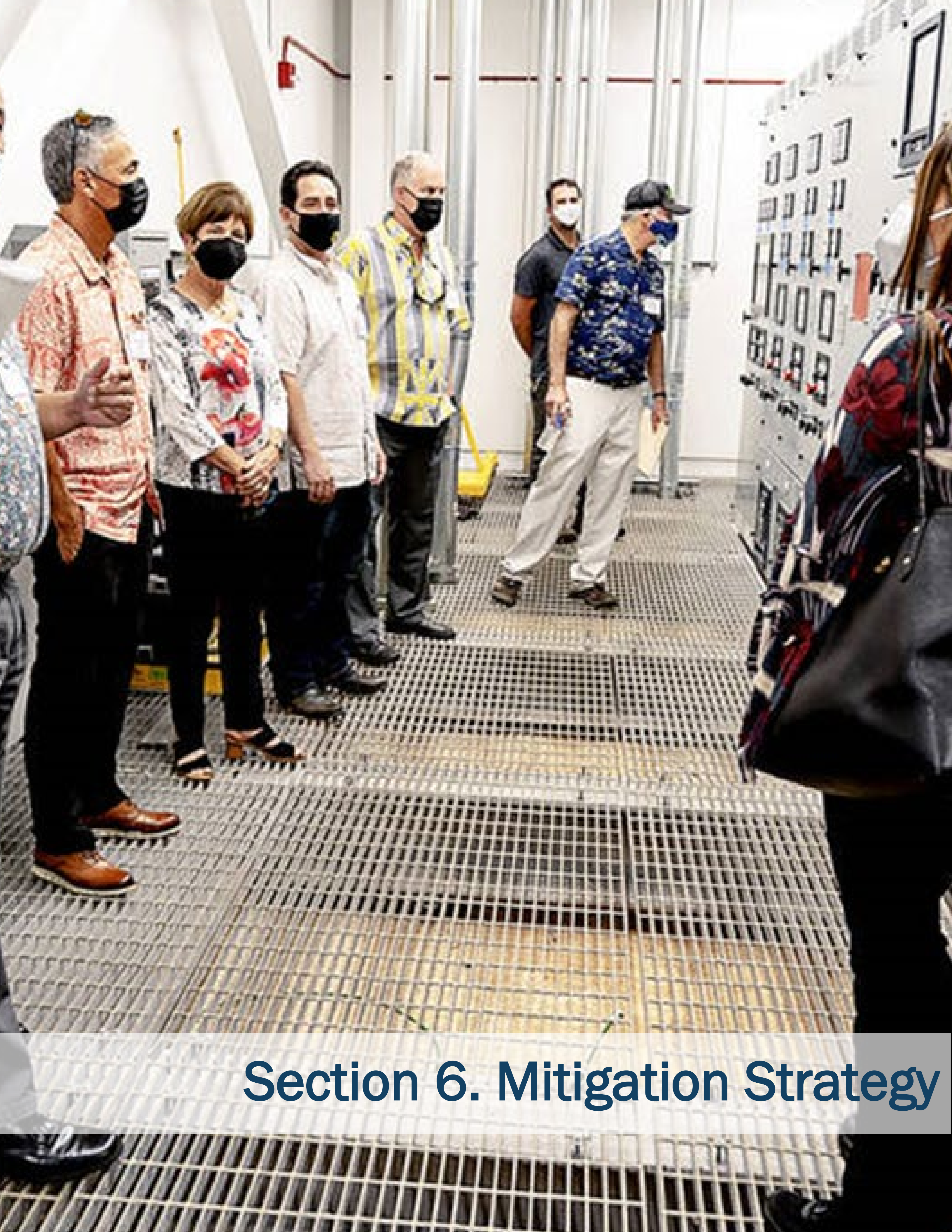
Table 5-8. Summary of Total Potential Scores and Criteria

<table>
<tr><th></th><th>BRIC</th><th>HMGP</th><th>FMA</th><th>HHPD</th></tr>
<tr><td>Base Score</td><td colspan="4">• Capacity to implement
• Alignment with SHMP objectives
• Socially vulnerable population impacted
• Climate change and future conditions
• Community engagement and outreach
• Nature-based solutions
• Advanced assistance
100 points</td></tr>
<tr><td>Additional Scoring</td><td>• Risk reduction/ resilience effectiveness
• Community engagement and outreach
• Leveraging partners
20 points</td><td>• Project area benefitting a disaster-impacted region
• Previous submittal
15 points</td><td>• Repetitive loss properties
10 points</td><td>• Project benefitting area
○ Residential homes
○ Community Lifelines
○ Economic Centers
25 points</td></tr>
</table>

	BRIC	HMGP	FMA	HHPD
Total Potential Score	***120*** *points*	***115*** *points*	***110*** *points*	***125*** *points*

Strategy for Continued Planning

HI-EMA has reviewed and conducted a comprehensive evaluation of the state's hazard mitigation program and has identified opportunities for a number of enhancements, which have been included as actions in the mitigation strategy (see Section 6 [Mitigation Strategy]) and included in the plan implementation and maintenance strategy (see Section 7 [Plan Maintenance]). HI-EMA, with the help of the Forum, will continue to refine and enhance the program to best meet the needs of the State of Hawaiʻi over the performance period of the 2023 SHMP Update.



Section 6. Mitigation Strategy

CONTENTS

TABLES

[1] *Section Cover Photo: Emergency generators installed at Wilcox Medical Center, Kauaʻi. Photo by Dennis Fujimoto/The Garden Island*

SECTION 6. MITIGATION STRATEGY

2023 SHMP Update Changes

- The mitigation goals were reviewed and validated. Overall, all 2018 SHMP goals were maintained with enhancements to strengthen the wording, and one new goal (goal 7) was added.
- Mitigation objectives were added to support the goals and measure mitigation success.
- A comprehensive review and evaluation of the 2018 SHMP mitigation action plan was conducted, and a synopsis of notable achievements was developed.
- The 2018 SHMP mitigation actions, updated risk assessment, updated capability assessment, local HMP actions, and stakeholder input were used to identify mitigation actions for the 2023 SHMP Update.
- The updated action plan only includes projects that state agencies have the authority to implement. Actions that individual counties have the authority to implement will be included in their respective local HMPs.
- The State Repetitive Loss Strategy has been comprehensively reviewed and updated.

6.1 OVERVIEW

The mitigation strategy sets the state's mitigation program priorities and helps guide the counties as they update their plans. The mitigation strategy is composed of goals, objectives, and actions that directly address the risks and vulnerabilities identified in the risk assessment as well as the findings of the capability assessment. The following sections outline the state's mitigation goals and objectives; reviews, evaluates, and updates the mitigation actions identified in the 2018 SHMP; identifies new actions; and prioritizes all actions for implementation over the performance period of the 2023 SHMP Update.

6.2 MITIGATION GOALS AND OBJECTIVES

Element S9, HHPD3, and 44 § CFR 201.4(c)(3)(i): The state plan must include goals to reduce long-term vulnerabilities from the identified hazards. The goals represent what the state seeks to accomplish through mitigation plan implementation using a wide range of funding, including non-FEMA funding. The goals must be consistent with the hazards and vulnerabilities identified in the risk assessment.

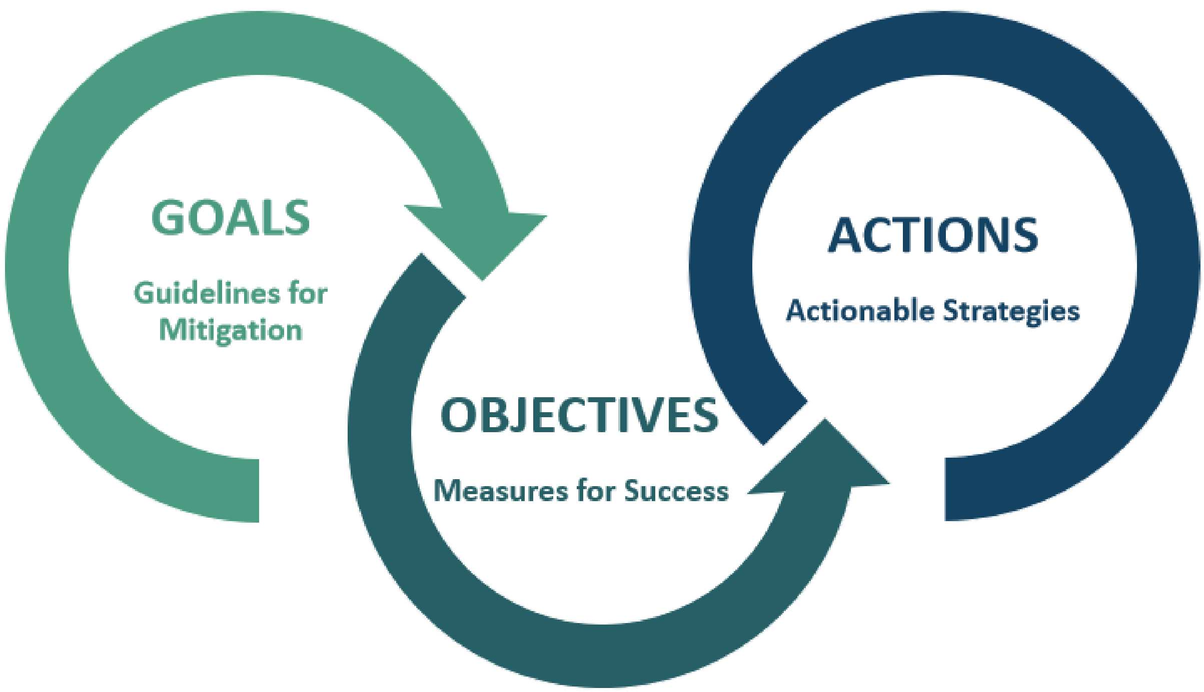
Key Term

Mitigation Goals are broad, long-term policy and vision statements that explain what will be achieved by implementing the mitigation actions.

Mitigation Objectives are defined, short-term measurable actions that lead to achieving an overall goal.

As part of the 2023 SHMP Update process, the 2018 SHMP goals (listed in Appendix G [Mitigation Strategy Supplement]) were reviewed, updated, and validated (see Figure 6-1). Objectives were developed for the 2023 SHMP to meet multiple goals and align with objectives already established in County HMPs; objectives were reviewed to verify that they could be used as measures for success for implementing actions in the updated 2023 mitigation plan.

Figure 6-1. Goal Setting



The goal review and objective development was led by HI-EMA with input from the Forum and was conducted over the course of the planning process. This linear approach to goal setting provides greater detail to identify what the state aims to achieve over the next five years.

At the October 2022 Forum meeting, the 2018 SHMP goals were reviewed and discussed to determine if the goals: (1) led to mitigation projects and changes in policy that reduced risk over the performance period of the 2018 SHMP; and (2) continue to articulate the long-term vision for mitigation activities in the state addressing both current and future vulnerabilities. Based on these discussions, modifications were made to the wording of goals to more closely align with the state's updated vision; two of the 2018 SHMP goals were revised; and a new goal was added (please see Appendix A [Planning Process Documentation] and Appendix G [Mitigation Strategy Supplement] to review the 2018 SHMP goals and modifications that were made).

Throughout the planning process, HI-EMA, the Forum, and state agency stakeholders reviewed the goals to ensure that the goals: (1) reflected the updated risk assessment; (2) supported changes in mitigation capabilities; and (3) supported other state-level priorities. Upon this review HI-EMA and the Forum confirmed the goals for the 2023 SHMP Update as follows:

- **Goal 1**—Reduce the long-term vulnerability of Hawaii's people, property and jurisdictions, including state-owned or operated buildings, infrastructure and critical facilities, to natural hazards while conserving the state's natural, historical, and cultural assets. This includes High Hazard Potential Dams and high-risk properties such as repetitive loss (RL) and severe repetitive loss (SRL) properties.
- **Goal 2**—Promote actions designed to ensure long-term resiliency to natural hazards and climate change impacts.
- **Goal 3**—Strengthen partnerships and leverage existing resources and capabilities to identify, assess and reduce the impact of natural hazards.
- **Goal 4**—Utilize state-of-the-art methods and technology and local knowledge to identify and analyze natural hazards and assess state capabilities to reduce the impact of those hazards.
- **Goal 5**—Promote public awareness of natural hazard risks and public action to reduce the long-term risks.
- **Goal 6**—Provide a framework for robust local hazard mitigation planning and mitigation strategy implementation in alignment with this plan.
- **Goal 7**—Build capacity and capabilities to increase disaster resiliency among historically underserved populations, individuals with access and functional needs, and in communities disproportionately impacted by disasters and climate change.

Objectives were identified and reviewed for their ability lead to achieving an overall goal. HI-EMA and the Forum confirmed the objectives for the 2023 SHMP Update as follows:

- **Objective 1**—Establish and maintain public-private partnerships among all levels of government, community groups, the private sector, and institutions of higher learning to improve and implement methods to protect life, property, and the environment.
- **Objective 2**—Utilize the best available data, science, and technology to identify and communicate the risk exposure to hazards, climate change risks, and vulnerabilities to inform risk reduction measures, preparedness response, and adaptation strategies.
- **Objective 3**—Improve the understanding of the locations, potential and cascading impacts, and linkages among the threats, hazards, vulnerabilities, and measures needed to protect life, community lifelines, the environment, property, and infrastructure.
- **Objective 4**—Promote, coordinate, and implement hazard mitigation planning and projects to reduce the negative impacts of hazards, to foster and reinforce resilient communities, and to be consistent with longer-term climate action and adaptation.
- **Objective 5**—Foster a comprehensive, statewide, whole community approach to hazard mitigation with equitable and inclusive engagements, plans, strategies, and actions that minimize disproportionate

impacts on underserved populations and historically marginalized communities. Prioritize efforts to improve resilience of community lifelines in socially vulnerable communities.

- **Objective 6**—Identify and encourage the use of statewide recommended criteria to develop and inform a shared data repository to integrate into state, local, and non-governmental plans, strategies, and actions.
- **Objective 7**—Develop and implement mitigation policies, protocols, programs, and procedures to address the state's changing environment and climate.
- **Objective 8**—Incentivize and implement mitigation measures into the built environment, especially in areas with substantial hazard risk and those known to have repetitive loss.
- **Objective 9**—Promote and implement the retrofit, hardening, acquisition or replacement of at-risk structures and lifelines to increase community resilience.
- **Objective 10**—Adopt and enforce building codes and standards that are affordable and feasible for life and property protection.
- **Objective 11**—Annually review the effectiveness of current land use related plans, codes, and standards for appropriate future development within hazard areas, and amend them as necessary to account for climate change effects.
- **Objective 12**—Minimize impacts of hazard incidents on the economic drivers for the state.
- **Objective 13**—Recognize and support the disaster resilience inherent in host culture traditions and practices, including holistic watershed management, community connectivity, and local, ahupuaʻa based decision-making.
- **Objective 14**—Support hazard mitigation measures that promote and enhance natural infrastructure and natural processes to minimize adverse impacts on the ecosystem and minimize public safety risks.
- **Objective 15**—Improve warning and emergency communication systems and utilize a diversity of communication media.

Using a consistent set of goals and objectives reinforces the plan integration process. The 2023 SHMP Update contains an updated set of goals, entirely new objectives based on applicable objectives contained in local HMPs, and revised strategies that can be incorporated into local hazard mitigation planning. When reviewing and evaluating local HMPs, state reviewers can ensure that local goals, objectives, and strategies are consistent with those of the state, and that local concerns are reflected in the overall state goals, objectives, and strategies. Consistent goals and objectives can lead to consistent mitigation strategies at both the state and local level.

Mitigation actions were selected and prioritized to move the state and its counties closer to achieving these goals and objectives over the performance period of the 2023 SHMP Update. Actions that were selected are discussed in Section 6.4 (Updated Mitigation Actions).

6.3 REVIEW AND EVALUATION OF 2018 SHMP MITIGATION ACTIONS

Element S12 and 44 § CFR 201.4(d): The state plan must reflect progress in statewide mitigation efforts and changes in priorities by providing a narrative of the status of each mitigation action in the previous plan identifying which actions have been completed and describing if an action is no longer relevant or included in the updated plan. The prioritization of mitigation actions and activities must be updated based on the updated analysis of risks, capabilities, and progress.

6.3.1 COMPREHENSIVE REVIEW AND EVALUATION OF THE 2018 SHMP MITIGATION ACTIONS

The 2023 SHMP Update included a comprehensive review of the 124 mitigation actions identified in the 2018 SHMP. This review was led by HI-EMA and involved a wide array of state and county agencies and other stakeholders. Progress on each identified mitigation action was reviewed to determine the status of each action, the source of funding used to implement the completed actions, and, for those actions that were not completed, if the action should be carried forward to the 2023 SHMP Update or discontinued. Actions that were identified for inclusion in the updated mitigation strategy were reviewed and evaluated to determine if the action should be revised to reflect any new information obtained as part of the plan update process (for example, changes in the risk assessment, capabilities, or lead agency).

The following is a summary of the progress in mitigation efforts over the performance period of the 2018 SHMP:

- 17 actions (14% of total actions) were completed.
- 63 actions (51% of total actions) were initiated but were not completed.
- 6 actions (5% of total actions) were determined to be ongoing activities and/or capabilities integrated into standard operations.
- 24 actions (19% of total actions) were not initiated or had no reported progress.
- 13 actions (10% of the total actions) were discontinued for many reasons, including changes in priorities or the action is no longer under the state's authority.

The 124 actions in the 2018 SHMP mitigation strategy included 34 actions that were considered high priority in County HMPs. The 2023 SHMP mitigation action plan no longer includes high priority actions also identified in the local HMPs; however, the counties were given an opportunity through participation on the Forum and invitation to the stakeholder workshops to identify mitigation activities to reduce risk in their jurisdiction. Regarding actions that are under the state's authority, 68 actions were reviewed and revised for inclusion in the 2023 SHMP Update mitigation strategy.

The comprehensive review and evaluation of the 2018 SHMP actions can be found in Appendix G (Mitigation Strategy Supplement).

6.4 UPDATED MITIGATION ACTIONS

Element S10, FMAG2, HHPD4, and 44 CFR 201.4(c)(1), 201.4(c)(3)(i), 201.4(c)(4)(ii), and 204.51(d)(2): The state plan must prioritize mitigation actions to reduce vulnerabilities identified in the risk assessment to reduce the vulnerability of jurisdictions within the state as well as the vulnerability of state-owned assets. The plan must describe the process to evaluate and prioritize actions that are cost-effective, environmentally sound, and technically feasible. Actions must contribute to goals and the state must describe how local government mitigation strategies link to the state mitigation strategy.

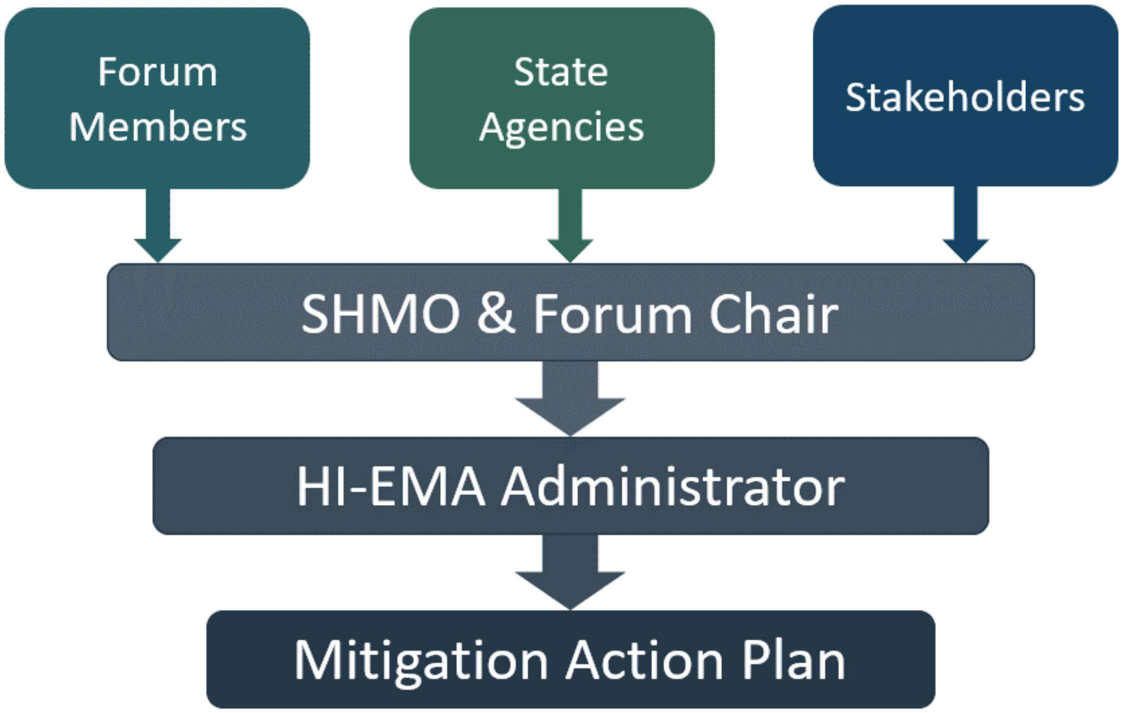
6.4.1 IDENTIFICATION OF MITIGATION ACTIONS

Mitigation actions for inclusion in the 2023 SHMP Update were identified through four primary sources:

- **2018 SHMP Mitigation Strategy**—Actions that were not completed during the 2018 SHMP were reviewed, revised, and included as described in Section 6.3.
- **Risk Assessment**—The results of the updated risk assessment were reviewed with the Forum and individual sector groups, and problem statements were developed. Mitigation actions were added after comparing the updated risk analysis with a focus on actions that would address high and medium ranked hazards and reduce the vulnerability of state assets.
- **Capability Assessment**—Challenges and opportunities identified during the capability assessment were reviewed with the Forum and individual sector groups. Mitigation actions were added to address challenges, capture opportunities, and enhance ongoing progress in capability development.
- **County Actions**—County local HMPs were reviewed to understand community vulnerabilities and priorities and to identify opportunities for the state to develop actions to support its Counties in their mitigation efforts.

Individual state agencies submitted actions that had been approved within their departments. Members of the Forum were given opportunities to submit mitigation actions throughout the planning process. County representatives on the Forum were encouraged to propose mitigation actions that would align local and state mitigation strategies. The February 2022 workshop participants, including numerous stakeholders, had the opportunity to identify mitigation actions. Actions were reviewed by the SHMO and the Forum Chair before being submitted to the HI-EMA Administrator (Figure 6-2). Additionally, actions that were included in local HMPs, but that focused on state assets, were considered for inclusion. Not all potential actions identified from the above sources were ultimately selected for the 2023 SHMP Update mitigation strategy. Those actions that were selected are described in the following sections.

Figure 6-2. Mitigation Action Plan Input



6.4.2 STATE MITIGATION ACTION PLAN

Implementable mitigation actions require more than just a statement of activity as actions are led by different departments and agencies, require various levels of effort, and have varied resource needs. The State of Hawaiʻi Mitigation Action Plan (see Table 6-1) includes information on implementation including:

- **Mitigation Action Title and Numbering**—The action plan assigns a numeric identifier to each action for tracking and progress reporting. Actions with a “2023” prefix are new actions identified for this SHMP update. Actions with a ”2023-2020”, “2023-2018” or “2023-2013” prefix are actions carried over from their respective mid-cycle or complete action plan updates.
- **Problem Statement**—The problem statement provides context as to why the action is needed. The problem connects the risk assessment, capability assessment, or both to the mitigation action.
- **Responsible Departments or Agencies**—The lead department or agency responsible for implementation is listed first, followed by any supporting departments or agencies.
- **Location**—The action plan lists the islands where the mitigation action will be implemented.
- **Existing or Future Development**—The action plan identifies whether each action will reduce risk to new assets as they are built, existing assets (i.e., retrofits), or both.
- **Community Lifelines Addressed**—The action plan lists which of the seven FEMA categories for lifelines each action will protect.
- **Estimated Costs**—The action plan lists estimated costs to implement the action.
- **Potential Funding Sources**—The action plan lists options for funding the action.

- **Timeline**—The action plan provides general project implementation and completion timing as follows:
  - **Short-Term**—The action can be completed within the 5-year performance period for the SHMP.
  - **Long-Term**—The action is likely to take longer than 5 years to complete.
  - **Ongoing**—The action is already funded and being implemented by the state as on ongoing program that does not have a completion date.
- **Hazards Addressed**—A list of hazards addressed by each mitigation action is contained in Appendix G (Mitigation Strategy Supplement).

Table 6-1. 2023 SHMP Update State of Hawaiʻi Mitigation Action Plan

Responsible Departments or Agencies	Location	Existing or Future Development	Community Lifelines Addressed	Estimated Costs	Potential Funding Sources	Timeline
2023-001— Lualualei Navy lands drainage improvements **Problem:** Contaminated soils on Navy lands can impair downstream water quality when flooding and runoff occur. **Action:** The DOH and the watershed coordinator will work with the Navy to identify depressions or relatively flat areas along stream channels to construct small detention ponds and/or check dams to reduce peak flood flows. These are easier to construct than a full sediment basin and will help reduce some of the sediment load and peak flows, potentially reducing flooding downstream. (Originally included in the City and County of Honolulu HMP)						
DOH	Oʻahu	Existing	All	>$100,000	State budgets; U.S. Navy; FEMA; USGS; NRCS	Long
2023-002— Micro grids for critical health infrastructure support **Problem:** Medical facilities such as hospitals and dialysis centers are community lifelines that need to remain in operation to provide critical services to health-vulnerable populations. There is no current backup power system in place to ensure their continuity of services if the primary power grid goes down. **Action:** Install micro grids to support medical facilities such as hospitals and dialysis centers in the event that the island's primary power grid goes down. (Originally included in the City and County of Honolulu HMP)						
DOH	Oʻahu	Existing	Health and Medical	>$100,000	State budgets; FEMA; BRIC; HMGP	Long
2023-003—High-hazard potential dam awareness program **Problem:** In recent years, public awareness programs have included general outreach on all dams in the state, or dams that have been damaged by severe storm events. A targeted campaign to provide awareness about all high hazard dams in the state is needed to inform the entire community of potential risks from dams that present the highest hazard potential. **Action:** HI-EMA will coordinate with the DLNR Engineering Division to expand the dam failure hazard awareness program to include all high-hazard potential dam risk areas.						
HI-EMA, DLNR	Statewide	Both	All	$10,000 to $100,000	State budgets	Ongoing

Responsible Departments or Agencies	Location	Existing or Future Development	Community Lifelines Addressed	Estimated Costs	Potential Funding Sources	Timeline
2023-004— Economic recovery and resiliency planning **Problem:** Hawaiʻi does not have an economic development district planning organization. Economic development districts are multi-county entities tasked to help lead and coordinate locally developed and regionally driven economic development to ensure the region's economic resilience and prosperity. **Action:** 1. Create and economic development district planning organization to unite stakeholders to support the diversification and self-sufficiency of Hawaii's economy and long-term economic resilience 2. Coordinate the integration of economic resilience in resilience hub planning and programing. 3. Interagency coordination of the analysis of short- and long-term economic impacts of known hazards and other shocks to Hawaii's people and businesses to inform documents such as the THIRA and Hazards and Vulnerabilities Overview. 4. Develop an economic recovery operations plan to align with the economic recovery support function. This document should detail how government will stand up economic recovery operations following a disaster or external shock. The document should be designed to prevent duplication of effort, gaps in recovery operations, and improve coordination between government agencies. 5. Develop the Hawaii Economic Recovery and Resilience Plan to address the economic vulnerabilities and hardships revealed during the pandemic particularly for socially vulnerable communities and businesses. The plan should identify the macro-economic vulnerabilities revealed during the pandemic. The plan should identify gaps in services, institutional vulnerabilities, actionable projects, and connect implementing organizations with funding sources. 6. Develop community/regional action plans to address the needs of specific audiences not currently represented in economic recovery/resiliency planning. 7. Update the 2014 Natural Disaster Economic Recovery Strategy (NDERS) to reflect changes in goals, objectives, and implementation strategies. 8. Develop an action planning process to mobilize implementation partners for the NDERS.						
OPSD	Statewide	Both	All	>$100,000	State budgets; EDA grants	Ongoing
2023-005— Develop a model to estimate probable maximum precipitation (PMP) using a high-resolution numerical weather model **Problem:** The potential impacts from severe rainfall events, triggered by climate change, are difficult to determine without proper modeling. Without accurate modeling, infrastructure rehabilitation and design may not withstand future severe precipitation events. **Action:** PMP is used by hydrologists, meteorologists, civil and environmental engineers, policy makers and decision makers in the design and rehabilitation of critical infrastructure (dams, spillways, bridges, and others) to prevent failure from inundation or overtopping from torrential rainstorms. Reliable PMP data is essential to keep the community safe. Climate change projections will be incorporated in the analysis. The model will focus on socially vulnerable areas (Puna District), parts of the state where flooding is common (North Shore Kauai), and watersheds where dams are located.						
SOEST	Kauaʻi and Hawaiʻi Counties	Both	All	>$100,000	HHPD, State budgets	Short
2023-006— Create rain gardens to reduce flooding **Problem:** Flooding and increased runoff is experienced frequently. Small-scale, individual property-specific actions are needed to contribute to the reduction in flooding. **Action:** Implement community projects such as rain gardens to reduce the volume of stormwater that enters the larger stormwater management system by increasing infiltration of run-off into the ground during rain events.						
Climate Change Mitigation and Adaptation Commission	Statewide	Both	All	$10,000 to $100,000	State budgets, FMA	Ongoing

Responsible Departments or Agencies	Location	Existing or Future Development	Community Lifelines Addressed	Estimated Costs	Potential Funding Sources	Timeline
2023-007— Increase urban forestry **Problem:** Extreme heat events triggered by climate change are impacting urban communities. Trees and vegetation lower surface air temperatures by providing shade and through evapotranspiration. The urban heat island effect will lessen if trees are planted and maintained in urban areas. **Action:** Increase tree planting efforts in urban communities, including Honolulu and surrounding areas, Līhuʻe, Kahului, Kona, and Hilo. to offset impacts of climate change						
Climate Change Mitigation and Adaptation Commission	Statewide	Both	All	>$100,000	State budgets	Ongoing
2023-008— Wetland restoration **Problem:** Natural wetlands have been negatively impacted by development and mismanagement. **Action:** Restore wetlands that act as sponges that ameliorate droughts by storing water and releasing it to maintain river flows long after the rains cease, and they protect against floods. Targeted wetlands throughout the state will be included.						
Climate Change Mitigation and Adaptation Commission	Statewide	Both	All	>$100,000	State budgets, HMGP, FMA, Forest Stewardship Program	Ongoing
2023-009— Coral reef restoration for flood risk reduction supporting Hawaiʻi State Legislature Senate Resolution 35 designating Hawaii's coral reefs as critical natural infrastructure **Problem:** Coral reefs are vulnerable to high wave action, pollution, and marine heat events. **Action:** Emergency/short term coral reef restoration actions for emergency hazard mitigation includes: • Reattachment of corals of opportunity on reef hardened structure to priority regions impacted by hazard • Out planting of nursery-grown corals to priority regions impacted by hazard • Removal of debris and sedimentation in priority regions impacted by hazard Coral reef restoration actions for long-term hazard mitigation include: • Translocation of corals of opportunity to priority reefs • Out planting of nursery-grown corals to priority reefs						
HI-EMA	Statewide	Both	All	>$100,000	State budgets, BRIC, FMA	Long
2023-010— Hazard mitigation plan StoryMap outreach **Problem:** Increased and continued public outreach is a critical component to hazard mitigation. A visual, interactive online solution to promote hazard awareness has been initiated but needs to be maintained and updated to remain a critical resources for residents to learn more about hazards in their community. **Action:** Update existing or develop new state and county hazard mitigation StoryMaps to promote hazard awareness, education, and mitigation initiatives.						
HI-EMA and Counties	Statewide	Both	All	$10,000 to $100,000	State budgets	Ongoing

Responsible Departments or Agencies	Location	Existing or Future Development	Community Lifelines Addressed	Estimated Costs	Potential Funding Sources	Timeline
2023-011— Residential Wind Retrofit Program **Problem:** The purpose of this residential wind/structural retrofit project is to reduce the vulnerability of and damage to homes from wind, and wind driven rain intrusion during a high-wind event such as hurricane winds up to 129 MPH. **Action:** HI-EMA in partnership with state department/agencies, county governments and other Non-Government Organizations (NGO) will implement a program to retrofit and strengthen qualified residential homes that will withstand the wind effects of a Category 3 Hurricane. HI-EMA submitted a HMGP application on 2/3/2023, re: State of Hawaii Residential Retrofit Program. FEMA is in the process of reviewing the application and we should hear back (approved or not approved for funding) later in 2023. While the application is being reviewed, we are working with partners to understand the construction requirements, permitting requirements, site selections, applicant's selection, assessment details, et al.						
HI-EMA	Statewide	Existing	Food, Water, Shelter	>$100,000	State budgets; BRIC; HMGP	Ongoing
2023-012— Support the development of a social vulnerability mapping tool that will accurately reflect the unique characteristics of the state **Problem:** Existing social vulnerability datasets developed on the national level do not represent the actual social vulnerability of the communities in Hawaiʻi. **Action:** Through interagency coordination lead by OPSD, state, county, and non-governmental organizations will collaborate to develop a tool that can be used across multi-discipline planning efforts to increase understanding of the location of vulnerable populations that will allow plans and grant funding opportunities to address their needs.						
OPSD	Statewide	Existing	All	>$100,000	State budgets; FEMA; BRIC; HMGP	Short
2023-013— Vulnerable Population Outreach **Problem:** Socially vulnerable communities have a disproportionate risk to sea level rise and coastal erosion hazards. **Action:** Further understand communities' needs to adapt to sea level rise and its associated hazards. Conduct a survey and interviews within identified vulnerable communities to allow for initial community input and give individuals the opportunity to define their needs.						
OPSD	Statewide	Existing	All	$10,000 to $100,000	State budgets; FEMA; BRIC; HMGP	Ongoing
2023-014— Managed retreat analysis and recommendations **Problem:** Managed retreat is a potential mitigation action to be considered to mitigate the impacts of flood and sea level rise; however, managed retreat concepts are fraught with legal, financial, and planning obstacles. **Action:** Provide an analysis of ways to achieve managed retreat in Hawaiʻi that will include 1. An analysis of relevant existing policies, laws, and regulations 2. An analysis of potential strategies to implement and finance managed retreat 3. Identification of challenges to implementation including practical and legal issues 4. Potential solutions to address those challenges. The desired outcomes include recommendations of amendments and/or new policies to facilitate the option of managed retreat, and recommendations of the most promising funding and financing strategies to support the implementation of a managed retreat strategy.						
OPSD	Statewide	Existing	All	>$100,000	State budgets	Long
2023-015— Develop and maintain a Hawaiʻi Digital Coastal Atlas **Problem:** Plans developed by different agencies do not have a way to coordinate coastal mapping. This results in duplication of efforts or inconsistency among plans. **Action:** This database would serve as a digital repository for the information and data acquired through the process of delineating and characterizing shoreline regions and subregions. The Atlas could also serve as a clearinghouse for a variety of products including guidance documents, studies and other information that would be made publicly accessible. The database may include a web viewer with downloadable GIS data.						
OPSD	Statewide	Existing	All	>$100,000	State budgets; FEMA; BRIC; HMGP	Ongoing

Responsible Departments or Agencies	Location	Existing or Future Development	Community Lifelines Addressed	Estimated Costs	Potential Funding Sources	Timeline
2023-016— Improve cross-agency coordination in coastal management **Problem:** Disparities in the coastal management process exist among local, state, federal agencies and landowners **Action:** 1. Identify current areas of inconsistent legal interpretations and challenges for DHHL beneficiaries when navigating county and state requirements for conducting activities in the shoreline area 2. Identify potential strategies to address these major challenges and inconsistencies. The results of this project will serve as the first step in a larger initiative, which may lead to the program change of proposing amendments to Hawaiʻi Coastal Zone Management Law (Hawaiʻi Revised Statutes (HRS) Chapter 205A) that establish DHHL as an Agency with authority to conduct coastal zone management, and developing MOU's/MOA's between DHHL and the County Planning Departments to outline relationships and workflows.						
OPSD	Statewide	Existing	All	>$100,000	State budgets; FEMA; BRIC; HMGP	Ongoing
2023-017— Vertical evacuation sites for schools **Problem:** Tsunami warnings triggered by a local event such as an earthquake may not allow enough time to evacuate entire schools to an area topographically above the tsunami evacuation zone. The logistics and expense involved in constructing vertical evacuation sites on school property necessitate feasibility studies to be performed first. **Action:** Conduct a study to determine the feasibility of constructing vertical evacuation sites at schools within the tsunami evacuation zones.						
HI-EMA, DOE	Statewide	Existing	Food, Water, Shelter	>$100,000	State budgets; FEMA; BRIC; HMGP	Short
2023-018— Coordinated planning for climate change hazards **Problem:** Plans developed by HI-EMA need to leverage the wealth of knowledge from subject matter experts to provide a better analysis of future conditions. **Action:** Align HI-EMA planning efforts (SHMP, HVO, THIRA) to increase the analysis and discussion of climate change hazards impacting the state including sea level rise, extreme heat, and severe weather.						
HI-EMA	Statewide	Both	All	>$100,000	State budgets	Short
2023-019— Statewide Wildfire Mitigation **Problem:** Devastating impacts from the August 2023 wildfires in Maui and Hawaiʻi Counties **Action:** Reassessment of the Community Wildfire Protection Plans; conduct a statewide re-evaluation of potential mitigation actions to increase resident safety (e.g., defensible space, fire-proof building materials, warning systems, early detection systems) coupled with collaborative public engagement to knowledge share and understand community needs and priorities.						
HI-EMA, DLNR	Statewide	Both	All	>$100,000	FEMA HMGP; BRIC; State budgets	Short/ Long
2023-2020-001—Modernization and hardening of the State Emergency Operations Center **Problem:** The current EOC was built before modern seismic and hurricane standards were adopted. It needs to be moved because it is currently located in a culturally sensitive area. **Action:** Relocate the EOC to a more suitable site where it can be built to meet current construction design standards. 1. Acquire suitable land 2. Acquire funds for design and engineering to include environmental assessment 3. Acquire funding for construction						
HI-EMA	Oʻahu	Existing	Safety and Security; Communications	>$100,000	State budgets; FEMA; BRIC; HMGP; DHS	Long

Responsible Departments or Agencies	Location	Existing or Future Development	Community Lifelines Addressed	Estimated Costs	Potential Funding Sources	Timeline
2023-2020-002—Warning systems and outreach programs						
Problem: Reliable real-time warning systems accompanied by comprehensive and timely public education programs are not widely available statewide.						
Action: High risk areas will be evaluated by subject matter experts to include governmental agencies having statutory responsibility for those activities.						
HI-EMA	All islands	Existing	Communications	>$100,000	State budgets; FEMA; BRIC; HMGP	Short
2023-2020-003—Hardening/retrofit/protection of food and agriculture facilities which involve production, storage, distribution, and research functions						
Problem: Adequate and safe food supply after disasters and emergencies is needed.						
Action: Hardening/retrofit/protection of food and agriculture facilities which involve production, storage, distribution, and research functions will include the following action items: 1. Structural Analysis of priority facilities 2. Acquire funds for design and engineering 3. Acquire funds for construction						
HI-EMA	All islands	Existing	Food, Water, Shelter	>$100,000	State budgets; FEMA; BRIC; HMGP	Short
2023-2020-004—American Red Cross (ARC) Hawai'i Chapter will conduct Disaster Emergency Life Safety Sheltering and Outreach training programs throughout the state						
Problem: Capacity and capability training is needed to increase the number of trained disaster and shelter volunteer responders for the Red Cross Disaster Preparedness & Response program accompanied by educational presentations to help communities better prepare for crises.						
Action: Increase the number of trained volunteers capable of responding and providing emergency support services at public shelter during a disaster.						
HI-EMA	All islands	Both	Food, Water, Shelter	$10,000 to $100,000	State budgets; Red Cross; FEMA; HMGP	Short
2023-2018-001—Conduct non-structural retrofits of schools and hospitals in Hawai'i County and Maui County						
Problem: Schools and hospitals built before current codes are at risk for non-structural damage that would render facilities inoperable even if there was no structural damage.						
Action: Conduct non-structural retrofits of schools and hospitals in Hawai'i County and Maui County. The following steps will be implemented: 1. Assess and prioritize schools and hospitals 2. Prepare work plans 3. Procure funding 4. Implement						
HI-EMA, HETAC, DOE (Schools), HAH (Hospitals)	Hawai'i; Maui	Existing	Safety and Security, Health and Medical	$10,000 to $100,000; >$100,000	State DOE and DOH budgets; FEMA; BRIC; HMGP	Short

<table>
<tr><th>Responsible Departments or Agencies</th><th>Location</th><th>Existing or Future Development</th><th>Community Lifelines Addressed</th><th>Estimated Costs</th><th>Potential Funding Sources</th><th>Timeline</th></tr>
<tr><td colspan="7">2023-2018-002—Feasibility study of multi-hazard, non-structural retrofit of Hawai‘i County and Maui County hospitals and schools
Problem: After the 2006 Kiholo Bay EQ several schools and hospitals were identified as potentially at risk for non-structural damage from earthquakes, hurricanes and flooding, and having limited emergency storage capacity, especially to those with special needs. An assessment is necessary to determine what actions are required to mitigation the potential damage and to provide the information necessary for a complete Hazard Mitigation Assistance application.
Action: Engage FEMA in a Cooperating Technical Partnership (CTP) to acquire technical assistance to assess the Hawai‘i and Maui County hospitals and schools for possible seismic, high wind and flooding non-structural vulnerabilities. The study would prioritize the hospitals and schools, prioritize non-structural actions, develop information for funding applications and develop documentation for benefit-cost analysis.</td></tr>
<tr><td>HI-EMA, HETAC</td><td>Hawai‘i; Lāna‘i; Moloka‘i</td><td>Both</td><td>Safety and Security; Health and Medical</td><td>>$100,000</td><td>FEMA; BRIC; HMGP; NEHRP</td><td>Short</td></tr>
<tr><td colspan="7">2023-2018-004— Increase mitigation capacity across all islands to support reduction in hazard risk
Problem: HI-EMA has been chronically understaffed for several years and as a result has missed several opportunities to advance numerous mitigation opportunities, including project development and implementation, public outreach and education, and technical assistance to county and state partners.
Action: Increase mitigation capacity across all islands to support reduction in hazard risk. The following steps will be implemented.
1. Document current shortfalls in implementing recent mitigation opportunities
2. Prepare justification for additional positions
3. Provide technical assistance to upcoming local mitigation plan updates</td></tr>
<tr><td>HI-EMA</td><td>All islands</td><td>Both</td><td>Safety and Security</td><td>>$100,000</td><td>State funding to DOD HI-EMA</td><td>Long</td></tr>
<tr><td colspan="7">2023-2018-005—Earthquake mitigation training
Problem: Live training is needed for earthquake mitigation design professionals and public officials to increase capacity and capability.
Action: Work with public and private sectors to determine specific training needs and resources to reduce vulnerability from earthquakes.</td></tr>
<tr><td>HETAC, HI-EMA</td><td>All islands</td><td>Both</td><td>All</td><td>>$100,000</td><td>HI-EMA Department Funds</td><td>Short</td></tr>
<tr><td colspan="7">2023-2018-006—Implement actions from Natural Disaster Economic Recovery Strategy (NDERS)
Problem: In 2014 the Hawai‘i Office of Planning, Department of Business, Economic Development & Tourism developed a NDERS for pre-disaster business continuity planning and post-disaster recovery actions for both public and private sector, with a focus on small business. The NDERS culminated in forty-nine recommendations which for the most part remain to be implemented. The NDERS is not being updated regularly.
Action: HI-EMA will re-engage with NDERS staff and assist with the implementation of the following recommendations:
1. Coordinate with the Office of Planning to re-engage with the NDERS stakeholders
2. Review and prioritize recommendations with a focus on implementation
3. Identify strategy “champions” and potential funding sources
4. Provide logistical support to champions and support agencies
5. Schedule regular follow up stakeholder meetings to track progress and identify gaps and solutions</td></tr>
<tr><td>HI-EMA and DBEDT</td><td>All islands</td><td>Both</td><td>Communications</td><td>$10,000 to $100,000</td><td>BRIC, EDA, State Funding</td><td>Short</td></tr>
</table>

Responsible Departments or Agencies	Location	Existing or Future Development	Community Lifelines Addressed	Estimated Costs	Potential Funding Sources	Timeline
2023-2018-007— Enhanced Coordination between HI-EMA and DLNR on Flood Mitigation Projects **Problem:** The State of Hawaiʻi is vulnerable to the flood hazards. Recent events have highlighted the vulnerability as evidenced by disaster declarations due to severe storms, flooding and landslides. Impacts have been to roads, bridges and structures. HI-EMA is committed to reduce the number of repetitive and severe repetitive loss properties in the state as outlined in Section 6 (Mitigation Strategy). **Action:** HI-EMA will continue to work with DLNR to identify flood vulnerability, identify flood mitigation projects and provide technical assistance to secure grant funding to implement the mitigation projects to reduce flood losses in the state. Mitigation measures may include but are not limited to structural projects, plans, studies, outreach, and training.						
HI-EMA and DLNR	All islands	Both	All	<$10,000	Operating Budgets – State Funding; FMA	Ongoing
2023-2018-009—Acquire GIS staff, training, and technology **Problem:** GIS, as a system of components that play a vital role to facilitate the coordination, collection, and dissemination of geographic information. A GIS system is comprised of 5 key components – hardware, software, data, people, and methods. Together GIS can help decision makers: MITIGATE - identify and prioritize threat levels to develop plans for evacuations and containment, PREPARE – inventory and assess assets and capabilities, training and exercises, inform the public, RESPOND - visualize and share real-time situations, dispatch first responders, direct limited resources, and RECOVER – via mapping damaged infrastructure, affected populations, and resources to more efficiently coordinate recovery efforts. Additional GIS capacity and capability is needed. **Action:** 1. Determine GIS needs and requirements for the Resilience Branch 2. Hire GIS staff for Resilience Branch to conduct project tracking and assist with mitigation planning 3. Acquire GIS licenses and equipment						
HI-EMA, Counties	All islands	Both	Communications	$10,000 to $100,000	BRIC, HMGP, cost reduction through State/ESRI (ArcGIS developer) Enterprise Licensing Agreement for software license and instructor-led training	Short
2023-2018-011—Housing Vulnerability Assessment **Problem:** Hawaiʻi has a shortage of shelter spaces for the immediate pre (for hazards with some lead time) and post event needs. The gap can be addressed with a combination of strengthening the existing housing stock through retrofits and building code upgrades and strengthening public buildings to serve as evacuation shelters. **Action:** Conduct a housing stock and social vulnerability assessment for seismic, high wind, and flooding vulnerabilities. The study would prioritize the retrofit actions, including incentives for homeowners to strengthen their residences, and to develop guidance for shelter retrofit guidance consistent with FEMA's grant program guidance.						
HI-EMA, HETAC	All islands	Both	Food, Water, Shelter	>$100,000	BRIC, HMGP, NEHRP	Short

Responsible Departments or Agencies	Location	Existing or Future Development	Community Lifelines Addressed	Estimated Costs	Potential Funding Sources	Timeline
2023-2018-012—Retrofit of the Kauaʻi War Memorial Convention Hall (KWMCH)-emergency shelter **Problem:** Mass care, specifically tropical cyclone evacuation shelters, is a top priority of the County of Kauai. A USACE study estimates that 27% of the population will seek shelter. Presently, there is a significant shortage of shelter spaces in the county. **Action:** Perform a structural analysis to determine suitability of KWMCH to serve as an emergency shelter and to determine scope of work. The retrofit will include hardening of the doors (33) and windows (40) which will serve as a minimum Type B Shelter (category 1 hurricane). This project will add about 1,668 shelter spaces for the County and the heavily populated area of Lihue. This increases by 44% the number of residents/visitors seeking shelters during hurricanes in the central portion of the Island.						
HI-EMA, County of Kauaʻi Department Parks and Recreation	Kauaʻi	Both	Food, Water, Shelter	>$100,000	BRIC, HMGP, State CIP Funds	Short
2023-2018-013—Retrofit of Molokaʻi High School gym-emergency shelter **Problem:** The island of Molokaʻi in the County of Maui presently has no suitable hurricane shelters. This is a life-saving issue. **Action:** This facility involves extensive retrofit of the building envelope, doors, windows, and other hardening measures. A initial engineering structural analysis has been completed, and a secondary SAM (Simulation and Analysis of Mechanisms) will be completed to ensure the retrofits are able to meet the Enhanced Hurricane Protection Areas (EHPA) standard.						
HI-EMA, State DOE, State DAGS	Molokaʻi	Both	Food, Water, Shelter	>$100,000	State CIP Funds, HMGP, BRIC	Short
2023-2018-016—Enhance the State Technical Assistance Program to support state agencies and counties **Problem:** During the period of performance of the 2018 HMP, limited resources were available to provide increased technical assistance on grant program support (notifications, training, application/BCA development) and a linkage between the local plans and the HMP. It is the intention of the HI-EMA to develop a standard operating procedure for state technical assistance program for local county hazard mitigation plans and mitigation activities, implement an annual review coordinated with and through the annual mitigation program consultation with FEMA. **Action:** Enhance HI-EMA's technical assistance program to support state agencies and Counties in all aspects of mitigation. Examples of program expansion and enhancement include: 1. Working with specific state agencies to support obtaining grant funding, such as DHHL, and submit projects for implementation 2. Developing a standard operating procedure for providing counties technical assistance in updating their local hazard mitigation plans and implementing hazard mitigation actions to reduce future losses in the state.						
HI-EMA, Forum	All islands	Not applicable	Safety and Security	$10,000 to $100,000	Operating Budget – State Funds	Short
2023-2018-017—Monitor water resources and conduct drought forecasts and impact assessments **Problem:** Drought is a slow-onset natural hazard. Monitoring and forecasting drought is important for managing this hazard through early mitigation and preparedness actions as well as response actions. **Action:** DLNR-CWRM will monitor water resources and conduct drought forecasts and impact assessments as follows: 1. Continue to and expand monitoring of hydrologic elements (rainfall, stream flow, reservoir water levels, ground water levels) 2. Improve drought forecasting 3. Increase drought research 4. Collaborate with the National Integrated Drought Information System						
DLNR – CWRM	All islands	Not applicable	Food, Water, Shelter	$10,000 to $100,000	Federal (NOAA), State (CWRM, University of Hawaiʻi), County (water departments)	Other

Responsible Departments or Agencies	Location	Existing or Future Development	Community Lifelines Addressed	Estimated Costs	Potential Funding Sources	Timeline
2023-2018-018—Increase water conservation, reuse, and recharge **Problem:** The archipelago state of Hawaii is surrounded by the Pacific Ocean and relies 100% on rainfall for its fresh water supplies. Reduced rainfall due to drought affects Hawaii's fresh water supply. To increase drought resilience, the state must make the most efficient use of available rainfall through water conservation, reuse of storm water and recycled wastewater, and increasing groundwater recharge. **Action:** The following actions are proposed to mitigate drought, and increase water conservation, reuse, and recharge: 1. Implement the Hawaiʻi Water Conservation Plan 2. Incentivize and promote reuse (e.g., grants, rebates, policies, etc.) 3. Protect and restore watersheds important to water supply (e.g., fencing, invasive species removal, replanting, etc.)						
DLNR – CWRM, DLNR – DOFAW, County water and wastewater departments, County planning departments	All islands	Both	Food, Water, Shelter	>$100,000	Federal (Bureau of Reclamation Title XVI program), State (CWRM, DOFAW Watershed Grant), County (water departments, watershed funding), Private grant funding	Other
2023-2018-019—Support the Hawaiʻi Association of Watershed Partnerships **Problem:** Healthy watersheds are key to a resilient and robust water supply. The Hawaii Association of Watershed Partnerships protects and restores watersheds to ensure that water is captured efficiently to replenish and maintain our water supplies, which are especially important during drought periods. **Action:** DLNR-DOFAW will support the Hawaiʻi Association of Watershed Partnerships through the following: 1. Seek dedicated, long-term funding for watershed protection, restoration, and maintenance 2. Support forest stewardship programs						
DLNR - DOFAW	All islands	Not Applicable	Food, Water, Shelter	>$100,000	Federal (USDA Forest Service), State (DOFAW Watershed Grant, general funds), County (water departments), private (Firewise Grant), Private funding	Other
2023-2018-021—Provide drought public education awareness and outreach **Problem:** Communities, sectors and stakeholders impacted by drought may not have the capacity to prepare for and respond to drought. Drought outreach and awareness will help to improve overall preparedness for drought. **Action:** The following public education and awareness are proposed: 1. Continue to promote drought awareness campaigns and public outreach events (e.g., Wildfire & Drought LOOK OUT!; Halawa Xeriscape Garden Open House and Unthirsty Plant Sale, etc.) 2. Seek cooperative outreach & education opportunities with agricultural agencies and organizations to promote drought awareness and conservation actions 3. Encourage water purveyors, businesses, and agricultural producers to develop individual drought plans						
DLNR – CWRM, County water departments, Soil & Water Conservation Districts	All islands	Not Applicable	Food, Water, Shelter	$10,000 to $100,000	Federal (USDA, NOAA), State (CWRM; DOFAW; University of Nebraska – NDMC), County (water departments), Private funding	Other

Responsible Departments or Agencies	Location	Existing or Future Development	Community Lifelines Addressed	Estimated Costs	Potential Funding Sources	Timeline
2023-2018-022—Statewide public information campaign to increase citizen resilience to flooding **Problem:** Property owners with a federally backed mortgage that have structure(s) located inside a Special Flood Hazard Area on FEMA FIRMs are required to have flood insurance. However, many property owners who have paid off their mortgage or are outside these zones are also at risk to flooding but likely have not maintained or have optionally purchased flood insurance. Public awareness and understanding of what insurance policies cover would encourage citizen resilience to flooding. This campaign would explain the three types of insurance homeowners should have: basic for property/fire, hurricane, and flood. For example, hurricane insurance doesn't cover flooding unless flooding occurs from a wind-driven rain. This public information campaign should be conducted annually well before hurricane season starts because there is a standard 30-day waiting period for new applications and for endorsements to increase coverage, with some exceptions. The effectiveness of such a campaign can be measured as a percent of increase in the number of flood insurance policies compared to baseline. **Action:** 1. Work with federal agencies with a role in insurance and state insurance regulator (DCCA) to develop campaign strategy and key messages 2. Develop a public information campaign including public service announcements, fact sheets, and other forms of communication on the types of insurance and the need to purchase flood insurance 3. Measure Change in the number of active flood insurance policies compared to baseline levels (57,941 policies statewide as of October 31, 2022)						
DLNR	All islands	Existing	Food, Water, Shelter	< $10,000	FEMA Mitigation Grants	Ongoing

Responsible Departments or Agencies	Location	Existing or Future Development	Community Lifelines Addressed	Estimated Costs	Potential Funding Sources	Timeline
2023-2018-023—Integrated hazard mitigation of state coastal highways and beaches from chronic coastal flooding **Problem:** Segments of state coastal highways are eroding due to annual high waves and coastal erosion exacerbated by sea level rise. The state is constantly engaged in repairing these segments to protect human safety and transportation. For many communities, coastal highways are the only way into or out of an area. Similarly, 75% of Hawaii's beaches are eroding due to a similar combination of hazards. The landward migration of beaches with sea level rise will be impeded by coastal highways and other structures resulting in the permanent loss of beaches for shoreline protection, recreational and cultural purposes and critical habitat for the Hawaiian monk seal. Some segments of coastal highways cross geological features such as sand deposits and dunes. In these areas, the redesign of coastal highways to enable landward beach migration would provide an opportunity to support multiple hazard mitigation objectives to protect human safety, reduce structure loss, and protect beaches that serve as natural buffer to waves and habitat to wildlife and reef ecosystems. **Action:** 1. Identify coastal highway segments across the state based on vulnerability to coastal hazards exacerbated by sea level rise and geological and physical viability for landward beach migration. (HDOT) 2. Select top five state coastal highway segments, in consultation with county and community stakeholders, to develop coastal highway mitigation alternatives and evaluate feasibility of each alternative. (HDOT) 3. Develop design specifications and implementation plan for the preferred alternative for each coastal highway segment (HDOT) 4. Implement coastal highway-beach mitigation (HDOT) 5. Conduct hazard mitigation utilizing nature-based approaches along coastal roads that are vulnerable to chronic and storm flooding and erosion, where relocation can't be implemented in the near-term, to improve public safety and community resilience and protect public trust resources. (CC) 6. Update coastal hazards modeling and vulnerability assessment as needed based on new climate science, sea level rise projections, and methods. (CC)						
Hawaiʻi DOT Highways Division (HDOT), Hawaiʻi Climate Change Mitigation and Adaptation Commission (CC), DLNR OCCL	All islands	Both	Transportation	>$100,000	FEMA, Federal DOT, State DLNR and HDOT	Short
2023-2018-024—Reduce and/or convert hazardous fuels on fallow agricultural lands **Problem:** With the passing of the plantation era in both sugar and pineapple production, including the closure of the state's last sugar plantation in 2016, abandoned agricultural land is susceptible to invasive, fire prone grasses and shrubs, thereby increasing fire risk to nearby communities and conservation land. **Action:** Implement fuel management through alternative land uses, such as reforestation and active agriculture. Also create and maintain fuel and fire breaks on fallow agricultural lands.						
DLNR-DOFAW and DOA	All islands	Both	Food, Water, Shelter; Hazardous Material	>$100,000	USFS Grant (Federal Funds); Private Landowner Assistance Programs (State and Federal Funds); Private Sector Funds	Ongoing

Responsible Departments or Agencies	Location	Existing or Future Development	Community Lifelines Addressed	Estimated Costs	Potential Funding Sources	Timeline
2023-2018-025—Reduce and/or convert hazardous fuels in the Wildland Urban Interface (WUI) to reduce the threat of wildfires to communities and conservation land near them **Problem:** Reducing and/or converting hazardous fuels in the WUI slow the spread of fire and stop the grass fire cycle through fuel breaks, including greenbreaks or vegetated fuel breaks; managed grazing; and as necessary, prescribed burns. Over 25% of the state is covered by invasive, fire prone grasses and shrubs. Each time fire burns into native forest, this percentage increases. Wildfires in the WUI have been carried rapidly by invasive grasses into forested watersheds, which recharge water supplies, control erosion and run off, and supply culturally important plants. **Action:** Implement fuel breaks, including green breaks or vegetated fuel breaks; managed grazing; and as necessary, prescribed burns. Increase plant propagation for outplantings in the green breaks.						
DLNR, DHHL, DOA, County Fire Departments, HWMO	All islands	Both	N/A	>$100,000	Operating Funds (State Funds); Operating GIA pursuant to Chapter 42F, HRS (State General Funds); USFS Grants (Federal Funds); Private Landowner Assistance Programs (State and Federal Funds); Private Sector Funds	Ongoing
2023-2018-026—Assess, identify, and implement state nursery improvements needed to provide native plants for green breaks **Problem:** Green breaks help shade out grass to break the grass fire cycle, by replacing non-native, invasive grasses and shrubs with mostly native plants and trees. **Action:** Assess, identify, and implement state nursery improvements in order to increase plant propagation for outplantings in the green breaks.						
DLNR-DOFAW	All islands	Both	N/A	>$100,000	CIP (State General Obligation Bond Funds); Operating Funds (State Funds)	Ongoing
2023-2018-027—Continue to develop water sources, including installation of additional water storage structures **Problem:** There are limited water resources in remote areas and are vulnerable to drought. **Action:** Install additional water storage structures, such as portable catchment tanks, reservoirs, and dip tanks.						
DLNR-DOFAW, DLNR-CWRM, DOA, DHHL, County Water Supply Agencies	All islands	Both	Food, Water, Shelter	>$100,000	CIP (State General Obligation Bond Funds); Operating Funds (State Funds)	Ongoing

Responsible Departments or Agencies	Location	Existing or Future Development	Community Lifelines Addressed	Estimated Costs	Potential Funding Sources	Timeline
2023-2018-028—Provide wildfire awareness, preparedness, and prevention education involving all sectors **Problem:** Pursuant to Chapter 185, HRS, DLNR is mandated to take measures for prevention of wildland fires on DLNR-DOFAW managed lands, and is required to cooperate with established fire control agencies of the counties and federal governments in developing plans and programs and mutual aid agreements for assistance of prevention of wildland fires on land not managed by DLNR-DOFAW. Over 98% of wildfires in Hawaii are human caused, which means many are preventable. Preventable wildfires cause losses which exceed the cost of prevention education. While under-publicized, the percentage of land area burned per year in Hawaii exceeds the national average, and some years surpasses the western states. Each fire agency and other entities present wildfire prevention materials differently and with varying frequency. A coordinated public awareness campaign allows for consistent messaging. **Action:** Provide wildfire awareness, preparedness, and prevention education involving all sectors, including: 1. Create a statewide, inter-agency wildfire prevention plan 2. Continue all-agency, unified wildfire and drought awareness campaign annually 3. Hold National Wildfire Community Preparedness Day events in each county annually 4. Establish Outreach and Education Specialists at each DLNR-DOFAW District Office 5. Reach a wider audience by participating in inter-agency wildfire outreach and education efforts at community emergency preparedness fairs.						
DLNR-DOFAW, DLNR-CWRM, HWMO, PFX, County Fire Departments	All islands	Both	N/A	\$10,000 to \$100,000	Operating Funds (State Funds); Operating GIA pursuant to Chapter 42F, HRS (State General Funds); USFS Grants (Federal Funds)	Ongoing
2023-2018-029—Maintain and improve fire and fuel breaks/access roads on state land **Problem:** Fire and fuel breaks/access roads stop advancing fire and provide access to firefighters to reduce the impacts of wildfires to native ecosystems and watersheds. Pursuant to Chapter 185, Hawaii Revised Statutes (HRS), DLNR is mandated to take measures for prevention, control, and extinguishment of wildland fires on DLNR-DOFAW managed lands, and is required to cooperate with established fire control agencies of the counties and federal governments in developing plans and programs and mutual aid agreements for assistance on land not managed by DLNR-DOFAW. **Action:** Maintain and improve fire and fuel breaks/access roads on state land: 1. Clear, reduce, and convert hazardous fuel in fire and fuel breaks and on both sides of access roads 2. Monitor vegetative regrowth due to year-round growing season and invasive, fire-prone grasses that grow back quickly 3. Improve access roads, including paving, repaving, or grading.						
DLNR-DOFAW	All islands	Existing	Transportation	>\$100,000	Operating Funds (State Funds); CIP (State General Obligation Bond Funds); USFS and USFWS Grants (Federal Funds)	Ongoing

Responsible Departments or Agencies	Location	Existing or Future Development	Community Lifelines Addressed	Estimated Costs	Potential Funding Sources	Timeline
2023-2018-030—Establish additional Community Wildfire Protection Plans (CWPP) **Problem:** CWPPs help communities address wildfire response, hazard mitigation, and community preparedness. Newly established CWPPs will make additional lands eligible for funds available through the WUI Grant Program, which funds mitigation actions. CWPPs are also an interagency planning tool. There are areas not covered by a CWPP, while others may need updating. **Action:** There are 14 CWPPs established throughout Hawaii, which cover over half of the state. Each county has at least one CWPP. Areas not covered by a CWPP will need to be prioritized. Once funding is secured, the entity writing the CWPP will hold community and agency meetings, process data, and write the plan.						
HWMO, DLNR-DOFAW, County Fire Departments, County Emergency Management Agencies	Hawaiʻi; Lānaʻi; Maui; Oʻahu	Both	All	>$100,000	Operating GIA pursuant to Chapter 42F, HRS (State General Funds); USFS Grant (Federal Funds)	Long
2023-2018-031—Prevent structure ignition from wildfires in the home ignition zone through home hardening **Problem:** Fire science research indicates that embers and low intensity surface fires are the primary ways that most homes ignite in wildfires. Home hardening with ignition resistant building materials and landscaping that supports vegetation removal and replacement with fire resistant plants can reduce home ignition potential and increase home survivability. **Action:** Currently 15 communities are part of the Firewise program. Hawaiʻi Wildfire Management Organization (HWMO) program would like to train more assessors from the community and county fire departments so additional assessments can take place.						
DLNR-DOFAW, DHHL, County Fire Departments, HWMO	All islands	Both	Food, Water, Shelter	>$100,000	Operating Funds (State Funds); Operating GIA pursuant to Chapter 42F, HRS (State General Funds); USFS Grant (Federal Funds); Private Sector Funds	Ongoing
2023-2018-032—Install and maintain remote automated weather stations (RAWS) **Problem:** Remote automated weather stations ensure that microclimate data is captured to help rate fire danger and monitor fuels. **Action:** Purchase and install additional RAWS. Continue to maintain existing RAWS to ensure that all stations within Hawaii's network are operational.						
DLNR-DOFAW for State operated RAWS.	All islands	Both	Communications	>$100,000	Operating Funds (State Funds); USFS Grant (Federal Funds)	Ongoing

Responsible Departments or Agencies	Location	Existing or Future Development	Community Lifelines Addressed	Estimated Costs	Potential Funding Sources	Timeline
2023-2018-033—High Priority Area Cesspool Abatement Program **Problem:** The State of Hawaii has identified 14 priority areas of the state where cesspool upgrades are critically needed to protect public health and the environment. There are approximately 88.000 cesspools within the state – 43,000 of which are in the identified priority areas. Cesspools provide no treatment of wastewater and inject an estimated 53 million gallons of raw sewage into the state's groundwater every day, potentially spreading disease and harming the quality of the state's only available drinking water supplies and recreational waters. The cost of upgrading all the state's roughly 88,000 cesspools is estimated at $1.75 billion. State law currently requires the elimination of cesspools in Hawai'i by 2050. **Action:** Implement a public-private cost share program between the state, counties, and the private landowners to incentivize upgrades of qualified cesspools to a septic tank or aerobic treatment system, prioritizing identified high priority areas and cesspools posing the greatest risk to ground water contamination and/or surface water impairment as a result of system overflow during heavy rainfall events.						
DOH, DBEDT – OP, City & County Planning Departments	All islands	Existing	Food, Water, Shelter	>$100,000	State & County - Capital Improvement Plan budgeting; Public-private partnership	Long-term and ongoing
2023-2018-034—Harden state laboratory facility to increase all-hazards resilience **Problem:** The State Laboratories Division (SLD) plays an essential role in public health and safety. Data provided by the SLD include those related to detecting infectious outbreaks, identifying hazardous chemicals, responding to emergencies, identifying environmental contaminants, and monitoring significant public health trends. It is imperative that the SLD is able to continue its core population-based activities when events occur that disrupt its normal operation. Originally constructed over 20 years ago, the State Laboratory has several critical vulnerabilities that pose a threat to the facilities continued operations during disaster. As there is only one State Laboratory facility within the state, hardening of the State Laboratory facility is necessary in order to ensure continuity of operations during all hazards. **Action:** Harden the State Laboratory facility to increase all-hazards resilience. 1. Add protective closure for cooling tower 2. Add shatter proof window films 3. Provide second transformer and double ended switchgear 4. Provide separate feeders to mechanical equipment 5. Provide redundant emergency generator 6. Provide additional fuel tank for 7-day supply of emergency generator fuel (5 additional days from current capacity) 7. Construct a 1,200 +/- square foot biosafety level 3 addition						
DOH	O'ahu	Existing	Safety and Security	>$100,000	FEMA Pre-Disaster Mitigation Grant; State appropriation of funding through CIP budget	Short and Long

Responsible Departments or Agencies	Location	Existing or Future Development	Community Lifelines Addressed	Estimated Costs	Potential Funding Sources	Timeline
2023-2018-041—Comprehensive education/outreach plan for the state **Problem:** People do not know where to go for hurricane vs., tsunami, or get evacuation steps confused. Additional education is needed for residents, visitors, and all organizations. **Action:** 1. 2017 HB-571 – Requires Comprehensive Education and Outreach Plan for emergency management and disaster preparedness. Implement strategies to reach all individuals and all organizations 2. For 2022-2023, an HMGP grant application is under FEMA review for the Project Aloha Safe Homes—Community Behavior, which targets unreceptive or difficult to reach citizens. A Communication Plan to Reach the Whole Community was submitted to the Legislature in 2020 (https://seagrant.soest.hawaii.edu/wp-content/uploads/2020/09/Communication-Strategy-Outreach-Plan-V.1.pdf)						
UH Sea Grant	All islands	Both	Food, Water, Shelter	>$100,000	Some limited State Funding under HB571, University of Hawaiʻi, Sea Grant	Ongoing
2023-2018-042—Homeowner's Handbook to prepare for natural hazards **Problem:** Residential structures and properties are vulnerable to hazard events and need information on how to assist with reducing impacts to their assets. **Action:** Update Homeowner's Handbook for hazard events. Obtain funding to reprint and incorporate lessons learned such as from Hurricane Ida in Louisiana						
UH Sea Grant	All islands	Both (Includes Retrofits of existing houses – measures for new)	Food, Water, Shelter	$10,000 to $100,000	State – 20 partners (companies, flood insurance program, CZM), FEMA HMGP	Short and Long
2023-2018-043—Implement actions from the Comprehensive Wastewater Management Plan **Problem:** The Department of Health has identified priority areas for cesspool upgrades and conversions across the state. The state also needs a comprehensive inventory of all onsite systems and outreach program with mandatory inspections, moving forward. Only upgrading does not address future vulnerabilities and risk of onsite system. **Action:** 1. Implement statewide wastewater management program with funding to inventory and maintain database of onsite systems. 2. Implement statewide code that requires maintenance contracts. 3. Develop robust education and outreach program.						
DOH, County Planning Dept., OP, UH Sea Grant	All islands	Both	Food, Water, Shelter	>$100,000	State and County – Capital improvement plan budgeting, public-private partnerships, Philanthropic Foundations (NOAA)	Long and ongoing
2023-2018-045—Building code amendments to reduce existing and future stock vulnerability to coastal hazards & climate impacts for the counties and the state **Problem:** Building codes reduce impacts and save lives. **Action:** Report on building code amendments to be produced for the counties to implement in their building code update process						
State of Hawaiʻi DBEDT OPSD-CZM	Hawaiʻi; Kauaʻi; Molokaʻi; Oʻahu	Both	Safety and Security; Food, Water, Shelter; Health and Medical	TBD; estimated at $10,000 to $100,000	National Oceanic and Atmospheric Administration and TBD	Short

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<tr><td colspan="7">2023-2018-046—Green infrastructure study and plan
Problem: A green infrastructure approach to stormwater management and flood risk reduction seeks to capture rainwater as close to where it falls as possible and let that water soak back into the ground. It integrates multiple smaller practices throughout the watershed, encourages the preservation of existing free space, increases tree canopy cover, works to restore degraded natural areas, and adds green space where possible. All of this is done with consideration of traditional piped stormwater systems, so that the green infrastructure elements reduce the volume of runoff that streams and piped systems need to carry.
Action: Develop a green infrastructure plan inclusive of the following:
1. Identify green infrastructure opportunities in the state, including any related costs and savings
2. Identify green infrastructure planning and development best practices in the state for potential application, including financing and community engagement practices.
3. Complete a plan that details how the state can move forward to cost effectively take advantage of identifies opportunities, including and related costs and savings
4. Identify any legal or regulatory changes that will be needed to execute the completed plan</td></tr>
<tr><td>DBEDT OPSD</td><td>All islands</td><td>Both</td><td>Safety and Security; Food, Water, Shelter; Health and Medical</td><td>$750,000</td><td>NOAA, State Appropriation</td><td>Short</td></tr>
<tr><td colspan="7">2023-2018-048—Infrastructure managed retreat and/or nature-based solutions engineering pilot project to protect threatened Hawaiʻi infrastructure
Problem: Infrastructure is threatened along the state’s shore. A pilot project is needed to examine methods to protect infrastructure, such as a roadway or a sewage treatment plant or a power generation facility, threatened by chronic coastal flooding, climate change and sea level rise by shifting it way from vulnerable coastal areas through retreat and/or a nature-based engineering solution to harden, if retreat is not possible.
Action:
1. Develop criteria to rank infrastructure most threatened by chronic coastal flooding, climate change and sea level rise
2. Develop mitigation strategy to either retreat threatened infrastructure or nature-based engineering solution to harden, if retreat is not possible
3. Retreat or harden infrastructure</td></tr>
<tr><td>State of Hawaiʻi DBEDT OPSD-CZM</td><td>All islands</td><td>Both</td><td>All</td><td>TBD; estimated >$100,000</td><td>National Oceanic and Atmospheric Administration and TBD</td><td>Long</td></tr>
</table>

Responsible Departments or Agencies	Location	Existing or Future Development	Community Lifelines Addressed	Estimated Costs	Potential Funding Sources	Timeline
2023-2018-049—Development of Comprehensive High Resolution Probabilistic Tsunami Design Zone Maps compatible with ASCE 7-16 for the Island of Oʻahu, State of Hawaiʻi **Problem:** The State of Hawaiʻi Department of Business, Economic Development & Tourism (DBEDT), Office of Planning (OP) Coastal Zone Management Program's (HCZMP's) federally approved Section 309 Assessment and Strategy for FY2016-2020 identifies key problems and opportunities to improve HCZMP's ability to prevent or significantly reduce coastal hazard's risk in high-hazard areas and to manage the effects of potential sea level rise. To implement Section 309 Assessment and Strategy, OP seeks implement this strategy to develop comprehensive high resolution probabilistic Tsunami Design Zone maps for the Island of Oʻahu, State of Hawaiʻi for upcoming use with the International Building Code (IBC) 2018 / American Society of Civil Engineers (ASCE) 7-2016, Chapter 6, Tsunami Loads and Effects standards. **Action:** 1. Develop Phase I project work plan 2. Conduct modeling and mapping of the City & County of Honolulu (urban core south coast and Haleʻiwa) 3. Complete modeling and mapping for entire City & County of Honolulu Island of Oʻahu 4. Conduct independent technical review to ensure compliance with the ASCE 7-16 Chapter6 Probabilistic Tsunami Hazard Analysis mapping criteria 5. Draft proposed language for the Honolulu City Council to consider amending the City &County of Honolulu Building Code to adopt the probabilistic Tsunami Design Zone maps and model data developed pursuant to this project along with styles of maps appropriate for use in the City & County of Honolulu Building Code and the ASCE Tsunami Design Geodatabase						
State of Hawaiʻi DBEDT OPSD-CZM	Oʻahu	Both	All	$430,000	National Oceanic and Atmospheric Administration	Short
2023-2018-050—Development of Comprehensive High Resolution Probabilistic Tsunami Design Zone Maps Compatible with ASCE 7-16 for the Counties of Hawaiʻi, Maui and Kauaʻi, State of Hawaiʻi **Problem:** The State of Hawaii Department of Business, Economic Development & Tourism (DBEDT), Office of Planning (OP) Coastal Zone Management Program's (HCZMP's) federally approved Section 309 Assessment and Strategy for FY2016-2020 identifies key problems and opportunities to improve HCZMP's ability to prevent or significantly reduce coastal hazard's risk in high-hazard areas and to manage the effects of potential sea level rise. To implement Section 309 Assessment and Strategy, OP seeks implement this strategy to develop comprehensive high resolution probabilistic Tsunami Design Zone maps for the Counties of Hawaii, Maui and Kauai, State of Hawaiʻi for upcoming use with the International Building Code (IBC) 2018 / American Society of Civil Engineers (ASCE) 7-2016, Chapter 6, Tsunami Loads and Effects standards. **Action:** 1. Initiate modeling and mapping for Hawaiʻi, Maui, and Kauaʻi counties 2. Complete modeling and mapping for Hawaiʻi, Maui, and Kauaʻi counties 3. Conduct independent technical review to ensure compliance with ASCE 7 criteria 4. Draft and complete proposed language for county councils of Hawaiʻi, Maui, and Kauaʻi to consider amending their building codes to adopt the probabilistic Tsunami Design Zone maps and model data developed pursuant to this project along with styles of maps appropriate for use in their respective county building codes and the ASCE Tsunami Design Geodatabase 5. Draft proposed language to adopt the probabilistic Tsunami Design Zone maps and model data developed pursuant to this project along with style of maps appropriate for use in State of Hawaiʻi Building Code 6. Present building code amendments for SBCC review and approval 7. Conduct rulemaking in accordance with HRS Chapter 91						
State of Hawaiʻi DBEDT OPSD-CZM	Hawaiʻi; Kauaʻi; Molokaʻi; Maui	Both	All	TBD; estimated >$100,000	National Oceanic and Atmospheric Administration and TBD	Long and Ongoing

Responsible Departments or Agencies	Location	Existing or Future Development	Community Lifelines Addressed	Estimated Costs	Potential Funding Sources	Timeline
2023-2018-051—Flood engineering analysis of Waimanalo watershed **Problem:** Waimanalo like many watersheds in Hawaii is subject to flooding. Erosion and development have exacerbated the flooding risk and existing infrastructure may no longer be adequate to contain the risk, leading to damage to farms, residences and businesses. **Action:** 1. Form workgroup of affected state and county agencies and affected landowners and stakeholders. 2. Develop a public information campaign including public service announcements, fact sheets, and other forms of communication on the types of insurance and the need to purchase flood insurance. 3. Measure change in the number of active flood insurance policies compared to baseline levels.						
HI-EMA	Oʻahu	Existing	All	>$100,000	FEMA, State funding, US Geological Survey, US Department of Agriculture, Natural Resources Conservation Service	Short
2023-2018-053—Coordinate the compilation of projected development to assist with future local and state HMPs **Problem:** Development continues to occur in the state. To avoid future losses, it is best to assess if projected new development may be impacted by hazards by conducting a spatial analysis. A statewide spatial layer of projected development (e.g., buildings, infrastructure) is not available. To conduct this exercise for the 2023 HMP Update, the following data was used: 1) Hawaiʻi Community Development Authority's Community Development Districts; 2) Enterprise Zones and 3) Maui Development Projects; refer to Section 3 (State Profile). It is recognized that these datasets do not represent all projected development in the state and a centralized location for this spatial data is needed to ensure a complete analysis is conducted. **Action:** HI-EMA will work with other departments at the state and local levels to coordinate the compilation of projected development in a spatial format to enable a more comprehensive analysis to identify problems and exposure prior to construction. This information will be included in the future update of local and state hazard mitigation plans; and be available to all entities for planning use.						
HI-EMA	All islands	Future	Other	< $10,000	Operating Funds (State Funds)	Ongoing
2023-2018-054—Reduce number of repetitive loss properties **Problem:** Properties continue to incur flood damages; the number of repetitive loss properties has increased over the performance period of the 2018 HMP. **Action:** The State of Hawaiʻi Department of Land and Natural Resources (DLNR), HI-EMA and the four County Governments will continue to work together to reduce the number of properties remaining on the repetitive loss list. The State Hazard Mitigation Forum will provide technical and scientific assistance. Mitigation measures to be considered for each property are: acquisition, re-location, elevation, or small flood control projects.						
HI-EMA in coordination with DLNR Engineering Division and the four Counties	All islands	Existing	Safety and Security; Food, Water, Shelter; Health and Medical	>$100,000	FEMA HMA grants, State Appropriation	Ongoing

Responsible Departments or Agencies	Location	Existing or Future Development	Community Lifelines Addressed	Estimated Costs	Potential Funding Sources	Timeline
2023-2018-055—Reduce and/or convert hazardous fuels along roadsides **Problem:** The State Wildfire Ignitions Mapping Project showed that the majority of ignitions occur along roads. Reducing and/or converting hazardous fuels along roadsides help prevent wildfires and stop or slow the spread of wildfires to communities and native ecosystems and watersheds. **Action:** 1. Roadways, portions of highways and private streets shall be cleared of combustible vegetation and other combustible growth 2. Certain ground covers shall be permitted to be exempt provided that they do not form a means of readily transmitting fire 3. Keep invasive, fire prone grasses and shrubs short 4. Monitor vegetative regrowth due to year-round growing season and invasive, fire-prone grasses that grow back quickly.						
State HDOT and County Departments of Transportation	All islands	Both	All	>$100,000	Operating Funds (State Funds)	Ongoing
2023-2018-056—Collaborate with partners and the State Hazard Mitigation Forum to evaluate and update the State Hazard Mitigation Plan on an annual basis **Problem:** In the process of updating the earlier versions of the HMP, it became apparent that mitigation processes, although well-intentioned, have been interrupted; including during the performance period of the 2018 SHMP. The SHMP needs to remain a living document in order to reduce future losses to the state. To do so, an annual evaluation on progress by meeting with the Forum, updates to the plan, supported by the local HMP roll-up and annual consultation with FEMA needs to take place. The HI-EMA is committed to this annual evaluation and update. **Action:** The Forum will meet quarterly, with at least one Forum meeting dedicated to discussion to evaluate the content of the SHMP. The framework and questions are outlined in Section 7 (Plan Maintenance). At the conclusion of these Forum meetings, the HI-EMA will capture the changes and progress discussed, and combine into an annual review report. The annual review report will be structured to align with the main sections of the 2023 SHMP Update and be included in an appendix to the plan for record. This will facilitate the incorporation of changes and progress made in the 2028 SHMP Update. The SHMO will continue to host the current version of the 2034 HMP Update on the HI-EMA website and ensure the annual review reports are included in an appendix to the SHMP and uploaded to the website for transparency and to keep stakeholders and the public up to date. The SHMO will meet annually with FEMA Region IX for the annual consultation process to ensure continual progress is made and feedback is obtained.						
HI-EMA, Counties, FEMA Region IX	All islands	Not applicable	Safety and Security	< $10,000	Operating Funds (State Funds)	Ongoing
2023-2018-057—Coordinate access to Hawaiʻi State Historic Preservation Division (SHPD)-maintained cultural resource information **Problem:** Cultural asset information in the State of Hawaiʻi is managed by the Hawai`i State Historic Preservation Division in the Department of Land and Natural Resources. It is a goal of the HI-EMA to work with the Department in the future in order to access this information for inclusion in future state hazard mitigation plan updates. **Action:** HI-EMA will work with (SHPD) in order to access to cultural resource information for inclusion in future state hazard mitigation plan updates.						
HI-EMA and State Historic Preservation Division	All islands	Existing	Safety and Security	< $10,000	Operating Funds (State Funds)	Short

Responsible Departments or Agencies	Location	Existing or Future Development	Community Lifelines Addressed	Estimated Costs	Potential Funding Sources	Timeline
2023-2018-058—Implement the mitigation measures as outlined in the Statewide Highway Shoreline Protection Study **Problem:** Several roadways in the state flood from chronic coastal flooding as well as storm events; and flooding may be exacerbated by projected sea level rise and changes in future conditions identified in this plan. These roads have been identified and catalogued in a study (State Highway Shoreline Protection Study: Final Report of Preliminary Field Investigation, Rankings and Recommendations; January 2018). **Action:** Implement the mitigation measures as outlined in the Statewide Highway Shoreline Protection Study: Final Report of Preliminary Field Investigation, Rankings and Recommendations of August 2019 has recommendations for next steps and has prioritized the roadways that require attention.						
State of Hawaiʻi DOT	All islands	Existing	Transportation	>$100,000	US Fed Highways, NOAA, State Appropriation	Long
2023-2013-001—High-occupancy design standard updates **Problem:** The number of safe public locations that can withstand hurricane impacts is not sufficient **Action:** By 2028, update the design standards for new high-occupancy public buildings that can provide enhanced hurricane protective areas, and consider Mass Care Working Group recommendations						
HI-EMA	All islands	Future	Safety and Security; Food, Water, Shelter; Health and Medical; Communications; Hazardous Material	$10,000 to $100,000	Department funding; FEMA CTP	Short
2023-2013-002—Perform a critical infrastructure vulnerability analysis **Problem:** Lack of information and identification of resilience needs **Action:** Evaluate vulnerability of critical infrastructure systems in the storm surge inundation zone (power, water, fuel, communications, ports, airports) and identify protective measures or back-up resources to the most practical extent						
HI-EMA	All islands	Existing	All	>$100,000	EMPG Funding; Department Funding; FEMA CTP	Long
2023-2013-004—Increase capabilities to adopt new building codes in a timely manner **Problem:** State adoption of building codes does not keep pace with the release of new building codes. This makes new construction more vulnerable to hazards and prevents the state from being competitive when applying for grants that require adoption of current building codes for scoring criteria. The SBBC does not have the capacity with its volunteer staff to keep up with the frequent changes in building codes. **Action:** Improve Building Codes to the most current standards. Adopt wind design standards for the installation of photovoltaic panels, power walls, and other alternative energy sources on residential/commercial buildings.						
HI-EMA, Building Code Council	All islands	Future	Food, Water, Shelter; Energy	$10,000 to $100,000	DR4062 HMGP Funds	Short
2023-2013-018—Vertical evacuation building evaluation and identification **Problem:** Sufficient facilities are not identified that can be used as vertical evacuation centers **Action:** Continue to support the Counties in the evaluation of existing policies for the use of buildings for vertical evacuation and update as necessary. Develop a standard procedure for evaluating existing multi-story buildings as tsunami (and hurricane) refuge structures						
HETAC, All Counties	All islands	Existing	Food, Water, Shelter	<$10,000	State Appropriation, FEMA HMA Grants	Ongoing

Responsible Departments or Agencies	Location	Existing or Future Development	Community Lifelines Addressed	Estimated Costs	Potential Funding Sources	Timeline
2023-2013-021—Update tsunami-resistant design standards **Problem:** Additional mapping and design regulations are needed for the tsunami hazard **Action:** Develop maps of probabilistic tsunami inundation and runup for use in designing or retrofitting critical infrastructure facilities, including bridges, major multi-story buildings, and vertical evacuation refuge buildings (required ASCE-7 implementation). Adopt tsunami-resistant design provisions. Enable "tsunami-ready" designation for risk category III and IV structures.						
DBEDT, OPSD-CZM	All islands	Both	All	>$100,000	NOAA Funding	Short, Ongoing
2023-2013-024—Priority-facility hazard evaluations and retrofits **Problem:** Hawaiʻi and Maui Counties lack the needed evaluations to determine the best options for retrofits to harden priority facilities **Action:** Conduct all hazard evaluations and develop cost-effective seismic retrofits for priority facilities in the Counties of Hawaiʻi and Maui						
HETAC, Counties of Hawaiʻi and Maui	Hawaiʻi, Maui, Molokaʻi, Lānaʻi	Existing	Safety and Security; Food, Water, Shelter; Health and Medical; Communications; Hazardous Material	>$100,000	FEMA CTP Funding; Department Funding; NOAA Funding	Short
2023-2013-025—Hurricane retrofit public information outreach **Problem:** Homeowners may lack knowledge about how to perform retrofits to their homes to withstand hurricanes and high winds. **Action:** Provide public outreach on how to retrofit and establish anchorage of post & pier foundations of Hawaiʻi light-frame housing						
HETAC, Counties of Hawaiʻi	All islands	Existing	Food, Water, Shelter	$10,000 to $100,000	FEMA CTP Funding; Department Funding	Short
2023-2013-026—Seismic bracing requirements for renovations **Problem:** Renovations do not currently require additional seismic bracing **Action:** Require implementation of seismic bracing requirements for equipment and ceiling systems in renovation and post-disaster repairs of schools and hospitals, and assisted living facilities						
Building Code Council	All islands, emphasis on Hawaiʻi and Maui	Existing	Safety and Security; Health and Medical	<$10,000	FEMA CTP Funding; Department Funding	Short
2023-2013-028—Bridge seismic retrofit performance evaluation **Problem:** Bridges are a critical part of transportation infrastructure. If a bridge is damaged from a seismic event, access could be cut off for weeks or months. Information is needed to determine retrofit performance. **Action:** Compile detailed County of Maui bridge seismic retrofit performance objective information from HDOT for 50-60 bridges, and update HAZUS inventory to reflect more accurate expected bridge loss estimates in data products						
State of Hawaiʻi DOT	Maui, Molokaʻi, Lānaʻi	Existing	Transportation	<$10,000	US Fed Highways, State Appropriation, NEHRP	Short

Responsible Departments or Agencies	Location	Existing or Future Development	Community Lifelines Addressed	Estimated Costs	Potential Funding Sources	Timeline
2023-2013-033—Construction performance evaluations **Problem:** Common construction methods may need to be enhanced to protect lives of occupants during hazard events **Action:** Conduct testing of the performance of current and future assets for the promotion of life-saving measures (single wall construction, pillar and post construction, and post disaster housing) when subjected to major earthquakes and hurricanes						
HI-EMA, UH	All islands	Future	Food, Water, Shelter	$10,000 to $100,000	Department Funding; FEMA Grants	Short
2023-2013-034— Tsunami warning and earthquake monitoring **Problem:** Local and distant earthquakes can trigger tsunamis. Additional monitoring is needed to determine potential impacts and evacuation measures needed. **Action:** Explore the use of subsea cabling for tsunami warning and earthquake monitoring systems						
HETAC, USGS	All islands	Not applicable	All	<$10,000	Operating Funds (State Funds)	Ongoing
2023-2013-035—Soils analysis and seismic modeling **Problem:** Soils data for all the islands is lacking **Action:** Generate ShakeMaps that incorporate soil conditions and the new seismic hazard model information for Hawaiʻi						
HETAC	All islands	Future	All	$10,000 to $100,000	Department Funding; FEMA Grants	Short
2023-2013-061—Real estate disclosures for landslide hazard areas **Problem:** Current real estate disclosures do not include landslide hazard areas. **Action:** Develop Zones of Required Special Investigations near hillsides. If mandated by the State Legislature, use these zones to define as a "duty to notify" during real estate transactions.						
UH, DLNR, State of Hawaiʻi DOT	All islands	Both	All	$10,000 to $100,000	State Appropriation, FEMA HMA Grants, NRCS	Short
2023-2013-071—Develop a pre-incident mission-ready package (MRP) for EMAC requests (Emergency Mutual Aid Compact) for licensed healthcare professionals **Problem:** Ability to respond efficiently to EMAC requests **Action:** As a small and remote state, Hawaiʻi is more likely to request assistance from other states than provide it. An ongoing plan has been developed for Department of Health Office of Public Health Preparedness Planners to handle EMAC requests as the need arises.						
DOH	All islands	Not applicable	Health and Medical	$10,000 to $100,000	PHP; HPP	Ongoing
2023-2013-072—DOH to maintain standard operating procedures for sharing information across agencies **Problem:** Communication problem among agencies **Action:** Maintain information sharing by continuing to implement DOH's Emergency Operations Plan for sharing information across agencies via WebEOC, veoci, various data and reports from lab/disease investigation/GIS, etc. and the network communication infrastructure including landline phones, computers, email, video conferencing, and fax. Satellite phones and 800 MHZ two-way radios are backup devices for communication.						
DOH	All islands	Not applicable	Safety and Security; Health and Medical; Communications	<$10,000	PHP	Ongoing

Responsible Departments or Agencies	Location	Existing or Future Development	Community Lifelines Addressed	Estimated Costs	Potential Funding Sources	Timeline
2023-2013-078—Update templates for public health emergency messaging **Problem:** Communication barriers **Action:** Continue to update templates for various public health emergencies that could be modify depending on the situation.						
DOH	All islands	Not applicable	Health and Medical; Communications	<$10,000	PHP/Operating Funds	Ongoing
2023-2013-086—Supply chain disruption preparation and outreach **Problem:** Food supply chain disruption **Action:** Investigate how to warehouse supplies to account for supply chain disruption. Continue preparedness messaging to residents to have food and water on hand for 14 days.						
HI-EMA	All islands	Existing	Food, Water, Shelter	$10,000 to $100,000	Department Funding, FEMA Grants, EDA	Short
2023-2013-088—Increase public building sheltering capability through retrofits **Problem:** The number of Enhance Hurricane Protection Area (EHPA) rated shelter locations across the state needs to be increased. **Action:** Using the "Hurricane Shelter Retrofit Procedural Guide" HI-EMA will continue to retrofit public shelter buildings to increase capacity to decrease the sheltering deficit. These shelter hardening actions will result in EHPA-rated hurricane shelters that will achieve category 3 hurricane protection.						
HI-EMA, All Counties	All islands	Existing	Food, Water, Shelter	>$100,000	HMGP, State CIP Funds	Long
2023-2013-095—Earthquake and tsunami public awareness campaign **Problem:** Outreach is not sufficient to property inform the public how to reduce impacts from earthquakes and tsunamis **Action:** Augment and expand education and outreach for earthquake and tsunami hazard reduction activities						
HETAC	All islands	Both	All	$10,000 to $100,000	NOAA Funding	Short
2023-2013-116—Continue to develop Operational Support Plans **Problem:** Lack of operational support plans could impact the flow of supplies during hazard events that are critical to operations **Action:** 1. Account for adequacy of critical marine/ground transportation to address supply chain and alternate port operations plan 2. Include Natural Systems Protection (NSP) elements						
HI-EMA	All islands	Existing	Transportation	>$100,000	EMPG Funding	Short
2023-2013-121—Harbor mapping for tsunami evacuation **Problem:** Tsunamis can cause damage or sink ships in harbor areas, putting the lives of sailors at risk if they are not evacuated in time. **Action:** Continue to develop harbor maps to define regimes of currents and timeframes for several scenarios of tsunami to estimate necessary period of ship evacuation						
HI-EMA	All islands	Existing	Transportation	$10,000 to $100,000	NOAA Funding	Short

Note:
See Appendix G (Mitigation Strategy Supplement) for additional information on implementation

6.4.3 ACTION PLAN PRIORITIZATION

Stakeholders prioritized identifying mitigation actions in the 2023 SHMP Update based on high- and medium-ranked hazards in the risk assessment, capabilities, and progress on previously identified actions. The prioritization schema for action implementation differs from the process and criteria the Forum uses to rank planning and project proposals for FEMA mitigation grant funding (see Appendix C – Capability Assessment Supplement). Each action in the 2023 SHMP Update was ranked based on the following criteria:

- Will the action result in life safety?
- Will the action result in property protection of vulnerable state assets?
- Will the action be cost-effective? (future benefits exceed cost)
- Is the action technically feasible?
- Will the action mitigate impacts from climate change?
- Does the state have the legal authority to implement?
- Is funding available for the action?
- Will the action have a positive impact on the natural environment?
- Does the action benefit socially vulnerable communities?
- Does the state have the administrative capability to execute the action?
- Will the action reduce risk to more than one hazard?
- Can the action be completed in less than 5 years?
- Is there an agency/department local champion for the action?
- Will the action support other local objectives (such as capital improvements, economic development, environmental quality, or open space preservation?) or policies of other plans and programs?

The answers to each of these questions are weighted as follows:

- Yes = 3 points
- Not sure, could be either yes or no, or question is difficult to quantify = 1 point
- No = 0 points

Following scoring of each action, priorities are assigned based on the following metrics:

- 31 or more = High Priority
- 15 to 30 = Medium Priority
- 0 to 14 = Low Priority

This prioritization process was applied to a revised action plan that focuses on high and medium hazards identified by the risk assessment conducted for the 2023 SHMP Update. It was also applied based on updates to the capabilities assessed in Section 5 (Capability Assessment) and Appendix C (Capability Assessment Supplement), as shown in the prioritization questions above. Table 6-2 shows the implementation priority for each action included in the 2023 SHMP Update, based on the following characteristics of the action:

- **Mitigation Goals**—Goals are listed in detail in Section 6.2 (Mitigation Goals and Objectives)
- **Mitigation Objectives**—Objectives are listed in detail in Section 6.2 (Mitigation Goals and Objectives)
- **Action Type**—Mitigation actions are summarized into the following four types define by FEMA:

- **State & Local Plans and Regulations**—Include government authorities, policies, or codes that encourage risk reduction, such as building codes and state planning regulations. This may also include planning studies.
- **Structure & Infrastructure Projects**—Involve modifying existing structures and infrastructure or constructing new structures to reduce the impact of hazards.
- **Natural Systems Protection**—Minimize losses while also preserving or restoring the function of natural systems.
- **Education and Awareness Programs**—Include long-term, sustained programs to inform and educate citizens and stakeholders about hazards and mitigation options. This category could also include training.

- **Implementation Priority**—The ranking criteria discussed above. See Appendix G (Mitigation Strategy Supplement) for the prioritization summary of each action.

Table 6-2. 2023 SHMP Update State of Hawai'i Action Plan Goals, Objectives, Action Type, and Priority

Action Number	Mitigation Goals	Mitigation Objectives	Action Type				Priority
			State & Local Plans and Regulations	Structure & Infrastructure Project	Natural Systems Protection	Education & Awareness Programs	
2023-001	1, 2, 3	1, 3, 4, 5, 14		◆	◆		Medium
2023-002	1, 2, 3, 4, 7	1, 2, 4		◆			High
2023-003	1, 3, 5	3, 4, 5, 15				◆	High
2023-004	1, 3, 6, 7	1, 4, 5, 12	◆				Medium
2023-005	1, 4, 5, 7	1, 2, 3, 4, 5, 6, 7	◆			◆	High
2023-006	1, 2, 3	1, 3, 5, 7, 13, 14			◆		High
2023-007	1, 2	1, 3, 4, 7, 14			◆		High
2023-008	1, 2	1, 3, 4, 7, 13, 14			◆		High
2023-009	1, 2	1, 3, 4, 5, 7, 13, 14		◆	◆		High
2023-010	1, 4, 5	2, 3, 4, 15				◆	Medium
2023-011	1, 2, 3, 5, 7	1, 3, 4, 5, 7, 8, 9		◆			High
2023-012	2, 4, 5, 7	1, 2, 5, 6				◆	Medium
2023-013	3, 5	1, 3, 5				◆	Medium
2023-014	1, 2, 3	2, 3, 4, 5, 7, 14	◆			◆	Medium
2023-015	1, 3, 4	1, 2, 3, 6				◆	Medium
2023-016	1, 3, 4	1, 3, 5, 13	◆				Medium
2023-017	1, 7	1, 2, 5, 9		◆			Medium
2023-018	1, 2, 3, 6	1, 2, 5, 6	◆				High
2023-019	1, 2, 3, 4, 5, 6, 7	All	◆	◆	◆	◆	High
2020-001	1, 2	4, 8, 9		◆			High
2020-002	3, 4, 5, 7	2, 15				◆	High
2020-003	1, 2, 3, 7	4, 8, 9		◆			Medium
2020-004	3, 5, 7	2, 15				◆	Medium
2018-001	1, 2, 4, 7	4, 8, 9		◆			High
2018-002	1, 2, 4, 7	4, 8, 9		◆			High

Action Number	Mitigation Goals	Mitigation Objectives	Action Type: State & Local Plans and Regulations	Action Type: Structure & Infrastructure Project	Action Type: Natural Systems Protection	Action Type: Education & Awareness Programs	Priority
2018-004	2, 3, 4	1, 2, 3, 4, 5, 6, 9	◆				Medium
2018-005	2, 5	1, 2, 3, 4, 5, 6, 9				◆	High
2018-006	1, 2, 3, 4, 6	1, 2, 5, 12	◆				Medium
2018-007	3, 4, 6	1, 4, 6, 9, 14	◆				High
2018-009	2, 3, 4	1, 2, 3, 6, 9, 13	◆	◆		◆	High
2018-011	1, 2, 3, 5, 7	2, 3, 4, 5, 6, 7, 8, 9, 10	◆	◆			High
2018-012	1, 2, 4, 7	1, 8, 9, 10	◆	◆			High
2018-013	1, 2, 4, 7	1, 8, 9, 10	◆	◆			High
2018-016	3, 6	1, 2, 3, 6, 8	◆			◆	High
2018-017	2, 3, 4, 7	2, 3, 4, 6, 7, 11, 13, 14	◆			◆	Medium
2018-018	2, 3	4, 5, 7, 13, 14	◆	◆	◆		Medium
2018-019	2, 3	1, 3, 4, 7, 13, 14			◆		High
2018-021	2, 3, 5	1, 2, 3, 4, 5, 7, 13				◆	Medium
2018-022	2, 3, 5	1, 2, 3, 4, 5, 7, 9, 12, 13, 14, 15				◆	High
2018-023	1, 2, 4, 6	2, 4, 6, 8, 9, 11, 12, 14	◆	◆	◆	◆	High
2018-024	2, 3	1, 2, 3, 4, 5, 14	◆		◆		High
2018-025	1, 2	2, 4, 7, 8, 9, 11, 12, 14	◆		◆		High
2018-026	2, 3	3, 4, 7, 14	◆	◆	◆		High
2018-027	1, 2, 4, 7	4, 5, 7, 8, 13, 14	◆	◆	◆		High
2018-028	2, 3, 5	1, 2, 3, 4, 5, 7, 9, 12, 13, 14	◆		◆	◆	High
2018-029	1, 2	8, 9, 10	◆	◆	◆		High
2018-030	2, 4, 6	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 14	◆	◆	◆	◆	High
2018-031	1, 2, 3, 4, 7	1, 2, 3, 4, 8, 9, 10	◆	◆		◆	High
2018-032	2, 4	1, 2, 3, 6	◆		◆		High
2018-033	1, 2, 3, 5, 7	1, 4, 5, 8, 9		◆	◆	◆	Medium
2018-034	1, 2, 4	2, 4, 9, 10		◆			High
2018-041	2, 3, 5	1, 2, 3, 4, 5, 7, 8, 9, 10, 12				◆	High
2018-042	2, 3, 5	2, 3, 4, 5, 8, 9, 12				◆	High
2018-043	1, 2, 3, 4, 6	1, 2, 5, 6, 7, 11, 12, 13, 14	◆			◆	High
2018-045	1, 2, 4	4, 10, 11, 12	◆				High
2018-046	2, 3, 4	2, 3, 4, 5, 6, 8, 9, 13, 14	◆		◆	◆	High
2018-048	1, 2, 3, 4	1, 2, 3, 4, 5, 6, 8, 9, 13, 14		◆	◆	◆	Medium
2018-049	1, 2, 4	2, 3, 4, 6	◆			◆	Medium
2018-050	1, 2, 4	2, 3, 4, 6	◆			◆	Medium
2018-051	2, 4	2, 4, 6, 13				◆	Medium
2018-053	3, 4, 6	2, 3, 4, 6	◆			◆	High

Action Number	Mitigation Goals	Mitigation Objectives	Action Type				Priority
			State & Local Plans and Regulations	Structure & Infrastructure Project	Natural Systems Protection	Education & Awareness Programs	
2018-054	1, 2, 3, 4, 7	2, 3, 8, 9, 10, 12		◆			High
2018-055	1, 2	4, 8, 14	◆		◆		High
2018-056	3, 6	1, 4, 11	◆			◆	High
2018-057	5, 7	1, 2, 3, 5	◆			◆	High
2018-058	4, 6	1, 4, 5, 6, 11, 13, 14		◆			High
2013-001	1, 2, 4	4, 8, 9, 10	◆				High
2013-002	1, 2, 3, 4	8, 9, 10, 11	◆	◆			High
2013-004	1, 3, 4	10	◆				High
2013-018	1, 2, 3, 4	2, 11	◆				Medium
2013-021	1, 2, 4	2, 4, 6, 8, 9	◆			◆	High
2013-024	1, 2, 3, 4	10	◆	◆			High
2013-025	2, 3, 5, 7	1, 3, 4, 8, 9, 12				◆	High
2013-026	1, 2, 6	4, 8, 9, 10		◆			High
2013-028	2, 3, 4	1, 2, 6	◆			◆	Medium
2013-033	4	2, 8, 9, 10		◆		◆	Medium
2013-034	4, 6	15	◆			◆	Medium
2013-035	4	2, 6	◆				Medium
2013-061	2, 3, 4, 5	1, 2, 5, 6, 7, 11, 12	◆		◆	◆	Medium
2013-071	1, 3, 5	1, 2, 3, 5	◆				Medium
2013-072	3	1, 2, 3, 6	◆			◆	Medium
2013-078	2, 4	15				◆	Medium
2013-086	1, 2, 3, 4, 5, 7	3, 4, 12, 15	◆			◆	High
2013-088	1, 2, 3, 6, 7	4, 8, 9		◆			Medium
2013-095	3, 5	1, 2, 3, 4, 9	◆			◆	Medium
2013-116	2, 3, 4, 5, 6	2, 3	◆				Medium
2013-121	2, 3, 4	2, 3	◆				Medium

6.5 REPETITIVE LOSS STRATEGY

44 CFR 201.4(c)(3)(v): A state may request the reduced cost share authorized under §79.4(c)(2) of this chapter for the FMA and SRL programs, if it has an approved state mitigation plan … that also identifies specific actions the state has taken to reduce the number of repetitive loss properties, which must include properties identified as severe repetitive loss, and specifies how the state intends to reduce the number of such repetitive loss properties.

To be eligible for an increased federal cost share, a FEMA-approved SHMP that addresses RL properties must be in effect at the time of grant award and the property must be a RL property. The State of Hawaiʻi received approval for its Repetitive Loss Strategy in October 2013. The updated RL Strategy, as detailed in this section, identifies actions the state has taken to reduce the number of RL properties. In addition, it describes the state's strategy to ensure that Counties with RL properties take actions to reduce the number of these properties, including the development of local HMPs.

6.5.1 REPETITIVE LOSS PROPERTIES IN THE STATE OF HAWAIʻI

Properties that are located within the SFHA and have federally-backed mortgages or were constructed using federal or federally-related financial assistance are required to purchase flood insurance. When an National Flood Insurance Program (NFIP)-insured property is damaged by flooding, a claim is filed. If the NFIP-insured property has had at least two paid flood losses of more than $1,000 each in any 10-year period since 1978, it is referred to as a RL property. An NFIP-insured property is known as a SRL property if: (1) the insured property has had four or more paid flood losses of $5,000 (amount of each claim) and a total amount of claims payments of $20,000; or (2) the insured property filed at least two separate claims that have been paid with the cumulative amount of claim payments exceeding the fair market value of the insured building on the day before each loss (FEMA 2020).

Section 4.6 (Flood) discusses the RL and SRL properties in each county. As of August 21, 2022, the state has 262 RL properties including 53 SRL properties throughout all four Counties. Refer to Table 6-3 for a summary of these statistics. Over the performance period of the 2018 SHMP, the number of RL properties has increased from 227 to 262 (an approximate 13% increase). The April 2018 flood event (DR-4365) contributed to the increase in RL and SRL properties.

Table 6-3. NFIP Statistics for the State of Hawaiʻi

County	Repetitive Loss Properties		Severe Repetitive Loss Properties	
	2018 Total	2023 Total	2018 Total	2023 Total
County of Kauaʻi	31	46	0	2
City and County of Honolulu	117	132	1	13
County of Maui	34	38	2	6
County of Hawaiʻi	45	46	6	32
Total	**227**	**262**	**9**	**53**

Source: FEMA 2022; State of Hawaiʻi SHMP 2018

6.5.2 GOALS TO ADDRESS RL AND SRL PROPERTIES

The State of Hawaiʻi is committed to reducing the number of RL and SRL properties by increased education, outreach, and successfully maximizing grant opportunities. This strategy aligns with the state's overall 2023 goals as outlined in subsection 6.2 above. More specifically, Goal 1 is to reduce long-term vulnerability of Hawaii's people and property, which includes high-risk properties such as RL and SRL properties. Goal 6 centers on the state providing a framework for robust local hazard mitigation planning and implementation of their mitigation strategy, including the support to reduce RL and SRL properties.

- **Goal 1**—Reduce the long-term vulnerability of Hawaii's people, property, and jurisdictions, including state-owned or operated buildings, infrastructure and critical facilities, to natural hazards while conserving the state's natural, historical, and cultural assets. This includes High Hazard Potential Dams and high-risk properties such as RL and SRL properties.
- **Goal 6**—Provide a framework for robust local hazard mitigation planning and mitigation strategy implementation in alignment with this plan.

The local HMPs were reviewed to identify goals or objectives that also address the reduction of RL and SRL properties.

- County of Kauaʻi
  - Goal 1 – Reduce the long-term vulnerability of the County of Kauaʻi's people, communities and property—including government-owned or operated buildings, lifelines, and infrastructure—to hazards, while conserving the County's natural, historical, and cultural assets. This includes high-risk properties such as RL and SRL properties.
  - Objective 2 – Reduce repetitive property losses due to floods, erosion, high winds, tsunamis, fire, and sea level rise through acquisition, retrofitting, design, and updated construction and land use regulations.
  - Objective 3 – Incorporate mitigation measures into repairs, major alterations, new development, and redevelopment, especially in areas with substantial hazard risk and those known to have RL.
- City and County of Honolulu
  - Goal 2 – Plan, design, and construct future development and retrofit existing structures within hazard areas to become resilient and minimize losses.
- County of Maui
  - Goal 1 – Protect the life, health, safety, and welfare of Maui County residents and visitors
  - Goal 3 – Protect and adapt property and infrastructure from the impacts of natural hazards and climate change.
- County of Hawaiʻi
  - Goal 2 – Ensure that all critical facilities and infrastructure withstand hazard incidents and have contingency plans to restore services quickly.
  - Objective 4 – Promote and implement the retrofit, hardening, or replacement of at-risk structures and lifelines to increase community resilience.

6.5.3 PRIORITIZATION OF RL AND SRL MITIGATION ACTIONS

The state's criteria to rank project proposals for FEMA mitigation grant funding programs is listed below and described in greater detail in the Capability Assessment Appendix (Appendix C – Capability Assessment Supplement). Several ranking criteria ensure the projects that include the reduction of RL and SLR properties are ranked high to proceed with proposal submission and project award. One of the ranking criteria for project selection is to give priority to problems that are "repetitive" (Resolve Significant Problems); and projects that are long-range solutions (Long-range). In addition, the hardening or retrofit of essential facilities and flood control projects are determined as high priority project types (Priority in the State).

- **Environmental/Historic Preservation**—Must be environmentally sound and in conformance with Floodplain Management, Historical Preservation, and Protection of Wetlands and Endangered Species laws and regulations.

- **Resolve Significant Problems**—Addresses a problem that has been repetitive or a problem that poses a significant risk to public health and safety if left unresolved.
- **Long-range**—Solution should be long-range.
- **Cost-effective**—Be cost-effective and substantially reduce the risk of future damage, loss, hardship, or suffering from a major disaster.
- **Priority in State Plan**—Types of projects which have been determined high priority for the State of Hawaiʻi.

6.5.4 CURRENT AND POTENTIAL FUNDING SOURCES TO IMPLEMENT REPETITIVE LOSS MITIGATION ACTIVITIES

The primary source of mitigation funding for flood mitigation projects is through FEMA's Hazard Mitigation Assistance grant programs which provide funding for eligible mitigation activities that reduce disaster losses and protect life from future disaster damages. These four FEMA funding opportunities require an approved local or state HMP and are listed below.

- Hazard Mitigation Grant Program (HMGP)
- Building Resilient Infrastructure and Communities (BRIC)
- Pre-Disaster Mitigation (PDM)
- Flood Mitigation Assistance (FMA)

The Capability Assessment and Capability Assessment Supplement Appendix (Section 5 and Appendix C, respectively) describe the pre- and post-disaster funding sources available for mitigation in the state.

6.5.5 SUPPORT OF LOCAL HAZARD MITIGATION PLANS

Element S14 and 44 CFR § 201.3(c)(5) and 201.4(c)(4)(i): The state plan must include a discussion of the process to support the development of approvable local government mitigation plans. This includes providing technical assistance, training, and funding. The plan must provide a summary of barriers to developing or updating, adopting, and implementing FEMA-approved local government mitigation plans and steps to remove barriers to help local governments advance mitigation planning.

As discussed in Section 5 (Capability Assessment), HI-EMA is committed to educating its Counties on grant availability, grant applications, and managing mitigation funds. Over the performance period of the 2018 SHMP, when funding opportunities became available, HI-EMA placed notifications in local newspapers, notified appropriate state and county agencies via email and other means, and communicated opportunities through networks via word of mouth. In addition, HI-EMA has provided training in groups and/or one-on-one on benefit-cost analysis (BCA), the E-Grants system, the environmental and historic preservation (EHP) review process, the Hazard Mitigation Assistance (HMA) program, and applicant briefings and trainings for the Hazard Mitigation Grant Program (HMGP).

Over the performance period of the 2023 SHMP Update, HI-EMA will work to expand discussion and outreach for these and other programs that provide funds for mitigation activities. Additional information on trainings is provided in the Section 5 (Capability Assessment).

As outlined in Section 7 (Plan Maintenance) HI-EMA has updated the plan maintenance strategy. Through the coordination of the SHMO and/or Chair of the Forum, the Forum will continue to meet quarterly. In addition to these meetings, the SHMO and Forum Chair may request the Forum meet following disaster events, to assure that procedures and resources are appropriate for plan maintenance and implementation. It is at these Forum meetings that project proposals for FEMA mitigation grant funding programs are ranked.

As each County's expiration date on their current hazard mitigation plan approaches, the SHMO will continue to notify each County regarding their status and advise to submit a FEMA HMA planning grant application to FEMA; refer to Section 7 – Plan Maintenance for further details.

6.5.6 STATE AND LOCAL CAPABILITIES FOR FUNDING AND IMPLEMENTING RL AND SRL MITIGATION ACTIONS

Element S11, HHPD5, and 44 CFR § 201.4(c)(3)(iv): The state plan must identify current and potential sources of funding to implement mitigation actions and activities, including the identification of current and/or potential sources of federal, state, local, or private funding for implementation. At a minimum, the plan must identify FEMA mitigation funding sources.

State and local capabilities for funding and implementing the mitigation of RL and SRL properties provide a basis for effectiveness of the RL Strategy. As discussed in the Capability Assessment (Section 5), HI-EMA administers the state's hazard mitigation program, with the SHMO serving as the official point of contact. As discussed in this plan, HI-EMA recognizes that the HI-EMA Mitigation Section is limited in staffing capacity, as discussed further in Section 5 (Capability Assessment), and that Forum meetings since the adoption of the 2018 SHMP have been sporadic. In addition, the COVID-19 pandemic and the frequency of hazard events and the state's necessity to redirect attention to disaster response and recovery diverted attention and resources away from the outlined 2018 SHMP maintenance process. The updated RL Strategy in the 2023 SHMP Update re-emphasizes the state's commitment to reducing the number of RL and SRL properties in the state.

DLNR is designated as the State Coordinating Agency responsible for assisting the coordination of the NFIP between the Federal and County agencies in the State of Hawaiʻi. Refer to Table 5.2-1 in Section 5 for a summary of the state's capabilities for the flood-related hazards of concern (climate change and sea level rise, flood, hurricane storm surge, and infrastructure (dam) failure).

The state's 2023 updated mitigation strategy includes focused actions carried over from the 2018 SHMP to reduce the number of RL and SRL properties as follows:

- 2023-2018-007—Better Coordination between the HI-EMA and DLNR on Flood Mitigation Projects
- 2023-2018-022—Statewide Public Information Campaign to Increase Citizen Resilience to Flooding
- 2023-2018-054—Reduce the number of RL properties

All four of the Counties are participating in and are in good standing with the NFIP; and each community has a representative County floodplain manager (refer to Table 5.3-2 in Section 5 [Capability Assessment] for information on County floodplain management programs). Hawaiʻi is the first state in the nation in which all Counties participate in the Community Rating System (CRS) program. In terms of local capabilities, the local HMPs were reviewed to examine the following (summarized further in Section 5.3 [Section 5 – Capability Assessment]):

- Foundational Capabilities
- Floodplain Management Capabilities
- Land Use Planning
- Evaluation and Effectiveness

A review of the County local HMPs reveals that there is limited discussion of the effectiveness of mitigation actions and specifically regarding RL and SRL properties. A summary of the results of the review are provided below. In addition, the local HMPs were reviewed to examine the local mitigation actions identified to reduce the number of RL and SRL properties in the state. The following summarize these findings by County; note, this is not considered an exhaustive list of all flood-related hazard mitigation actions identified in each plan.

- County of Kauaʻi Multi-Hazard Mitigation and Resilience Plan, 2021
  - The County of Kauai's HMP summarizes the County's flood mitigation capability in Chapter 7 and Appendix L. The probable causes of flooding for all properties in identified RL areas has been determined to be commensurate with the risk reflected in the SFHA mapping. Since the development of the 2021 Kauaʻi HMP, the County has been admitted into the CRS program.
  - Mitigation Actions:
    - Work with the state NFIP Coordinator to develop the program for participation in the CRS
    - Develop and maintain public awareness of hazards, vulnerability, mitigation and adaptation strategies.
- City and County of Honolulu Multi-Hazard Pre-Disaster Mitigation Plan, 2020
  - The City and County of Honolulu summarized RL in Chapter 8. Since the development of the 2020 HMP, the County has been admitted into the CRS program.
  - Mitigation Actions:
    - CRS: Participate in the NFIP Community Rating System to reduce flood losses and lower flood insurance premiums.
    - Critical Facilities Plan: Plan for flood control public works for the defense of critical facilities and major economic assets. Harden critical facilities, utilities, power and communication networks, and port facilities.
- County of Maui Hazard Mitigation Plan Update, 2020
  - The County of Maui's HMP summarized RL in its flood hazard profile. All but one RL property in Maui County have been identified as residential structures. Many RL properties are clustered in specific areas.

- Mitigation Actions:
  - Where appropriate and feasible, provide technical assistance and administer financial support to willing property owners for the completion of projects to protect structures located in hazard-prone areas from future damage, with RL and SRL properties as priority.
  - Participate in the CRS program and identify opportunities across all relevant County departments and programs to improve current CRS class.

- County of Hawaiʻi Multi-Hazard Mitigation Plan, 2020
  - The County of Hawaiʻi HMP summarizes RL in Chapter 11. All of the properties are within or immediately adjacent to the FEMA-mapped SFHA; most are residential. The probable causes of flooding for all properties in identified RL areas has been determined to be commensurate with the risk reflected in the SFHA mapping.
  - Mitigation Actions:
    - Vulnerable Property Protection. Where appropriate, support retrofitting, purchase or relocation of structures located in hazard areas, prioritizing those that have experienced repetitive losses and/or are located in high- or medium-risk hazard areas.
    - Maintain CRS Participation. Continue to maintain and enhance (where feasible) the County's classification under the CRS program.

The results of this assessment were used by the state to develop its mitigation strategy and strengthen the RL Strategy for the 2023 SHMP Update.

Section 7. Plan Maintenance

CONTENTS

TABLES

[1] *Section Cover Photo: Waiʻānapanapa State Park, Maui. Photo courtesy of DLNR*

SECTION 7. PLAN MAINTENANCE

2023 SHMP Update Changes

- For the 2023 SHMP Update, changes to this section are based on an evaluation of the operational feedback regarding the effectiveness of the plan maintenance procedures outlined in the 2018 SHMP.

The development of a plan maintenance process ensures that the SHMP remains a “living” document that is intended to be changed and updated throughout its performance period. Maintaining momentum in mitigation strategy implementation can lead to significant long-term changes and overall risk reduction. As such, a formal process is required to ensure that the SHMP will remain an active and relevant document. HI-EMA is the reponsible agency for the preparation and maintenance of the SHMP; and the SHMO is the individual responsible for overseeing the coordination, implementation, and maintenance of the plan collaboratively across the state.

This section evaluates the challenges and successes of the 2018 SHMP maintanence procedures and outlines an updated strategy to maintain the 2023 SHMP Update to ensure it remains current and reflects changes to the statewide mitigation program over time.

7.1 REVIEW OF THE 2018 SHMP MAINTENANCE PROCEDURES

It is the state’s intent to ensure this plan remains a “living” document that will be updated and revised as appropriate and as new information becomes available. In recognition of the need for implementing the formal maintenance process, HI-EMA, the lead to update and maintain the SHMP, analyzed whether the previously approved plan’s method and schedule for monitoring, evaluating, and updating the plan was appropriate and successful. It determined that the method and schedule in the previous plan were appropriate. However, as in previous years, the mitigation process was interrupted.

HI-EMA recognizes that the HI-EMA Mitigation Section is limited in staffing capacity, as discussed further in Section 5 (Capability Assessment) and that Forum meetings and support since the adoption of the 2018 SHMP have not been consistent on a quarterly basis. In addition, the frequency of hazard events and the state’s necessity to redirect attention to disaster response and recovery diverted attention and resources away from the outlined 2018 SHMP maintenance process.

Since the adoption of the 2018 SHMP, HI-EMA experienced several significant staffing changes. In October 2018, the SHMO became semi-retired after more than two decades of service at HI-EMA. An interim SHMO stepped into the role temporarily. Then a new SHMO was hired to fill the position from January 2020 to June 2022, after which there was an abrupt change in staff. A mitigation planner in the HI-EMA Mitigation Section was appointed as the new acting SHMO in August 2022. In February 2023, there was a change in the HI-EMA Administrator.

In terms of Forum support, only one meeting was held in 2019 which included support for the Kīlauea eruption recovery. In-person and virtual Forum meetings were held in 2020; however, meeting summaries were not availabe to consult and summarize in this update. Despite the challeges of meeting during the COVID-19 pandemic, the Forum held three virtual meetings in 2021. Four regular Forum meetings and one special session devoted to the SHMP Update were held in 2022 with a hybrid format so attendees could participate in-person or virtually. Forum activities in 2022 and 2023 included supporting the review of propose projects under FEMA DR-4510 (COVID-19) and updating the SHMP.

Without enough capacity to dedicate to mitigation, there were increased challenges in executing the plan maintenance procedures outlined in the 2018 SHMP; therefore plan maintenance was not fully actualized (refer to Table 7-1). During the 2018 plan performance period, HI-EMA tracked progress on FEMA HMA-funded plans and projects and their implementation progress. In addition, the Forum met periodically to discuss the prioritization of projects to be submitted for FEMA HMA funding as well as special topics of interest.

Table 7-1. Implementation Schedule of the 2018 SHMP

Year	Implementation Milestone	Progress Status
October 2018	• FEMA-approval and state adoption of the 2018 SHMP Update	• HI-EMA led the 2018 SHMP Update
2019 (Year 1)	• Continue Forum meetings • In August 2019, solicit Forum and stakeholder assistance to document mitigation action implementation progress to date using the BATool℠ • Evaluate the 2018 SHMP Update utilizing the framework above • Develop the annual review report by the end of September 2019, include in Appendix H of the 2018 SHMP Update, and update the HI-EMA website with the new information	• One Forum meeting (August) • Staffing limitations prevented progress on stated items • BATool℠ was not utilized
2020 (Year 2)	• Continue Forum meetings • In August 2020, solicit Forum and stakeholder assistance to document mitigation action implementation progress over the past year using the BATool℠ • Evaluate the 2018 SHMP Update using the framework above • Develop the annual review report by the end of September 2020, include in Appendix H, and update the HI-EMA website with the new information	• In-person and virtual Forum meetings • Staffing limitations prevented progress on stated items • BATool℠ was not utilized • New mitigation actions were identified, confirmed by the Forum, and added to the mitigation strategy in 2020
2021 (Year 3)	• Continue Forum meetings • Apply for FEMA PDM planning grant to develop the 2023 SHMP Update • In August 2021, solicit Forum and stakeholder assistance to document mitigation action implementation progress over the past year using the BATool℠ • Evaluate the 2018 SHMP Update using the framework above • Develop annual review report by September 2021, include in Appendix H, and update the HI-EMA website with the new information	• Virtual Forum meetings (April, August, October) • PDM grant period of performance start date: August 4, 2020 • Plan enhancements were suggested and the schedule discussed for the 2023 SHMP Update. • Staffing limitations prevented progress on other stated items • BATool℠ was not utilized
2022 (Year 4)	• Continue Forum meetings • Commence 2023 SHMP Update • Request mitigation action progress by July 2022 • Develop annual review report by September 2022, include in Appendix H, and update the HI-EMA website with the new information	• Virtual and in-person Forum meetings (March, June, August, October (special session), and November) • 2023 SHMP Update began in July • Starting in August 2022, BATool℠ was utilized to report action progress
2023 (Year 5)	• Continue Forum meetings • Continue preparation of the 2023 SHMP Update • Submit updated SHMP to FEMA by August 2023	• Virtual and in-person meeting held in March 2023 • SHMP Update in progress as of March 2023

Due to limited staffing and the number of disaster declarations that occurred, HI-EMA focused its priorities on sustaining those communities most affected by the hazard events as well as other unanticipated needs. Additional interruptions or delays in plan maintenance resulted from staffing and logistic complications due to the COVID-19 pandemic. The HI-EMA Mitigation Section staff met with each county individually at least twice each year between 2019 and 2023 to discuss the mitigation program, mitigation planning, and mitigation project development.

7.2 MONITORING, EVALUATING, AND UPDATING

Element S17 and 44 CFR 201.4(c)(5)(i): The state plan must describe the method and schedule for keeping the plan current, including the process to monitor, evaluate, and update the plan. The description must include the responsible agency/office and the schedule.

As discussed in Section 2, the 2023 SHMP Update was led by HI-EMA and overseen by the SHMO, with guidance and input from other state departments, the Forum, stakeholders, and the public. The 2023 SHMP Update will be maintained on the HI-EMA website at Hawaiʻi Emergency Management Agency | Hazard Mitigation Plans. The SHMO will continue to lead the SHMP maintenance throughout the plan's peformance period (2023 to 2028).

Through the coordination of the SHMO and/or the Chair of the Forum, the Forum will continue to meet quarterly, as per their bylaws updated in August 2017 (Appendix B), throughout the 2023 SHMP Update performance period to support implementation of and discuss amendments to the 2023 SHMP Update. In addition to these meetings, the SHMO and Forum Chair may request the Forum meet following disaster events to ensure that procedures and resources are appropriate for plan maintenance and implementation. The SHMO may continue to invite additional stakeholders that were invited to Forum meetings during the 2023 SHMP Update to ensure continuity of involvement and subject matter expertise. The continuous review and evaluation of the SHMP will help determine its overall effectiveness and ensure its ongoing relevance to the state's mitigation needs.

At a minimum of one Forum meeting per year, the SHMO will lead the SHMP update discussion to evaluate the content of the plan and specifically review and discuss progress on the mitigation strategy. Agencies not already represented on the Forum that are responsible for implementing the 2023 SHMP Update mitigation strategy will be invited to participate in this annual meeting. The framework and questions listed below will be asked. At the conclusion of these Forum meetings, HI-EMA will capture the changes and progress discussed and combine them into an annual review report. The annual review report will be structured to align with the main sections of the 2023 SHMP Update and be included in Appendix H. This will facilitate the incorporation of changes and progress made in the 2028 SHMP Update. The SHMO will continue to host the current version of the 2023 SHMP Update on the HI-EMA website and ensure the annual review reports are included in Appendix H and uploaded to the site.

- Planning Process
  - What milestones in plan integration have been made (e.g., updated State Strategic Plan and THIRA)?
  - Are there any changes needed to the Forum membership to ensure broad participation across all sectors and counties?

- State Profile
  - Have there been any significant changes in terms of demographics, development, state assets, or other factors?
- Capability Assessment
  - What changes in programs and policies have occurred at the local, state, and federal levels?
  - As local HMPs are updated, integrate their updated local capabilities into the State Capability Assessment.
- Risk Assessment
  - Have the nature and magnitude of hazard risks and/or development changed?
  - Is there any updated climate science data to integrate into the plan?
  - Is there updated data regarding socially vulnerable communities to integrate into the plan?
  - Document new disaster declarations and impacts incurred.
- Mitigation Strategy
  - What progress has been made toward the SHMP's goals?
  - Do the goals still address current and expected conditions?
  - Discuss any change in state's priorities.
  - Report mitigation action implementation progress (discussed further below).
  - Review existing mitigation action items to determine appropriateness of funding.
  - Discuss changes in available funding sources, programs, and priorities.
  - Re-prioritize state-level potential mitigation projects, if needed, using the methodology described in the plan.

In addition to the annual review report on the SHMP, a summary of the FEMA annual consultation will be included in the appendix as well. Table 7-2 outlines the updated plan maintenance strategy that HI-EMA will implement, in coordination and collaboration with the Forum, and other state agencies/departments over the next five years.

7.3 SYSTEM FOR TRACKING PROGRESS

Element S18 and 44 CFR 201.4(c)(5)(ii) and 201.4(c)(5)(iii): The state plan must describe the system for monitoring implementation and reviewing progress, including tracking implementation of the mitigation activities and projects identified in the mitigation strategy. The description must include the responsible agencies/offices, role of the agencies/offices, and criteria and process for evaluating progress.

Tracking progress on state-level mitigation activities shall continue to be led by HI-EMA. To standardize and facilitate collection of progress data and information on the specific mitigation actions in the SHMP, HI-EMA will utilize the BATool[SM] Program plan review module, an online plan review service that will allow Forum members and other state agencies and stakeholders to login to a secure site and provide a status update to their mitigation actions.

Table 7-2. Plan Maintenance Strategy for the 2023 SHMP Update

Year	Implementation Milestone	Responsible Entity
October 2023	• FEMA-approval and state adoption of the 2023 SHMP Update	HI-EMA
2024 (Year 1)	• Quarterly Forum meetings	HI-EMA will schedule Forum meetings in coordination with the Forum Chair
	• In August 2024, document mitigation action implementation progress to date using the BATool℠ Program	Agencies in the Mitigation Strategy will update their actions
	• Evaluate the 2023 SHMP Update utilizing the framework above	HI-EMA and Forum
	• Explore state and other federal funding opportunities to implement mitigation actions when FEMA mitigation grant funding is not available	HI-EMA and Forum
	• Develop the annual review report by the end of September 2024, include in Appendix H of the 2023 SHMP Update, and update the HI-EMA website with the new information	HI-EMA
2025 (Year 2)	• Quarterly Forum meetings	HI-EMA will schedule Forum meetings in coordination with the Forum Chair
	• In August 2025, document mitigation action implementation progress to date using the BATool℠ Program	Agencies in the Mitigation Strategy will update their actions
	• Evaluate the 2023 SHMP Update using the framework above	HI-EMA and Forum
	• Explore state and other federal funding opportunities to implement mitigation actions when FEMA mitigation grant funding is not available	HI-EMA and Forum
	• Develop the annual review report by the end of September 2025, include in Appendix H and update the HI-EMA website with the new information	HI-EMA
2026 (Year 3)	• Quarterly Forum meetings	HI-EMA will schedule Forum meetings in coordination with the Forum Chair
	• Apply for FEMA planning grant to develop the 2028 SHMP Update	HI-EMA
	• In August 2026, document mitigation action implementation progress to date using the BATool℠ Program	Agencies in the Mitigation Strategy will update their actions
	• Evaluate the 2023 SHMP Update using the framework above	HI-EMA and Forum
	• Explore state and other federal funding opportunities to implement mitigation actions when FEMA mitigation grant funding is not available	HI-EMA and Forum
	• Develop annual review report by September 2026, include in Appendix H and update the HI-EMA website with the new information	HI-EMA
2027 (Year 4)	• Quarterly Forum meetings	HI-EMA will schedule Forum meetings in coordination with the Forum Chair
	• Commence 2028 SHMP Update	HI-EMA
	• Request mitigation action progress by July 2027 using the BATool℠ Program	Agencies in the Mitigation Strategy will update their actions
	• Explore state and other federal funding opportunities to implement mitigation actions when FEMA mitigation grant funding is not available	HI-EMA and Forum
	• Develop annual review report by September 2027, include in Appendix H, and update the HI-EMA website with the new information	HI-EMA
2028 (Year 5)	• Quarterly Forum meetings	HI-EMA will schedule Forum meetings in coordination with the Forum Chair
	• Explore state and other federal funding opportunities to implement mitigation actions when FEMA mitigation grant funding is not available	HI-EMA and Forum
	• Continue preparation of the 2028 SHMP Update	HI-EMA, Forum, and stakeholders
	• Submit updated SHMP to FEMA by June 2028	HI-EMA

Notes:
BATool℠ Baseline Assessment Tool Program

The service has been established and populated with SHMP mitigation actions prior to FEMA approval of this plan. The link, instructions, and login credentials will be distributed prior to the next scheduled Forum meeting, and a training session on the BATool℠ Program will be provided. HI-EMA will collect progress on an annual basis and report progress in the annual review report appended to this plan to facilitate integration into the 2028 SHMP Update. While tracking progress on documented actions, this will be an opportunity for HI-EMA, the Forum, and stakeholders to identify modifications to existing actions and add new mitigation actions to the state mitigation strategy, all of which can be accomplished in the BATool℠ Program.

The BATool℠ Program services have been secured for the first year after FEMA approval (October 2023 – October 2024). HI-EMA is currently identifying a funding mechanism to continue using the program for the full 2023 SHMP performance period. The BATool℠ Program will automatically send email reminders to state entities with actions in the plan 60, 30, 15, and 7 days prior to HI-EMA's progress review deadline requesting their review and report progress on each of their mitigation actions. At the defined HI-EMA deadline, the BATool℠ Program will automatically draft and email a populated report to HI-EMA summarizing action progress entered for all mitigation actions to date. If HI-EMA decides not to utilize the BATool℠ Program beginning year 2, or is unable to secure funding to extend its service term, the report template developed in year 1 may be used by HI-EMA to further customize and update in subsequent years to facilitate the continued documentation of action progress.

Local mitigation projects funded by FEMA are administered through HI-EMA and are tracked from initiation. Counties that receive project grant awards are required to submit progress reports on the status of their projects. Currently, HI-EMA uses a grant-tracking program for this purpose.

7.4 DOCUMENTING AND SUPPORTING LOCAL HAZARD MITIGATION PLANS

The SHMO or representative from HI-EMA sends an email notification to the Counties with plans expiring within 24 months of upcoming funding cycles. The HI-EMA Mitigation Section staff provides technical assistance, when requested, to the four counties during their local mitigation plan development and update. Due to limited staffing at the HI-EMA Mitigation Section, technical assistance has been somewhat limited over the past five years. As the HI-EMA Mitigation Section capacity increases, so will the technical assistance it can provide to the counties. A final plan review is made by HI-EMA to ensure all requirements of the program have been met before forwarding the updated plan to FEMA for final review and approval.

During the period of performance of the 2018 SHMP, limited resources were available to provide a linkage between the local plans and the SHMP. However, HI-EMA conducted training, as part of the state technical assistance program, for local county hazard mitigation plans and mitigation activities to implement an annual review coordinated with and through the annual mitigation program consultation with the FEMA Pacific Area Office. During this consultation for the performance period of the 2023 SHMP Update, methods and progress on linking the 2023 SHMP Update and local HMPs will be discussed and evaluated.

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SECTION 7. PLAN MAINTENANCE

No References

Appendix A. Planning Process Documentation

CONTENTS

TABLES

FIGURES

[1] *Section Cover Photo: Tree-lined street in Poipu, Kaua'i. Photo by Megan Brotherton*

APPENDIX A. PLANNING PROCESS DOCUMENTATION

This appendix provides supporting information on the planning process captured in Section 2 (Planning Process). Information on agency, stakeholder, subject matter expert, focus group, and public outreach that was conducted as part of the 2023 SHMP Update planning process and is not already captured in Section 2 (Planning Process) is included below. In addition, the public comments received on the draft 2023 SHMP Update are summarized.

Meeting agendas, sign-in sheets, and presentations (where applicable and as available) for the State Hazard Mitigation Forum, FEMA, and public meetings convened during the development of the 2023 SHMP Update are included. Additional meeting information is available upon request.

Table A-1 summarizes the key planning meetings and milestone during the 2023 SHMP Update planning. Table A-2 lists the SMEs identified and consulted in the 2023 SHMP Update planning process.

When the draft 2023 SHMP Update was completed in early 2023, the SHMO identified lead and supporting reviewers per plan section to ensure the first-round of review was conducted by SMEs. The lead reviewers are listed in Table A-3. The draft 2023 SHMP Update sections were distributed to the lead reviewers via the project Microsoft Teams file sharing site. All comments received from the SMEs were considered by the HI-EMA Mitigation Section and Forum Chair, and incorporated into the draft, where appropriate. In addition, the SHMO invited stakeholders listed in Table A-2 and Table A-3 to review the draft plan released on April 26, 2023, concurrent with public review.

A summary of the various sectors engaged in the update process is in Table A-4 below, along with a brief description of their involvement. Forum members and hazard specific SMEs already captured in Table A-2 and Table A-3 are not included below.

Table A-1. Key 2023 SHMP Update Planning Meetings and Milestones

Date	Meeting and Planning Milestone	Participants (where applicable)
June 6, 2022	HI-EMA/Mitigation Plan Consultant Introductory Meeting • Forum participation overview • Schedule project kick-off meeting	HI-EMA and Tetra Tech
July 15, 2022	HI-EMA Project Kick-Off with Mitigation Plan Consultant • Review of 2018 SHMP and new FEMA planning policy • Organization of the planning team • Outreach strategy • Changes and enhancements to updating the mitigation strategy	HI-EMA, Forum Chair, and Tetra Tech
July 29, 2022	FEMA Mitigation Program Annual Consultation	HI-EMA and FEMA Region IX
August 18, 2022	State Hazard Mitigation Planning Meeting • Hazards of concern determined	HI-EMA, Forum Chair, Tetra Tech
August and September 2022	Meetings with State Agencies, Stakeholders, Focus Groups, and SMEs • Data collection (events/losses, spatial data) • Building codes and standards overview • Defined social vulnerability for Hawaiʻi	County of Hawaiʻi, City and County of Honolulu, County of Kauaʻi, County of Maui, DBEDT, DLNR, DOH, FEMA, HETAC, HI-EMA, Hawaiʻi Interagency Council on Homelessness, Hawaiʻi Tourism Authority, NOAA, OHS, OPSD, SBCC, SEAOH, SOEST, UH
September 2022	StoryMap developed for public outreach	N/A
September 2022– February 2023	State agency reviews and updates to the mitigation strategy	SBCC, DBEDT, DLNR, DOH, HETAC, HI-EMA, UH
October 5, 2022	State Hazard Mitigation Planning Meeting • Review goals • Develop objectives	HI-EMA, Forum Chair, Tetra Tech
October 12, 2022	Special State Hazard Mitigation Forum Meeting • New FEMA Planning Policy • Hazards of concern • Forum role and involvement • Subject matter expert and focus group outreach • Goals and objectives exercise • Mitigation strategy overview	HI-EMA, Forum, Tetra Tech

December 7, 2022	State Hazard Mitigation Forum Meeting
	• Define Community Lifelines
	• Risk assessment
	    ○ Analysis methodology and new data
	    ○ Review scenarios
	    ○ Present draft vulnerability results
		HI-EMA, Forum, Tetra Tech

December 20, 2022	Virtual Statewide Public Meeting • Public hazard awareness survey released • Hazard mitigation plan overview • Mitigation success stories • Social vulnerability requirements and map overview • Risk assessment results	HI-EMA, Tetra Tech

Date	Meeting and Planning Milestone	Participants (where applicable)

December 28, 2022	State Hazard Mitigation Planning Meeting
	• Capability assessment working session
	  ○ Review and update 2018 SHMP capabilities
	  ○ Add new capabilities
		HI-EMA, Forum Chair, Tetra Tech

January 11, 2023	State Hazard Mitigation Planning Meeting • Mitigation strategy update progress • Hazard ranking review	HI-EMA, Forum Chair, Tetra Tech
January–February 2023	Draft 2023 SHMP Update hazard sections to lead subject matter expert reviewers	Refer to Table 2.1-3
February 7, 2023	Capabilities and Mitigation Action Workshop • Capabilities interactive exercise • SMEs share best practices in mitigation • Mitigation action development	County of Hawaiʻi, City and County of Honolulu, County of Kauaʻi, County of Maui, DHHL, HDOT, DBEDT, DLNR, DOH, HETAC, HI-EMA, Hawaiʻi Broadband and Digital Equity Office, Hawaiʻi Council on Homelessness, Hawaiʻi Tourism Authority, Honolulu Board of Water Supply, Kauaʻi Utility Board, OPSD, SBCC, SEAOH, SOEST, State Energy Office, UH, USGS
February–March 2023	State agencies, stakeholders, and SMEs update capabilities	County of Hawaiʻi, City and County of Honolulu, County of Kauaʻi, County of Maui, DHHL, HDOT, DBEDT, DLNR, DOH, HETAC, HI-EMA, Hawaiʻi Broadband and Digital Equity Office, Hawaiʻi Council on Homelessness, Hawaiʻi Tourism Authority, Honolulu Board of Water Supply, Kauaʻi Utility Board, OPSD, SBCC, SEAOH, SOEST, State Energy Office, UH, USGS
February 8–10, 2023	Mitigation Action Item Development Workshops with Individual Sectors • Housing • Health and Social Services • Infrastructure • Land Use and Development • Economic Development • Emergency Management • Natural and Cultural Resources	County of Hawaiʻi, City and County of Honolulu, County of Kauaʻi, County of Maui, DHHL, HDOT, DBEDT, DLNR, DOH, HETAC, HI-EMA, Hawaiʻi Broadband and Digital Equity Office, Hawaiʻi Council on Homelessness, Hawaiʻi Tourism Authority, Honolulu Board of Water Supply, Kauaʻi Utility Board, OPSD, SBCC, SEAOH, SOEST, State Energy Office, UH, USGS
March 1, 2023	State Hazard Mitigation Planning Meeting • Plan maintenance • Funding prioritization	HI-EMA, Forum Chair, Tetra Tech

Date	Meeting and Planning Milestone	Participants (where applicable)
March 23, 2023	State Hazard Mitigation Planning Meeting • Final risk ranking • Review of hazard dashboarding and new mitigation actions • Draft plan overview and how to comment • Upcoming public meetings and how to promote	HI-EMA, Forum Chair, Tetra Tech
March–April 2023	Draft 2023 SHMP Update sections to lead reviewers	Refer to Table 2.1-3
April 5, 2023	City and County of Honolulu In-person Public Meeting • Purpose of the Hawaiʻi State Hazard Mitigation Plan • Draft Plan Overview • Mitigation Strategies Input • Coordination with Other Planning Efforts	City and County of Honolulu, DLNR, Members of the Public, HI-EMA, Forum Chair, Tetra Tech
April 17 and 18, 2023	County of Hawaiʻi In-person Public Meetings in Hilo and Kona • Purpose of the Hawaiʻi State Hazard Mitigation Plan • Draft Plan Overview • Mitigation Strategies Input • Coordination with Other Planning Efforts	County of Hawaiʻi, Members of the Public, HI-EMA, Forum Chair, Tetra Tech
April 19 and 20, 2023	County of Maui In-person Public Meetings on Molokaʻi and Maui Island • Purpose of the Hawaiʻi State Hazard Mitigation Plan • Draft Plan Overview • Mitigation Strategies Input • Coordination with Other Planning Efforts	Maui County, Members of the Public, HI-EMA, Forum Chair, Tetra Tech
April 24, 2023	County of Kauaʻi In-person Public Meeting • Purpose of the Hawaiʻi State Hazard Mitigation Plan • Draft Plan Overview • Mitigation Strategies Input • Coordination with Other Planning Efforts	Kauaʻi County, Members of the Public, HI-EMA, Forum Chair, Tetra Tech
April 26, 2023	Draft 2023 SHMP Update posted on the project website and StoryMap for Forum and public review and comment	N/A
May 3, 2023	Statewide Hybrid Public Meeting in Kapolei • Purpose of the Hawaiʻi State Hazard Mitigation Plan • Draft Plan Overview • Mitigation Strategies Input • Coordination with Other Planning Efforts	DHHL, Members of the Public, HI-EMA, Forum Chair, Tetra Tech
May 22, 2023	Submit to FEMA for review	

Table A-2. Agency and Stakeholder Coordination

Agency	Name	Area of Expertise
Emergency Management		
Maui County Emergency Management Agency	Gina Albanese	Hazard mitigation, emergency management
Maui County Emergency Management Agency	Herman Andaya	Hazard mitigation, emergency management
Hawai'i Office of Homeland Security	Jimmie Collins	Critical infrastructure security and resilience, cybersecurity, and emerging threats
Hawai'i State Department of Health, State Toxicologist	Diana Felton	Toxicology, hazardous materials, human health, chemical contamination
Kaua'i Emergency Management Agency	David Kennard	Hazard mitigation, resiliency, communication
Honolulu Board of Water Supply	Ernie Lau	Watershed management, water quality
Hawai'i Emergency Management Agency	David Lopez	Emergency management
County of Hawai'i Civil Defense Agency	Talmadge Magno	Disaster recovery, emergency management
County of Hawai'i Civil Defense Agency	Barry Periatt	Disaster recovery, emergency management
Kaua'i Emergency Management Agency	Chelsie Sakai	Hazard mitigation, emergency management
Honolulu Department of Emergency Management	Hirokazu Toiya	Emergency management
Kaua'i Emergency Management Agency	Elton Ushiro	Disaster recovery, emergency management
Hawai'i Emergency Management Agency	Carmela Vigue	Emergency Management
Honolulu Department of Emergency Management	Jennifer Walter	Hazard mitigation, emergency management
Economic Development		
Department of Business, Economic Development & Tourism	Lauren Primiano Amber Ternus	Economic development
DAGS Risk Management Office	Tracy Kitaoka Ann Sueoka	Economic development
Land Use and Development		
State Office of Planning and Sustainable Development	Danielle Bass	Sustainability planning, policy development, urban and regional planning, Hawai'i legislature
County of Maui Department of Planning	James Buika	Coastal planning, shoreline setbacks, land use policy
Martin, Chock & Carden Structural Engineers; State Building Code Council	Lyle Carden	Building codes and standards
Hawai'i Planning Department	Douglas Le	Disaster recovery, community planning
Hawai'i Planning Department	Bethany Morrison	Long-range planning, shoreline setbacks, community resiliency
Office of Planning and Sustainable Development	Ann Ogata-Deal	Planning, land use policy
Hawai'i Planning Department	April Surprenant	Long-range planning, recovery, resilience, and sustainable planning
County of Hawai'i Public Works Building Division; Hawai'i State Energy Office, State Building Code Council	Neal Tanaka	Building codes and standards
State of Hawai'i Office of Planning and Sustainable Development, Coastal Zone Management	Lisa Webster	GIS, Coastal Zone Management, Ocean Resources Management Plan, urban and regional planning
Hawai'i State Energy Office, State Building Code Council	Howard Wiig	Energy resiliency, building codes
Housing		
Department of Human Services	Joe Campos	Housing

Agency	Name	Area of Expertise
Health and Social Services		
Hawaiʻi State Department of Health, State Toxicologist	Diana Felton	Toxicology, hazardous materials, human health, chemical contamination
Hawaiʻi State Department of Health, Disease Investigations Branch	Caroline Pratt	Infectious diseases, health risks
Infrastructure		
Hawaiʻi State Energy Office	Jonathan Chin	Energy efficiency, energy systems planning, energy analysis
City and County of Honolulu, Office of Climate Change, Sustainability and Resiliency	Sarah Harris	Hazard mitigation and long-term disaster recovery
State of Hawaiʻi Department of Land and Natural Resources, Engineering Division	Edwin Matsuda	Dam safety, flood control
Honolulu Board of Water Supply	Ernie Lau	Watershed management, water quality
Kauaʻi Public Works	Michael Moule	Civil and transportation engineering codes and standards
Honolulu Board of Water Supply	Raelynn Nakabayahi	Critical infrastructure: water supply
State Department of Transportation, Highways Division	Genevieve Sullivan	Environmental policy, climate change, and resiliency initiatives for transportation planning
Kauaʻi Utility Board	Jan TenBruggencate	Communications, outreach, scientific writing
State Department of Transportation, Airports Division	Herman Tuiolosega	Planning
Hawaiʻi State Energy Office, State Building Code Council	Howard Wiig	Energy resiliency, building codes
Natural and Cultural Resources		
County of Maui Department of Planning	James Buika	Coastal planning, shoreline setbacks, land use policy
Department of Land and Natural Resources Aha Moku	Leimana DaMate	Traditional Hawaiian methodologies and knowledge of cultural and natural resource management
Office of Planning and Sustainable Development Coastal Zone Management	Justine Nihipali	Coastal zone management, land use policy
Maui Planning	Tara Owens	Coastal processes, hazards, and resilience; science and policy communication; community building
State of Hawaiʻi Department of Land and Natural Resources, Division of Forestry and Wildlife	Michael Walker	Forestry
State of Hawaiʻi Office of Planning and Sustainable Development, Coastal Zone Management	Lisa Webster	GIS, Coastal Zone Management, Ocean Resources Management Plan, urban and regional planning
Department of Land and Natural Resources Hawaiʻi State Historic Preservation Division	Michael Wahl	GIS, anthropology, cultural resources, water conservation, native food resources
Climate Change		
School of Ocean and Earth Science and Technology, University of Hawaiʻi	Chip Fletcher, PhD	Coastal processes, hazards, and resilience
University of Hawaiʻi Sea Grant Program; State DLNR, Office of Conservation and Coastal Lands	Bradley Romine, PhD	Coastal processes, hazards, and resilience
Maui Planning	Tara Owens	Coastal processes, hazards, and resilience; science and policy communication; community building

Agency	Name	Area of Expertise
State of Hawai'i Office of Planning and Sustainable Development, Coastal Zone Management	Lisa Webster	GIS, Coastal Zone Management, Ocean Resources Management Plan, urban and regional planning
Kaua'i Planning, University of Hawai'i Sea Grant Program	Ruby Pap	Coastal processes, hazards, and resilience
Social Vulnerability		
Hawai'i Tourism Authority	Jennifer Chun	
Department of Hawaiian Home Lands	Niniau Kawaihae	
Department of Business, Economic Development & Tourism	Lauren Primiano	Economic development planning
Hawai'i State Department of Health, State Toxicologist	Diana Felton	Toxicology, hazardous materials, human health, chemical contamination
Department of Business, Economic Development & Tourism Broadband Strategy Officer	Burt Lum	Economic development planning
Hawai'i Interagency Council on Homelessness	Scott Morishige	
	Dayevin Bunao	
Lead for America	Alexis Ching	Community Building
Hazards of Concern		
School of Ocean and Earth Science and Technology, University of Hawai'i	Chip Fletcher, PhD	Climate Change and Sea Level Rise
State of Hawai'i Department of Land and Natural Resources, Engineering Division	Edwin Matsuda	Infrastructure Failure (Dam Failure)
Drought and Water Conservation Coordinator Hawai'i Department of Land and Natural Resources	Neal Fujii	Drought
University of Hawai'i, East-West Center	Ryan Longman	Climate, water resources, drought
United States Geological Survey, Hawaiian Volcano Observatory	Paul Okubo, PhD	Earthquake
State of Hawai'i Department of Land and Natural Resources, Engineering Division; National Flood Insurance Program Coordinator	Carol Tyau-Beam	Flood
State of Hawai'i, Department of Land and Natural Resources, Engineering Division	Jizella San Andres	Flood
State of Hawai'i Department of Land and Natural Resources, Engineering Division	Edwin Matsuda	Flood
State of Hawai'i Office of Planning and Sustainable Development, Coastal Zone Management	Lisa Webster	Flood
Hawai'i County Floodplain Manager	Bryce Harada	Flood
Hawai'i State Department of Health, State Toxicologist	Diana Felton	Hazardous Materials
Hawai'i Institute of Geophysics and Planetology Center for the Study of Active Volcanoes	Donald Thomas, PhD	Hazardous Materials
Hawai'i State Department of Health	Judy Kern	Hazardous Materials
Hawai'i State Department of Health, State Toxicologist	Diana Felton	Health Risks
Hawai'i State Department of Health	Judy Kern	Health Risks
Hawai'i State Department of Health Office of Public Health Preparedness	Michelle Kwok	Health Risks

Agency	Name	Area of Expertise
Hawaiʻi State Department of Health Office of Public Health Preparedness	Casey Nagatoshi	Health Risks
Hawaiʻi State Climatologist, University of Hawaiʻi	Pao-Shin Chu, PhD	Windstorm
Federal Emergency Management Agency	Victor DeJesus	Windstorm
National Oceanic and Atmospheric Administration/ National Weather Service Honolulu Forecast Office	Kevin Kodama	Windstorm
National Oceanic and Atmospheric Administration	Tina Stall	Windstorm
United State Geological Survey	Ken Hon	Landslide and Rockfall
Hawaiʻi State Climatologist, University of Hawaiʻi	Pao-Shin Chu, PhD	Hurricane
National Oceanic and Atmospheric Administration	Jon Bravender	Hurricane
University of Hawaiʻi	Gerald Fryer, PhD	Tsunami
University of Hawaiʻi	Ian Robertson	Tsunami
State of Hawaiʻi Office of Planning and Sustainable Development, Coastal Zone Management	Lisa Webster	Tsunami
United States Geological Survey	Jim Kauahikaua	Volcanic Hazards
United States Geological Survey	Frank Trusdell	Volcanic Hazards
United States Geological Survey	Patricia Maddau	Volcanic Hazards
Hawaiʻi Institute of Geophysics and Planetology Center for the Study of Active Volcanoes	Donald Thomas, PhD	Volcanic Hazards
State of Hawaiʻi Department of Land and Natural Resources, Division of Forestry and Wildlife	Dietra Myers Tremblay	Wildfire
State of Hawaiʻi Department of Land and Natural Resources, Division of Forestry and Wildlife	Michael Walker	Wildfire
Building Codes		
City and County of Honolulu, Office of Climate Change, Sustainability and Resiliency	Matthew Gonser	Building codes, climate change, resiliency
County of Maui Department of Planning	James Buika	Coastal planning, shoreline setbacks, land use policy
Kauaʻi Emergency Management Agency	David Kennard	Hazard mitigation, resiliency, communication
County of Hawaiʻi Public Works Building Division; Hawaiʻi State Energy Office, State Building Code Council	Neal Tanaka	Building codes and standards
Hawaiʻi State Energy Office, State Building Code Council	Howard Wiig	Energy resiliency, building codes
Martin, Chock & Carden Structural Engineers; State Building Code Council	Lyle Carden	Building codes and standards
State of Hawaiʻi, Department of Land and Natural Resources, Engineering Division	Carol Tyau-Beam	Flood, Infrastructure Failure (Dam Failure), National Flood Insurance Program Coordinator
Hawaiʻi Emergency Management Agency	Francis Kau	Emergency preparedness and response, individual assistance
County of Hawaiʻi Public Works Building Division	Kelly Wilson	Building codes and standards
City and County of Honolulu, Office of Climate Change, Sustainability and Resiliency	Sarah Harris	Hazard mitigation, long-term disaster recovery

Table A-3. Lead Draft 2023 SHMP Update Reviewers

Section	Agency	Name
Section 1 – Introduction	County of Kaua'i and State Hazard Mitigation Forum Chair	David Kennard
Section 2 – Planning Process	County of Kaua'i and State Hazard Mitigation Forum Chair	David Kennard
Section 3 – State Profile	County of Kaua'i and State Hazard Mitigation Forum Chair	David Kennard
Section 4.0 – Risk Assessment*	County of Kaua'i and State Hazard Mitigation Forum Chair	David Kennard
Section 4.1 – Overview*	County of Kaua'i and State Hazard Mitigation Forum Chair	David Kennard
Section 4.2 – Climate Change and Sea Level Rise	School of Ocean and Earth Science and Technology, University of Hawai'i	Chip Fletcher, PhD
Section 4.3 – Cyber Threat	State Office of Homeland Security	Jimmie Collins
Section 4.4 – Drought	Drought and Water Conservation Coordinator Hawai'i Department of Land and Natural Resources	Neal Fujii
Section 4.5– Earthquake	United States Geological Survey	Paul Okubo, PhD
Section 4.6 –Flood	State of Hawai'i, Department of Land and Natural Resources, Engineering Division	Carol Tyau-Beam
		Jizella San Andres
Section 4.7 – Hazardous Materials	Hawai'i State Department of Health	Diana Felton
	Hawai'i Institute of Geophysics and Planetology Center for the Study of Active Volcanoes	Donald Thomas, PhD
Section 4.8 – Health Risks	Hawai'i State Department of Health	Diana Felton
Section 4.9 – Hurricane	Hawai'i State Climatologist, University of Hawai'i	Pao-Shin Chu, PhD
Section 4.10 – Infrastructure Failure	State of Hawai'i Department of Land and Natural Resources, Engineering Division	Edwin Matsuda
Section 4.11 – Landslide and Rockfall	United State Geological Survey Hawaiian Volcano Observatory	Ken Hon
Section 4.12 – Terrorism	State Office of Homeland Security	Jimmie Collins
Section 4.13 – Tsunami	Geophysicist, Pacific Tsunami Warning Center	Gerard Fryer, PhD
Section 4.14 – Volcanic Hazards	United States Geological Survey	Jim Kauahikaua, PhD
	Hawai'i Institute of Geophysics and Planetology Center for the Study of Active Volcanoes	Donald Thomas, PhD
Section 4.15 – Wildfire	State of Hawai'i Department of Land and Natural Resources, Division of Forestry and Wildlife	Michael Walker
Section 4.16 – Windstorm	Hawai'i State Climatologist, University of Hawai'i	Pao-Shin Chu, PhD
Section 4.17 – Vulnerability Summary	County of Kaua'i and State Hazard Mitigation Forum Chair	David Kennard
Section 5 – Capability Assessment**	County of Kaua'i and State Hazard Mitigation Forum Chair	David Kennard
Section 6 – Mitigation Strategy**	County of Kaua'i and State Hazard Mitigation Forum Chair	David Kennard
Section 7 – Plan Maintenance	County of Kaua'i and State Hazard Mitigation Forum Chair	David Kennard
Appendices	County of Kaua'i and State Hazard Mitigation Forum Chair	David Kennard
References	County of Kaua'i and State Hazard Mitigation Forum Chair	David Kennard
Acronyms	County of Kaua'i and State Hazard Mitigation Forum Chair	David Kennard
Executive Summary	County of Kaua'i and State Hazard Mitigation Forum Chair	David Kennard

Notes:
** The risk assessment methodology was discussed with SMEs listed in Table 2.1-3 at the beginning stages of the 2023 SHMP Update.*
***The State Hazard Mitigation Forum members and state agencies were consulted throughout the planning process, both at in-person and virtual meetings and via email and telephone to update their agency-specific information and contribute to each of these sections.*

Table A-4. Sectors Engaged in the 2023 SHMP Update

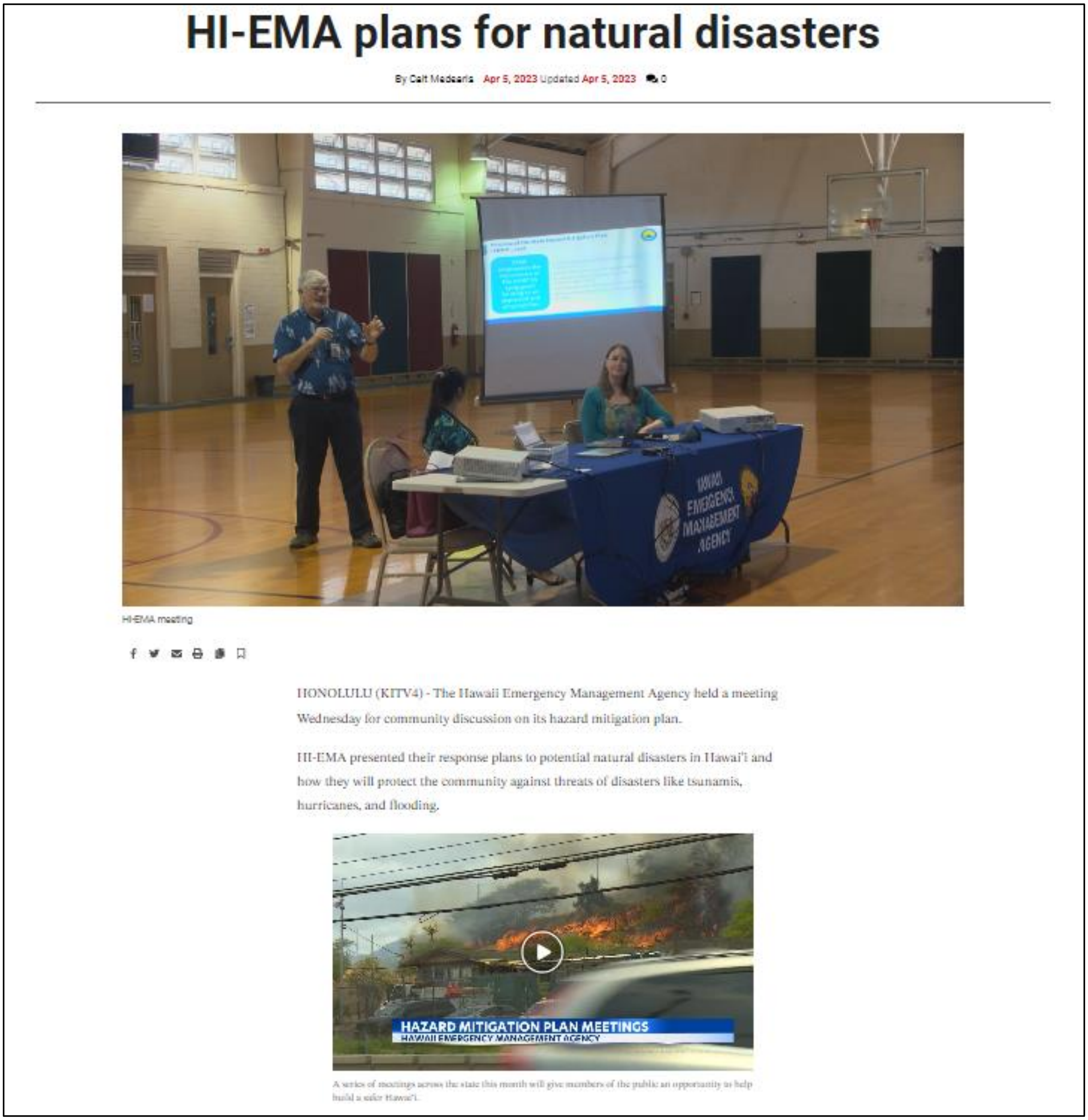
Agency	Involvement
Emergency Management	
FEMA Region 9 Pacific Area Office	Invited to and attended Forum meetings to provide input on all aspects of the 2023 SHMP Update.
FEMA Region 9	Invited to and attended Forum meetings; participated in regular calls with the HI-EMA Mitigation Section regarding the 2023 SHMP Update progress.
HI-EMA	The Mitigation Section led the 2023 SHMP Update; additional sections and SMEs were invited to and attended Forum meetings as noted in the Forum member table (Table 2.2-1 above); invited to the Mitigation Workshop in February 2023 and invited to updated capabilities and submit mitigation strategies.
City and County of Honolulu Office of Climate Change, Sustainability and Resiliency	Invited to and participated in the Building Codes and Standards Focus Group; invited to the Mitigation Workshop in February 2023 and invited to update capabilities and submit mitigation strategies.
State of Hawaiʻi Office of Homeland Security	Member of the Forum; invited to and attended Forum meetings to provide input on all aspects of the 2023 SHMP Update; subject matter expert for cyber and terrorism hazard sections.
County Emergency Management Agencies	Members of the Forum include county emergency management agency representatives; invited to and attended Forum meetings to provide input on all aspects of the 2023 SHMP Update.
Economic Development	
Hawaiʻi State Department of Business, Economic Development and Tourism	Invited to and participated in the Social Vulnerability Focus Group; invited to the Mitigation Workshop in February 2023 and invited to update capabilities and submit mitigation strategies.
State Department of Accounting and General Services - State of Hawaiʻi Risk Management Office	Provided state building database for the risk assessment; invited to public meetings.
Land Use and Development	
State of Hawaiʻi Office of Planning and Sustainable Development, Coastal Zone Management	Member of the Forum; invited to and attended Forum meetings to provide input on all aspects of the 2023 SHMP Update; invited to and participated in the Social Vulnerability Focus Group.
County Planning Departments	Members of the Forum include county planning department representatives; invited to and attended Forum meetings to provide input on all aspects of the 2023 SHMP Update.
Housing	
Department of Human Services	Invited to participate in the Social Vulnerability Focus Group; invited to the Mitigation Workshop in February 2023 and invited to update capabilities and submit mitigation strategies.
Health and Social Services	
Hawaiʻi State Department of Health	Member of the Forum; invited to and attended Forum meetings to provide input on all aspects of the 2023 SHMP Update; SME review of the hazardous materials and health risks sections (Sections 4.7 and 4.8); contributed mitigation strategies.
Infrastructure	
State Department of Transportation – Harbors Division	Member of the Forum; invited to and attended Forum meetings to provide input on all aspects of the 2023 SHMP Update; invited to the Mitigation Workshop in February 2023 and invited to update capabilities and submit mitigation strategies.

Agency	Involvement
State Department of Transportation – Highways Division	Member of the Forum; invited to and attended Forum meetings to provide input on all aspects of the 2018 SHMP Update; invited to the Mitigation Workshop in February 2023 and invited to updated capabilities and submit mitigation strategies.
State Department of Land and Natural Resources, Engineering Division	Ex officio member of the Forum; invited to and attended Forum meetings to provide input on all aspects of the 2018 SHMP Update; invited to the Mitigation Workshop in February 2023 and invited to update capabilities and submit mitigation strategies.
Kaua'i Island Utility Cooperative	Member of the Forum; invited to and attended Forum meetings to provide input on all aspects of the 2023 SHMP Update; invited to the Mitigation Workshop in February 2023 and invited to update capabilities and submit mitigation strategies.
Honolulu Board of Water Supply	Member of the Forum; invited to and attended Forum meetings to provide input on all aspects of the 2023 SHMP Update; invited to the Mitigation Workshop in February 2023 and invited to update capabilities and submit mitigation strategies.
Hawai'i State Energy Office	Member of the Forum; invited to and attended Forum meetings to provide input on all aspects of the 2023 SHMP Update; invited to the Mitigation Workshop in February 2023 and invited to update capabilities and submit mitigation strategies.
State Building Code Council	Invited to and participated in the Building Codes and Standards Focus Group; invited to the December 7, 2022 Forum meeting; invited to the Mitigation Workshop in February 2023 and invited to update capabilities and submit mitigation strategies.
Natural and Cultural Resources	
Department of Land and Natural Resources, Hawai'i State Historic Preservation Division	Provided dataset for cultural resources for the vulnerability assessment.
Department of Land and Natural Resources, Division of Forestry & Wildlife	Member of the Forum; invited to and attended Forum meetings to provide input on all aspects of the 2023 SHMP Update; invited to the Mitigation Workshop in February 2023 and invited to update capabilities and submit mitigation strategies.
University of Hawai'i Sea Grant Program	Member of the Forum; invited to and attended Forum meetings to provide input on all aspects of the 2023 SHMP Update; invited to the Mitigation Workshop in February 2023 and invited to update capabilities and submit mitigation strategies; SME review of the climate change and sea level rise hazards (Section 4.2).
Department of Land and Natural Resources, Engineering Division and State National Flood Insurance Program Coordinator	Ex officio member of the Forum; invited to Forum meetings to provide input on all aspects of the 2023 HMP Update; invited to the Mitigation Workshop in February 2023 and invited to update capabilities and submit mitigation strategies; SME review of the flood and infrastructure failure hazards (Sections 4.6 and 4.10); Invited to participate in the Building Codes and Standards Focus Group.
Department of Hawaiian Home Lands Planning Office	Invited to the Mitigation Workshop in February 2023 and invited to update capabilities and submit mitigation strategies.
Private Sector	
Building Industry Association of Hawai'i	Invited to the public meetings in April and invited to submit mitigation strategies.
Structural Engineer Association of Hawai'i (SEAOH)	
American Institute of Architects	

A.1 Additional Public Outreach

Additional news articles publicizing the availability of the draft 2023 SHMP Update for review and comment and associated public meetings are highlighted in Figure A-1 through Figure A-4. Refer to Section 2 (Planning Process) for the HI-EMA meeting announcements.

Figure A-1. KITV News Coverage of the April 5, 2023 Public Meeting in Honolulu



HI-EMA plans for natural disasters

By Cait Medearis Apr 5, 2023 Updated Apr 5, 2023 0

HI-EMA meeting

HONOLULU (KITV4) - The Hawaii Emergency Management Agency held a meeting Wednesday for community discussion on its hazard mitigation plan.

HI-EMA presented their response plans to potential natural disasters in Hawai'i and how they will protect the community against threats of disasters like tsunamis, hurricanes, and flooding.

HAZARD MITIGATION PLAN MEETINGS
HAWAII EMERGENCY MANAGEMENT AGENCY

A series of meetings across the state this month will give members of the public an opportunity to help build a safer Hawai'i.

Source: KITV

Figure A-2. April 10, 2023 Maui News Article Promoting Public Meetings

State seeks public input on hazard plan

LOCAL NEWS

APR 10, 2023

The Maui News

The Hawaii Emergency Management Agency will host meetings on Maui, Molokai and Lanai this month to seek public input on how the state can better protect against hazards like hurricanes and wildfires.

Meetings on the 2023 State Hazard Mitigation Plan had originally been planned for December but were postponed because the agency staff who were organizing them were assigned to work the Mauna Loa volcanic eruption. The agency gathered public input from across the state for the 2023 plan during a virtual meeting in December.

"We fully update these plans every five years because they're a key tool we use to reduce or eliminate the harm caused by the hazards we face across Hawai'i," James Barros, administrator of the agency, said in a news release Tuesday.

The state and the counties rely on these plans to guide their efforts to protect communities against the threats of flooding, hurricanes, wildfires, tsunamis and other hazards.

Meetings will be held across the state, including at:

• Mitchell Pauole Community Center, 90 Ainoa St., Kaunakakai, 5-6 p.m. April 19.

• Kahului Community Center, 275 Uhu St., 5-6 p.m. April 20.

The site for the April 25 meeting on Lanai is to be determined.

For more details on upcoming meetings, the draft plan or the online public input survey, visit experience.arcgis.com/experience/f60e1a0a7dfc4069a0ea862108023c43/page/Public-Participation/ or scan the QR code.

Source: State seeks public input on hazard plan | News, Sports, Jobs - Maui News

Figure A-3. April 18, 2023 Public Meeting Promotion on Hawaii News Now

HAWAII NEWS NOW

Live News Weather Sunrise Sports Special Reports Podcasts HI Now Entertainment Merrie Monarch Festival

High Surf Advisory Is In Effect

State agency requests community input for Hawaii's hazard mitigation plan

The Hawaii Emergency Management Agency is continuing a series of community meetings across the state to help refresh its hazard mitigation plan.

By HNN Staff

Published: Apr. 18, 2023 at 5:36 AM HST | Updated: Apr. 18, 2023 at 10:28 AM HST

HONOLULU (HawaiiNewsNow) - The Hawaii Emergency Management Agency is continuing a series of community meetings across the state to help refresh its hazard mitigation plan.

HIEMA's plans are updated every 5 years in an effort to minimize or prevent long-term risks from threats including flooding, hurricanes, wildfires and tsunamis.

Officials said Mauna Loa's eruption forced the agency to reschedule meetings that were originally set for last December.

Those who want to see the current Multi-hazard mitigation plan can do so on HI-EMA's website. Public comments can also be

Source: State agency requests community input for Hawaii's hazard mitigation plan (hawaiinewsnow.com)

Figure A-4. April 27, 2023 Post on Big Island Video News

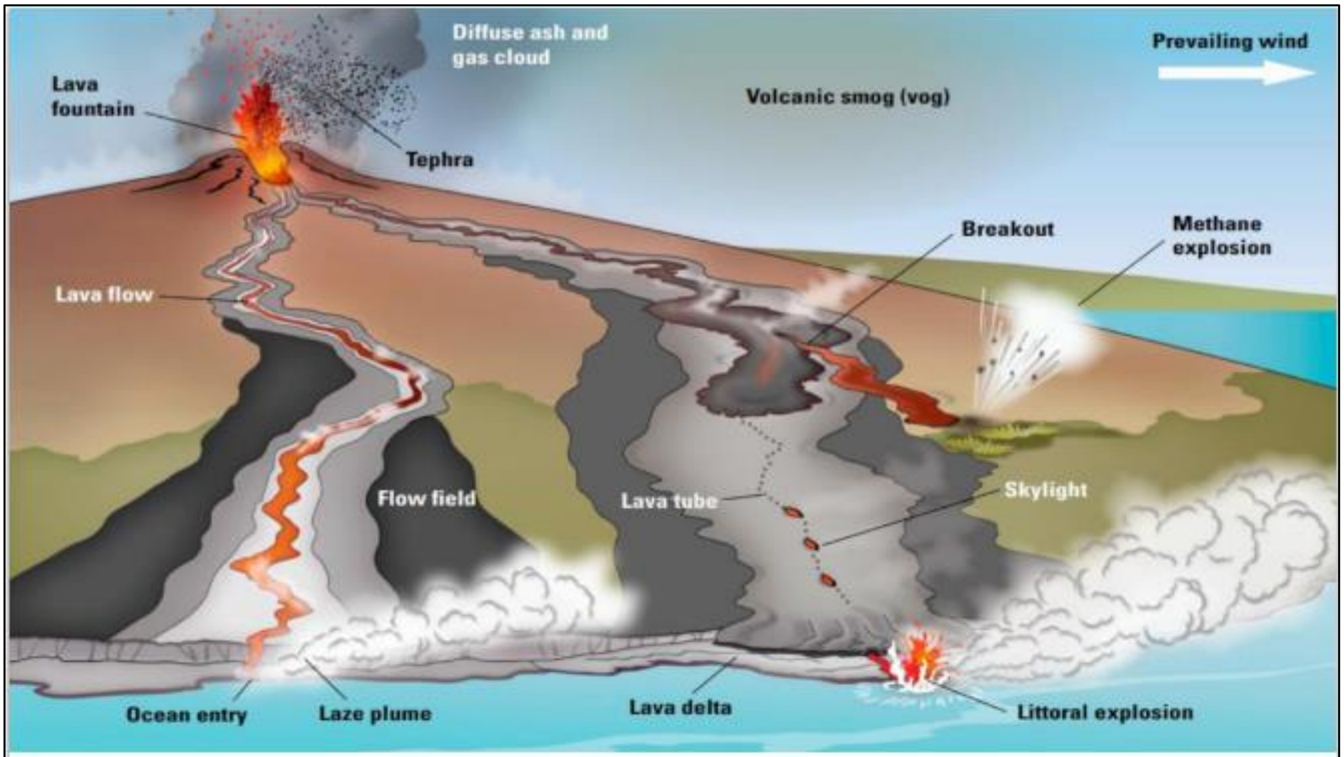


Figure 4.14-1 from the draft plan, Shield Volcano and Lava Field Components (Source: U.S. Geological Survey 2019)

Hawaiʻi Posts Draft Hazard Mitigation Plan For Public Comment

by Big Island Video News
on Apr 27, 2023 at 1:17 pm

93
Shares

Source: Hawaiʻi Posts Draft Hazard Mitigation Plan For Public Comment (bigislandvideonews.com)

A.2 Summary of Public Comments Received on the Draft 2023 SHMP Update

HI-EMA held one virtual public meeting, six in-person public meetings, and one hybrid statewide meeting to allow residents the opportunity to provide input on the planning process. Additionally, the state posted the draft 2023 SHMP Update on the StoryMap and HI-EMA websites, along with a comment capture form to enable residents to submit comments based on their review of the plan. All comments received were considered by the HI-EMA Mitigation Section and Forum Chair for incorporation into the final submittal to FEMA. Table A-5 provides a summary of the public meetings.

Table A-5. Summary of Public Meetings

Date and Time	Location	Number of Persons Signed In
December 20, 2022 (5:30–6:30 p.m.)	Virtual (Statewide)	23
April 5, 2023 (4–5 p.m.)	HI-EMA Building 300 Gym 3949 Diamond Head Road, Honolulu 96816	14
April 17, 2023 (5–6 p.m.)	Aupuni Center Conference Room 101 Pauahi Street, Hilo 96720	15
April 18, 2023 (5–6 p.m.)	West Hawaiʻi Civic Center Community Meeting Hale 74-5044 Ane Keohokalole Highway, Kailua-Kona 96740	10
April 19, 2023 (4–5 p.m.)	Mitchell Pauole Community Center 90 Ainoa Street, Kaunakakai 96748	8
April 20, 2023 (4–5 p.m.)	Kahului Community Center 275 Uhu Street, Kahului 96732	6
April 24, 2023 (4–5 p.m.)	Moikeha Conference Room 4444 Rice Street, Līhuʻe 96766	19
May 3, 2023 (5–7 p.m.)	HIARNG Building 19, Room 121 19 Shangrila Street, Kapolei 96707 and Virtual	18

On December 20, 2022, a virtual public meeting was held to provide an overview and status update on the 2023 SHMP Update. A brief presentation provided an overview of the plan, the update process, and the draft risk assessment results. The meeting was publicly advertised to encourage residents to provide input on the planning process.

The following provides a summary of the topics discussed during the December meeting:

- Social vulnerability considerations in the State of Hawaiʻi
- Hardening facilities against wind, wildfire, and other hazards
- Revising hazard maps to account for roads inundated by lava from the Kīlauea eruption

A survey was released during the December public meeting to gauge awareness of hazards in the State of Hawaiʻi. The survey was kept open until April 30, 2023. 15 members of the public provided input via the survey about hazards experienced:

- Ten or more of the respondents have experienced an earthquake, hurricane, flood, or health risk.
- Between 5 and 9 respondents have experienced:
  - Climate change and sea level rise
  - Cyber threat
  - Drought
  - Landslide and rockfall
  - Tsunami
  - Wildfire
  - Windstorm
  - Volcanic hazard
- Less than 5 respondents have experienced:
  - Hazardous Materials Incident
  - Infrastructure/Dam Failure
  - Terrorism
  - Volcanic Hazards
  - Additional comments indicated that respondents had experienced a missile threat and post-fire air quality issues when soil is blown by the wind.

On April 26, 2023, HI-EMA released the draft 2023 SHMP Update allowing the public to provide input on the draft plan prior to submittal to FEMA. The public comment period was open through May 9, 2023. The principal avenues for public comment on the draft plan were the StoryMap and HI-EMA website. In total, 29 comments were received via the form posted on the websites. Additionally, public meetings were held to allow an opportunity to provide comment on the draft plan, ask questions, and discuss mitigation with the SHMO. These meetings were held on all the major islands.

At each meeting, the SHMO, the State Hazard Mitigation Chair, and the planning consultant gave a presentation and answered questions posed by attendees. Specific comments received are available upon request. All comments were reviewed by the SHMO and planning consultant and incorporated into the draft plan as appropriate. The following provides a summary of the topics discussed at the public meetings and the public comments received via the websites.

- April 5, 2023 Public Meeting in the City and County of Honolulu:
  - Local mitigation successes and potential new mitigation projects
  - Feasibility of implementing mitigation projects
- April 17, 2023 Public Meeting in Hilo, Hawaiʻi County:
  - Progress with CDBG funding related to local hazard mitigation projects
  - Social vulnerability distribution across the island
  - Integration of additional USGS data when representing earthquake risk
  - Lack of local emergency evacuation routes

- April 18, 2023 Public Meeting in Kailua-Kona, Hawaiʻi County:
  - Risks from floods, lack of evacuation routes, and potential fallout from a missile attack
  - Importance of including impacts to animals (agricultural, ranching, and domestic) in the risk assessment
- April 19, 2023 Public Meeting on Molokaʻi Island, Maui County:
  - Mitigation grant funding distribution for remote islands like Molokaʻi
  - Ideas for mitigation projects that would be viable for the island
- April 20, 2023 Public Meeting on Maui Island, Maui County:
  - Challenges of effective emergency management when staff resources are reduced
- April 24, 2023 Public Meeting in Kauaʻi County:
  - Need for atmospheric modeling to predict increased storms and flooding
  - Actual cost of building code upgrades verses the benefits
  - Mitigation funding for health risks
  - Mayor Kawakami expressed the need for disaster preparedness/shelter-in-place kits for visitors staying in vacation rentals and for socially vulnerable populations
  - Datasets to better represent social vulnerability
- May 3, 2023 Hybrid Statewide Public Meeting in Kapolei, Honolulu County:
  - Additional consideration of historic windstorms in the Kawaihae
- Public Comments Received on the Draft Plan via the Form on the Website
  - Consider extreme heat as a separate hazard
  - Well-written draft that explains concepts clearly
  - Include biosecurity and additional invasive species hazard discussion and analysis in planning efforts
  - Discuss additional funding and plan implementation strategies
  - Dashboards provide a great snapshot of each hazard section
  - Include additional information on drought and its connection to climate change
  - Dataset coordination needed among state agencies and planning efforts
  - Vulnerability of both Maui and Hawaiʻi counties to the earthquake hazard should be emphasized
  - Indicate hazard mitigation planning compliance with National Incident Management System (NIMS)
  - Include success of the Hawaiʻi Mesonet efforts for climate monitoring

A.3 Meeting Attendees and Materials

All agencies and stakeholders listed in Table A-2 were invited to the public meetings in December 2022, April 2023, and May 2023. Those who attended included representatives from the County of Kauaʻi, the City and County of Honolulu, the County of Maui, the County of Hawaiʻi, Hawaiʻi Department of Land and Natural Resources, and the Department of Hawaiian Homelands.

Representatives from each of the sectors listed in Table A-4 were invited to and attended the capability and mitigation strategy working sessions and applicable sector meetings in February 2023.

All Forum members listed in Appendix B (State Hazard Mitigation Forum Membership and Bylaws) were invited to Forum meetings. Attendees at each meeting included representatives from each county and sector.

Meeting presentations (where applicable and as available) for the State Hazard Mitigation Forum meetings and public meetings convened during the development of the 2023 SHMP Update are included in chronological order. Photographs from select public meetings are also included in chronological order. Sign-in sheets for public meetings and more information on project status meetings, Forum meetings, FEMA meetings and meetings with subject matter experts is available upon request.

TETRA TECH

State of Hawai‘i 2023 Hazard Mitigation Plan

Special Hawai‘i State Hazard Mitigation Forum Meeting

October 12, 2022

Megan Brotherton, Tetra Tech

StoryMap

[HI State Hazard Mitigation Plan Update (arcgis.com)](https://experience.arcgis.com/experience/f60e1a0a7dfc4069a0ea862108023c43/)

https://experience.arcgis.com/experience/f60e1a0a7dfc4069a0ea862108023c43/

TETRA TECH

Online, interactive platform for stakeholders and the public to remain engaged throughout the planning process.

- Background Information
- Overview of planning process
- Plan drafts
- Opportunities for engagement

Why update the State HMP?

TETRA TECH

- Meet new FEMA requirements for State Plans
- Update Hazard Analysis and Risk Assessment
- Update Capability Assessment
- Update Mitigation Strategy
- Keep the State eligible for FEMA mitigation grant funding

New FEMA Planning Policy

TETRA TECH

Assess **climate change** impacts on natural hazards.

Assess **future changes** in population and development.

Incorporate considerations for **underserved communities and socially vulnerable populations**.

Assess adoption and enforcement of **building codes**.

New FEMA Planning Policy

TETRA TECH

Evaluate all **dam risk** and include criteria required under High Hazard Potential Dam grant program.

Demonstration **integration of FEMA programs** (e.g., Community Lifelines, Fire Mitigation Assistance Grant, NFIP, Risk MAP, etc.).

Detailed description of **planning process and stakeholder engagement**.

Detailed description of State support for **local hazard mitigation planning**.

Hazards Addressed in the 2023 Update

TETRA TECH

1. Climate Change and Sea Level Rise
2. Cyber Threat (new)
3. Drought
4. Earthquake
5. Flood
   (including Chronic Coastal and Event-Based)
6. Hazardous Materials
7. Health Risks
8. Hurricane
9. Infrastructure Failure
   (including Dam Failure)
10. Landslide and Rock Fall
11. Terrorism (new)
12. Tsunami
13. Volcanic Hazards
14. Wildfire
15. Windstorm

Forum Role and Involvement

The Hawaiʻi State Hazard Mitigation Forum serves in an advisory capacity relative to the incorporation of hazard mitigation in policy in Hawaiʻi.

- Coordinate hazard mitigation activities in the State
- Recommend and prioritize project nominations for the Hazard Mitigation Grant Program (HMGP)
- Conduct a statewide public awareness campaign
- Assist in obtaining funds for mitigation projects
- Develop a hazard mitigation strategy for the State

The Forum will be engaged throughout the planning process during regularly scheduled meetings, including:

- Providing expertise to the planning process including emergency management, natural hazards, land use planning, building codes, transportation and infrastructure from both state and county perspectives
- Updates on the planning process
- Providing data and information to support the update
- Reviewing interim and draft plan deliverables

Subject Matter Expert and Focus Group Outreach

Tetra Tech and HI-EMA engaged about 35 subject matter experts to provide current hazard data sources and inform hazard scenarios.

Focus Group meetings were conducted to gather current local information on:

- Building Codes and Standards
- Social Vulnerability

Goals and Objectives Overview

TETRA TECH

Guiding Principle

Theme for the Plan

Goals

Swim Lanes for Mitigation

Objectives

Measures for Success

Actions

Actionable Strategies

- All components stand on their own merit.
- Each component is selected based on the ability to meet multiple aspects of its superior component.
- Objectives are used to prioritize actions.
- Aim to develop multi-objective actions.

Goals and Objectives Exercise

TETRA TECH

https://www.surveymonkey.com/r/HawaiiHMPGO

Draft Goals

TETRA TECH

2018 Goals	2023 Goals – *Suggested Revisions*
Goal 1—Reduce the long-term vulnerability of Hawaii's people, property and jurisdictions, including state-owned or operated buildings, infrastructure and critical facilities, to natural hazards while conserving the State's natural, historical, and cultural assets. This includes high risk properties such as repetitive loss (RL) and severe repetitive loss (SRL) properties.	**Goal 1 —** Utilize state-of-the-art methods and technology and local knowledge to identify and analyze hazards and assess State capabilities to reduce the impact of those hazards. *(2018 goal #4 was moved to #1)*
Goal 2—Promote actions designed to ensure long-term resiliency	**Goal 2 —** Promote public awareness of hazard risks and public action to reduce the long-term risks. *(2018 goal #5 was moved to #2)*
Goal 3—Strengthen partnerships and leverage existing resources and capabilities to identify, assess and reduce the impact of natural hazards	**Goal 3** – Provide a framework for robust local hazard mitigation planning and mitigation strategy implementation in alignment with this plan. *(2018 goal #6 was moved to #3)*
Goal 4—Utilize state-of-the-art methods and technology and local knowledge to identify and analyze natural hazards and assess State capabilities to reduce the impact of those hazards	**Goal 4** – Strengthen partnerships and leverage existing resources and capabilities to identify, assess and reduce the impact of hazards. *(2018 goal #3 was moved to #4)*
Goal 5—Promote public awareness of natural hazard risks and public action to reduce the long-term risks	**Goal 5** – Promote long-term resiliency by reducing the vulnerability and consequences of Hawaii's people and property, including state-owned or operated buildings, infrastructure, and critical facilities, to hazards and their impacts while conserving the State's natural, historical, and cultural assets. *(Combined 2018 goals #1 and #2. Moved the goal to #5 in 2023 plan.)*
Goal 6—Provide a framework for robust local hazard mitigation planning and mitigation strategy implementation in alignment with this plan.	***Goal 6*** *—Build capacity and capabilities to increase disaster resiliency among historically underserved populations, individuals with access and functional needs, and in communities disproportionately impacted by hazards and their impacts.* *(New goal for 2023)*
	Goal #7 – Leverage federal grant programs such as the High Hazard Potential Dams, Hazard Mitigation Grant Program Post Fire, and Flood Mitigation Assistance, to strengthen Hawai'i's resilience to hazards and their impacts. *(Split the latter part of 2018 goal #1 out into its own goal)*

Draft Objectives to Consider (1-10 of 23)

TETRA TECH

1. Establish and maintain public-private partnerships among all levels of government, community groups, the private sector, and institutions of higher learning to improve and implement methods to protect life, property and the environment.
2. Utilize the best available data, science and technology to identify and communicate the risk exposure to hazards, climate change risks, and vulnerabilities to inform risk-reduction measures, preparedness response, and adaptation strategies.
3. Improve the understanding of the locations, potential and cascading impacts, and linkages among the threats, hazards, vulnerabilities, and measures needed to protect life, community lifelines, the environment, property, and infrastructure.
4. Promote, coordinate, and implement hazard mitigation plans and projects to be consistent with and supportive of climate action and adaptation goals, policies, and programs, and community needs at all governmental levels.
5. Actively promote and work collaboratively with local governments on coordinated hazard mitigation planning efforts to foster and reinforce resilient communities while addressing risk at a scale consistent with hazard areas.
6. Promote plan integration of local hazard mitigation plans and provide training and guidance to integrate and strengthen the linkages between the plans.
7. Increase community capacity to develop community-based disaster resilience plans that incorporate education and risk -reduction measures, for residents and visitors.
8. Reduce mitigation related disparities impacting underserved populations and historically marginalized communities through developing equitable and inclusive plans, investments, and engagements. Develop plans, programs, and policies that are adaptive and recognize the historic, cultural, economic, social, and demographic influences of the community.
9. Encourage and promote leveraging existing federal, state, local, and non-governmental resources to foster a comprehensive state-wide, whole community approach to mitigation.
10. Identify and encourage the use of state-wide recommended criteria to develop and inform a shared data repository to integrate into state, local, and non-governmental plans, strategies, and actions.

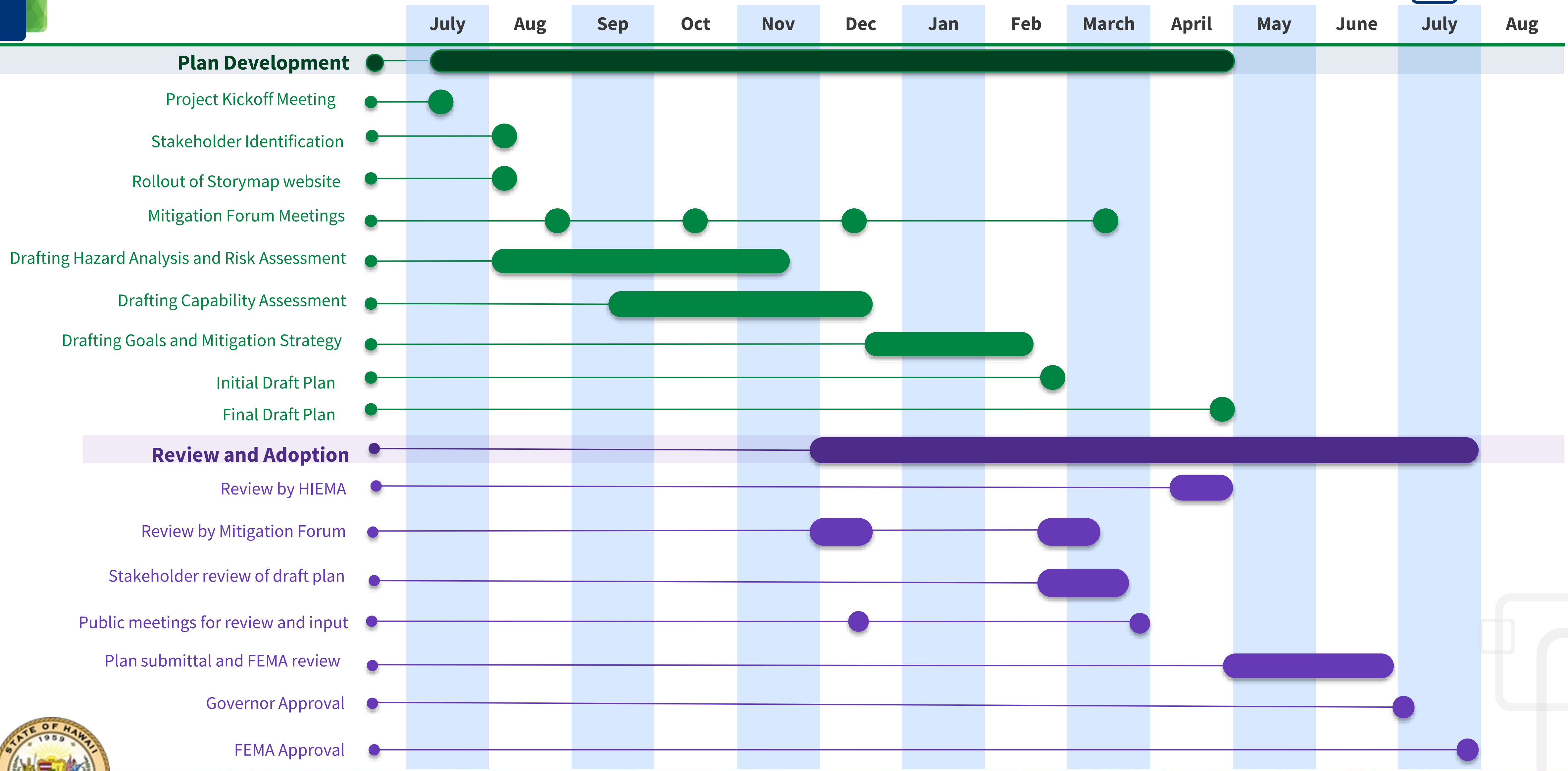
Draft Objectives to Consider (11-23 of 23)

TETRA TECH

11. Develop and implement mitigation policies, protocols, programs, and procedures to address the state's changing environment and climate.
12. Incorporate mitigation measures into the built environment, especially in areas with substantial hazard risk and those known to have repetitive loss.
13. Incentivize and implement mitigation measures for hazard risk and repetitive loss areas to address repairs, major alternations, development plans and practices.
14. Promote and implement the retrofit, hardening, acquisition or replacement of at-risk structures and lifelines to increase community resilience.
15. Adopt and enforce building codes and standards that are affordable and feasible for life and property protection.
16. Annually review the effectiveness of current land use related plans, codes, and standards for appropriate future development within hazard areas, and amend them as necessary to account for climate change effects.
17. Prioritize investment and support efforts to improve resilience of community lifelines in socially vulnerable communities.
18. Minimize impacts of hazard events on the economic drivers for the State.
19. Recognize and support the disaster resilience inherent in host culture traditions and practices including holistic watershed management, community connectivity, and local, ahupuaʻa based decision-making.
20. Support hazard mitigation measures that promote and enhance natural infrastructure and natural processes to minimize adverse impacts on the ecosystem and minimize public safety risks.
21. Improve warning and emergency communication systems and utilize a diversity of communication media.
22. Create supply chain diversity and improved resilience by supporting local food and energy production and increased multi-modal transportation.
23. Leverage limited financial and human resources by prioritizing projects that provide multiple benefits addressing social equity, disaster mitigation, and greenhouse gas reduction.

Schedule

TETRA TECH



Mitigation Strategies (Action Plan)

TETRA TECH

- The 2023 action plan will be developed after the 2018 actions are updated
  - Mitigation Strategy Workshop will be scheduled in December
- Actions will address hazards analyzed in the risk assessment
- FEMA mitigation grants are only available for natural hazards
- Each action will be designed to meet multiple objectives
- Focus on measurable actions that can be completed during the next 5 years

TETRA TECH

State of Hawai‘i 2023 Hazard Mitigation Plan

Hawai‘i State Hazard Mitigation Forum Meeting

December 7, 2022

Megan Brotherton, Tetra Tech

Risk Assessment Analysis

Three levels of analysis were used depending on the data available for each hazard:

- **Qualitative Analysis and Historical Occurrences** —Qualitative assessments used best available data and professional judgement. Historic impacts were examined to understand potential future events of similar size.
- **Exposure Assessment**—Hazards with defined extent and locations were overlayed with assets in GIS to determine which assets are exposed to the hazard.
- **Hazus Loss Estimation**—Hazus modeling software was used to estimate potential losses for Earthquake, Flood, Hurricane, and Tsunami hazards.

What is Hazus?

TETRA TECH

Hazus is a nationally standardized risk modeling methodology. FEMA’s Hazus Program provides standardized tools and data for estimating risk from:

- Earthquake
- Flood
- Hurricane
- Tsunami

Hazus can quantify and map risk information such as:

- **Physical damage** to residential and commercial buildings, schools, critical facilities and infrastructure.
- **Economic loss**, including lost jobs, business interruptions, and repair and reconstruction costs.
- **Social impacts**, including estimates of displaced households, shelter requirements, and populations exposed to floods, earthquakes, hurricanes and tsunamis.

Risk Assessment Analysis Summary (Qualitative, Exposure, Hazus)

TETRA TECH

Hazard	Data Analyzed						
	State Buildings	State Roads	Community Lifelines & Critical Facilities	Total Population & Vulnerable Population	General Building Stock	Environmental Resources	Cultural Assets
Climate Change and Sea Level Rise	E	E	E	E, H	E, H	E	E
Cyber Threat	Q	Q	Q	Q	Q	Q	Q
Drought	Q	Q	Q	Q	Q	Q	Q
Earthquake	E, H	E, H	E, H	E, H	E, H	E	E
Flood							
Chronic Coastal	E	E	E	E	E	E	E
Event-Based	E, H	E, H	E, H	E, H	E, H	E	E
Hazardous Materials	Q	Q	Q	Q	Q	Q	Q
Health Risks	Q	Q	Q	Q	Q	Q	Q
Hurricane	E, H	E, H	E, H	E	E, H	E	E
Infrastructure Failure (Dam Failure)	E	E	E	E	E	E	E
Landslide and Rockfall	E	E	E	E	E	E	E
Terrorism	Q	Q	Q	Q	Q	Q	Q
Tsunami	E	E	E	E, H	E, H	E	E
Volcanic Hazards	E	E	E	E	E	E	E
Wildfire	E	E	E	E	E	E	E
Windstorm	Q	Q	Q	Q	Q	Q	Q

New Risk Assessment Data

The 2023 SHMP update analyzes:

- **Critical Facilities *and* Community Lifelines**—The seven Community Lifeline categories are included in the risk assessment.
- **Coral Reefs**—Reefs are now included in the Environmental Resources analysis along with critical habitat, wetlands, and parks and reserves.
- **Total Population *and* High Vulnerability Population**—Tracts that met the overall Social Vulnerability Index score of >=80% are included in the high vulnerability population analysis.

Community Lifelines

- Lifelines are the most fundamental services in the community that, when stabilized, enable all other aspects of society to function.

- FEMA has developed a construct for objectives-based response that prioritizes the rapid stabilization of Community Lifelines after a disaster.

Safety and Security - Law Enforcement/Security, Fire Service, Search and Rescue, Government Service, Community Safety

Food, Water, Shelter - Food, Water, Shelter, Agriculture

Health and Medical - Medical Care, Public Health, Patient Movement, Medical Supply Chain, Fatality Management

Energy - Power Grid, Fuel

Communications - Infrastructure, Responder Communications, Alerts Warnings and Messages, Finance, 911 and Dispatch

Transportation - Highway/Roadway/Motor Vehicle, Mass Transit, Railway, Aviation, Maritime

Hazardous Material - Facilities, HAZMAT, Pollutants, Contaminants

Climate Change & Sea Level Rise
Hazard Scenarios and Select Vulnerability Results

TETRA TECH

Scenarios:

- **Sea Level Rise Exposure Area (SLR-XA) 3.2ft scenario** (future chronic coastal flooding)
- **1%-Annual-Chance Coastal Flood Zone (1%CFZ) + 3.2ft SLR** (event-based coastal flooding plus SLR)

State Building Loss from (SLR-XA-3.2), by County:

County	Total Number of State Buildings	Total Value	Number of State Buildings in SLR-XA-3.2	Percent of Total Buildings	Total Value of State Buildings in SLR-XA-3.2	Percent of Total Value
County of Kaua'i	531	$990,850,824	1	0.19%	$248,896	0.03%
City and County of Honolulu	3,472	$17,393,945,915	51	1.47%	$56,886,036	0.33%
County of Maui	831	$3,097,491,689	2	0.24%	$370,372	0.01%
County of Hawai'i	1,261	$4,638,567,141	0	0.00%	$0	0.00%
Total	**6,095**	**$26,120,855,568**	**54**	**0.89%**	**$57,505,304**	**0.22%**

Earthquake
Hazard Scenarios and Select Vulnerability Results

TETRA TECH

Hazus:

- **100-year probabilistic EQ event**
- **4 USGS ShakeMap scenarios:**
  - Kalapana 1975 M7.7 scenario
  - Kaʻū M8.0 scenario
  - Lānaʻi M7.0 scenario
  - NE Maui M7.0 scenario

202 U.S. Census Population Located on the NEHRP Class D and E Soils by County:

County	Population				
	Total Population	Total Population Located in Hazard Area	Population Exposed as Percent (%) of Total Population	High Vulnerability Population Located in Hazard Area	Population Exposed as Percent (%) of Total Population
County of Kauaʻi	71,949	-	-	-	-
City and County of Honolulu	979,682	-	-	-	-
County of Maui	167,093	80,507	48%	2,764	1.65%
County of Hawaiʻi	201,350	6,681	3%	20,783	10.32%
Total	**1,420,074**	**87,188**	**6%**	**23,547**	**1.66%**

Flood
Hazard Scenario and Select Vulnerability Results

TETRA TECH

Hazus:

- **Loss Assessment to 1% Annual Chance Flood**

State Road Exposure to the 1% Annual Chance Flood Event by County:

County	Length (in miles)		
	Total Length	Length in the SFHA	Percent of Total Length
County of Kaua'i	103.7	15.5	14.95%
City and County of Honolulu	374.9	44.9	11.98%
County of Maui	245.9	20.7	8.42%
County of Hawai'i	379.2	4.4	1.16%
Total	**1,103.70**	**85.5**	**7.75%**

Hurricane
Hazard Scenario and Select Vulnerability Results

TETRA TECH

Hazus:

- **SLOSH** (**S**ea, **L**ake and **O**verland **S**urges from **H**urricanes) **Categories 1-4**

Storm Surge Inundation by County:

County	Area (in square miles)								
	Total Area	Cat 1	Cat 1 as % of Total Area	Cat 2	Cat 2 as % of Total Area	Cat 3	Cat 3 as % of Total Area	Cat 4	Cat 4 as % of Total Area
County of Kaua'i	624.2914	4.5	0.72%	5.8	0.93%	10.1	1.62%	12.2	1.95%
City and County of Honolulu	598.5707	10.9	1.82%	22.3	3.73%	31.8	5.31%	38.2	6.38%
County of Maui	1,176.28	5.8	0.49%	7.9	0.67%	9.8	0.83%	11.4	0.97%
County of Hawai'i	4,039.64	1.9	0.05%	2.5	0.06%	3.7	0.09%	5.3	0.13%
Total	**6,438.78**	**23.1**	**0.36%**	**38.5**	**0.60%**	**55.4**	**0.86%**	**67.1**	**1.04%**

Infrastructure Failure (Dam Failure)
Hazard Scenario and Select Vulnerability Results

TETRA TECH

Scenario:

- **All High Hazard dam inundation areas**

Critical Facilities Exposure to High Hazard Dam Inundation Areas by Community Lifeline Category:

Community Lifeline Category	Total Number of Critical Facilities	Total Replacement Cost Value	Number of Critical Facilities in Hazard Area	Percent of Total Facilities	Value in the Hazard Area	Percent of Total Value
Communications	188	$776,797,683	12	6.38%	$47,000,315	6.05%
Energy	89	$3,093,949,530	15	16.85%	$557,941,340	18.03%
Food, Water, Shelter	345	$11,847,189,588	21	6.09%	$740,398,300	6.25%
Hazardous Material	12	$436,474,800	0	0.00%	$0	0.00%
Health and Medical	193	$4,606,713,364	7	3.63%	$95,885,988	2.08%
Safety and Security	486	$38,164,188,232	21	4.32%	$3,036,032,806	7.96%
Transportation	56	$2,039,091,600	8	14.29%	$290,352,000	14.24%
Additional Critical Facilities	106	$447,698,794	5	4.72%	$86,491,270	19.32%
Total	**1,475**	**$61,412,103,591**	**89**	**6.03%**	**$4,854,102,018**	**7.90%**

Landslide and Rockfall
Hazard Scenario and Select Vulnerability Results

TETRA TECH

Scenario:

- **High landslide susceptibility areas**

State Land Use Districts Located in High Landslide Susceptibility Areas:

Land Use District	Total (square miles)	Square Miles in High Landslide Susceptibility Areas	Percent of Total Area
Agricultural	2,973.6	645.5	21.71%
Conservation	3,202.9	512.8	16.01%
Rural	16.3	0.2	1.22%
Urban	319.1	14.4	4.51%
Total	**6,511.95**	**1,172.90**	**18.01%**

Tsunami
Hazard Scenarios and Select Vulnerability Results

TETRA TECH

Hazus:

- **SOEST Historic (200-yr)**
- **Great Aleutian Tsunami (GAT) (1,500-yr)**
- **ASCE Design Inundation Mapping (3,500-yr)**

Environmental Resources in SOEST Inundation Areas:

Environmental Resource	Statewide		
	Total Square Miles of Resources	Square Miles in the SOEST Inundation Area	Percent (%) of Total Resource Area
Critical Habitat	951	1	0.1%
Wetlands	3,637	18	0.5%
Parks and Reserves	2,778	9	0.3%
Reefs	55	1	1.9%
Total	**7,420**	**29**	**0.4%**

Volcanic Hazards
Hazard Scenarios and Select Vulnerability Results

TETRA TECH

Scenarios:

- **Hawai‘i County lava zones 1-4**
- **Maui County lava zones 1-2**

Cultural Resources Located in the Lava Flow Hazard Area:

Cultural Resource Site Type	Area in square miles		
	Total Square Miles of Asset	Square Miles in Lava Flow Hazard Areas	Percent of Total Asset Area
Archaeology	90.9	19.2	21.1%
Burial Sensitivity Area	2.1	0.5	24.5%
Historic Building	2.7	0.4	15.3%
Historic District	849.4	358.2	42.2%
Historic Object	9.6	9.6	99.9%
Historic Structure	20.7	16.5	79.4%
Total	**975.4**	**404.4**	**41.5%**

Wildfire
Hazard Scenario and Vulnerability Results

TETRA TECH

Scenario:

- **Communities at Risk from Wildfire (CAR) high wildfire risk areas**

Hawaiian Home Lands Located in the High Wildfire Risk Hazard Area:

County	Area (in square miles)		
	Total Area	Hazard Area	Hazard Area as Percent of Total Area
County of Kauaʻi County	32.1	2.2	6.8%
City and County of Honolulu	10.6	4.5	42.1%
County of Maui	102.6	38.3	37.3%
County of Hawaiʻi	191.5	6.1	3.2%
Total	**336.7**	**51.0**	**15.1%**

State of Hawai‘i 2023 Hazard Mitigation Plan

Virtual Open House

December 20, 2022

Mahalo for joining!

The program will begin soon.

Virtual Open House Participants

- Luke Meyers, Administrator, HI-EMA
- Kelsey Yamanaka, Acting State Hazard Mitigation Officer, HI-EMA
- Amber Ternus, Mitigation Strategist, HI-EMA
- David Kennard, Kaua‘i Emergency Management Agency (KEMA) Disaster Assistance Project Manager, State Hazard Mitigation Forum Chair
- Megan Brotherton, Lead Project Planner, Tetra Tech, Inc.
- and YOU!

Agenda and Ground Rules

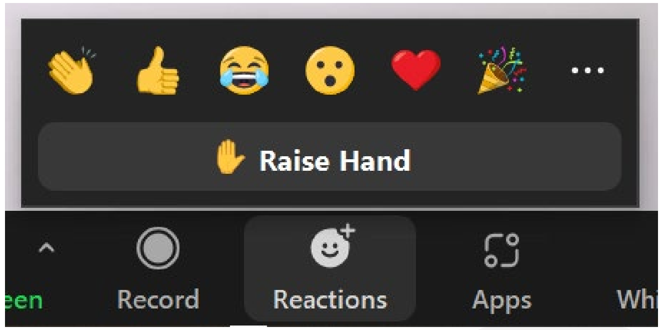
- Hazard Mitigation Plan Overview
- Social Vulnerability Requirements
- Risk Assessment Results and Path Forward

Each agenda item allows for public comment and questions

To participate, use the “Raise Hand” feature in “Reactions”

Or add your question or comment to “Chat”

Please limit comments to 3 minutes



Public Survey and Comment Form

Please use the link below or scan the QR code to take a brief survey and share comments about the plan update.

https://www.surveymonkey.com/r/SaferHI

Contacts for Emergency Management Agencies

- Hawaiʻi Emergency Management Agency HawaiiEMA@hawaii.gov
- Kauaʻi Emergency Management Agency kema@kauai.gov
- Maui Emergency Management Agency emergency.management@mauicounty.gov
- Honolulu Department of Emergency Management dem@honolulu.gov
- County of Hawaiʻi Civil Defense hccda@hawaiicounty.gov

Purpose of the State Hazard Mitigation Plan (SHMP)

Why do we have a SHMP? Why do we update it?

- FEMA and the Emergency Management Community acknowledge that our communities are subject to natural hazards and recognize that Hazard Mitigation Planning provides a framework to:
  - Identify the natural hazards and assess their impacts on the State and our communities,
  - Assess State's capacity to respond to and recover from the impacts of the natural disasters,
  - Develop strategies to reduce or eliminate these impacts on lives and property and to ensure the continued functionality of critical services, and
  - Reduce the disaster assistance costs resulting from natural disasters

Purpose of the State Hazard Mitigation Plan (SHMP), cont.

Why do we have a SHMP? Why do we update it?

- FEMA emphasizes the importance of the SHMP by tying grant funding to an approved and adopted Plan
  - Certain categories of Public Assistance (PA Categories C-G)
  - Hazard Mitigation Grant Program (HMGP)
  - Building Resilient Infrastructure and Communities (BRIC)
  - Fire Management Assistance Grants (FMAG)
  - Rehabilitation of High Hazard Potential Dam (HHPD)

SHMP Update Process and Timeline

- FEMA and the EM Community recognized that Hazards, Capabilities and Strategies can change
  - FEMA requires States to update the SHMP at least every 5 years
  - HI-EMA and its Consultant (Tetra Tech) are wrapping up the updated Hazard Assessment
  - Will soon begin reviewing the Capability Assessment, and updating the Mitigation Strategy with Mitigation Actions
  - Have final draft SHMP Update ready for FEMA review and approval by October

County of Hawaiʻi – Department of Water Supply Emergency Standby Power Connection at Critical Sites

Honokohau – Transfer Switch

Honokohau – Termination Box

Piihonua – Transfer Switch and Term Box

Piihonua Interconnect

County of Hawai‘i – Hilo Fire Station Structural Retrofit

County of Maui – Maui Food Bank Generator

MAUI FOOD BANK
Helping the Hungry

City and County of Honolulu – Hardening of Honolulu Harbor

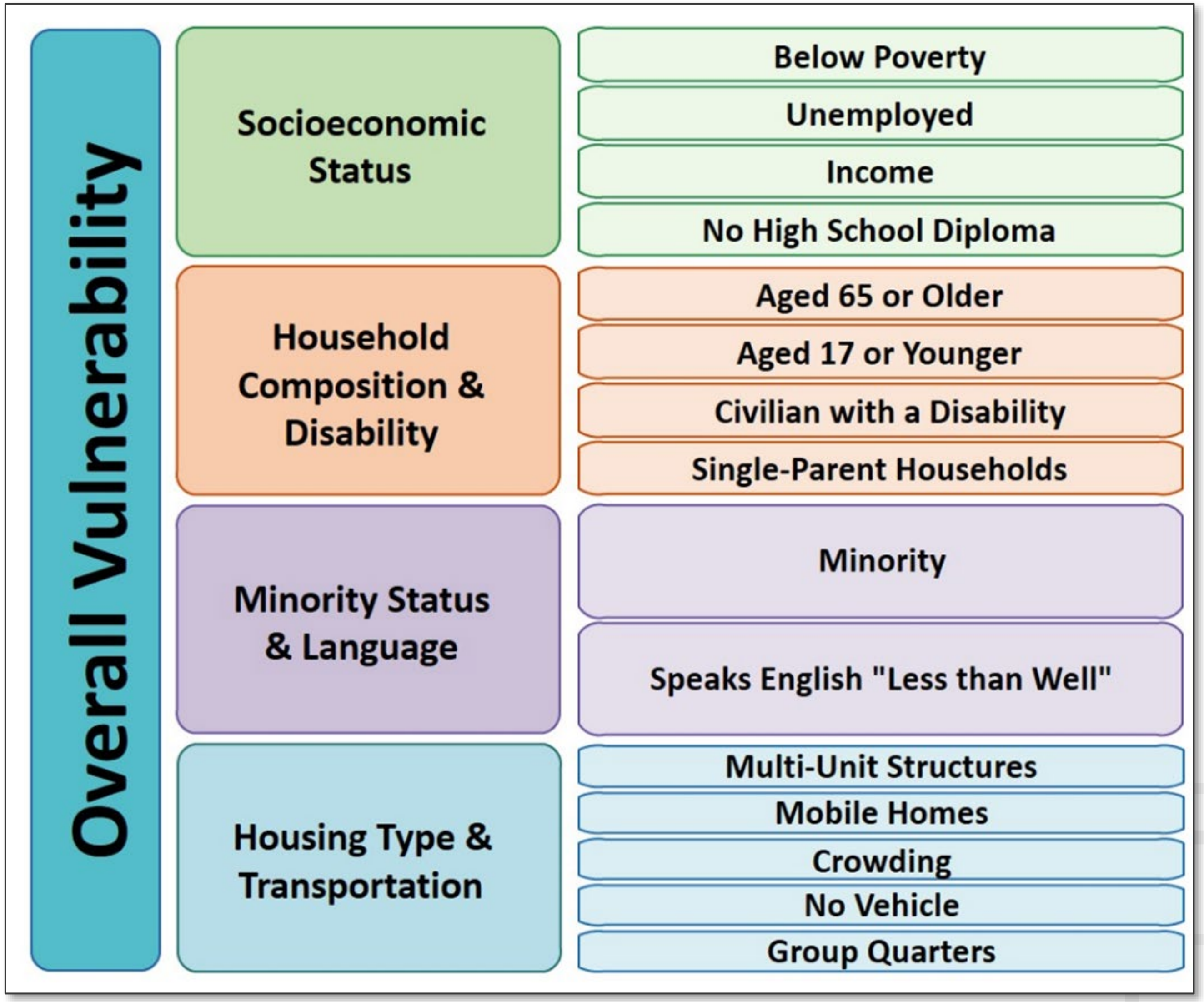
City and County of Honolulu – Waikiki Fire Station Bay Door Hardening

County of Kauaʻi - Kauaʻi War Memorial Convention Hall Envelope Hardening

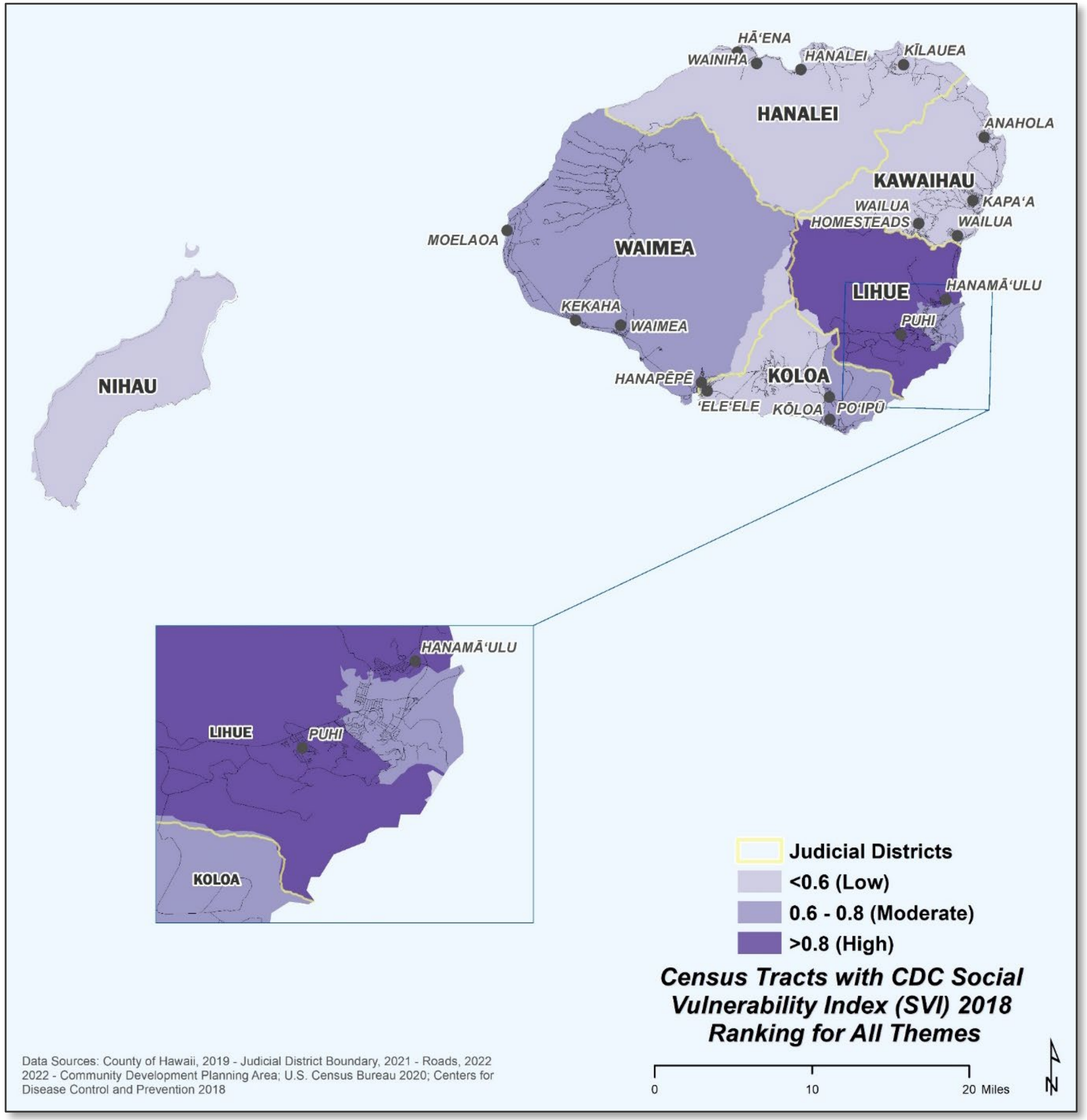
Please “Raise Hand” in “Reactions” or type your question in “Chat”

New FEMA Requirement for 2023

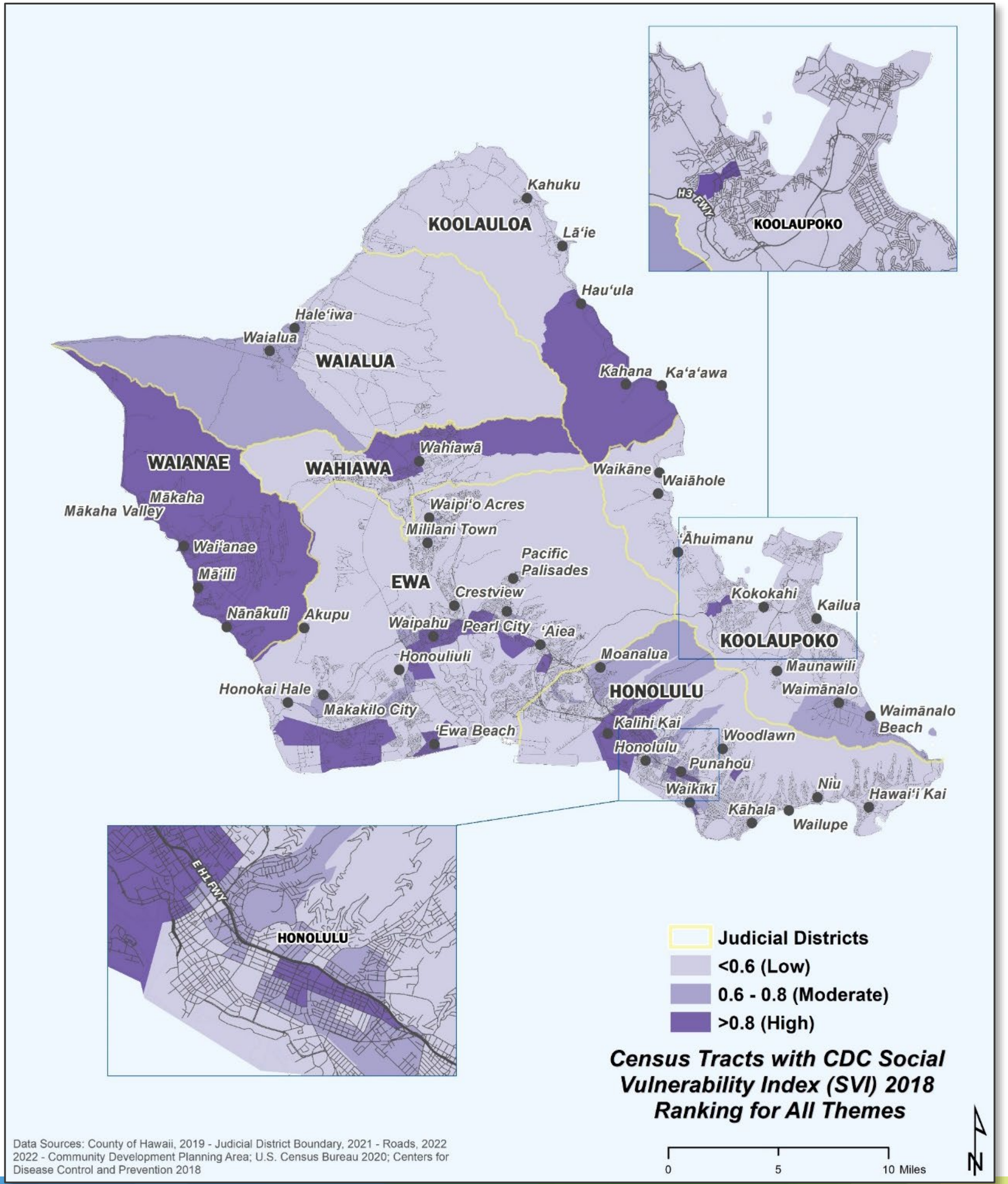
Incorporate considerations for underserved communities and socially vulnerable populations



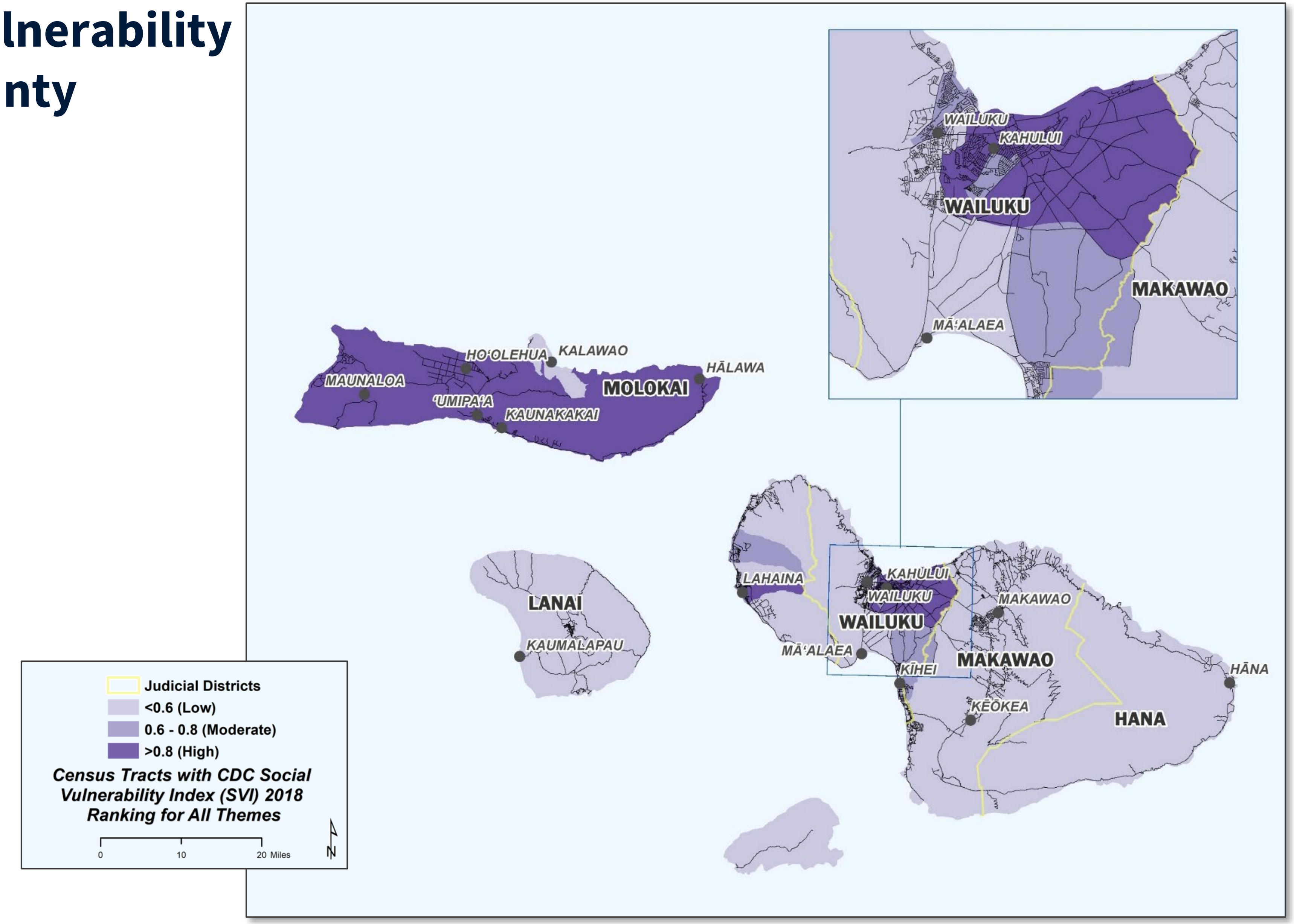
Social Vulnerability Kaua‘i County



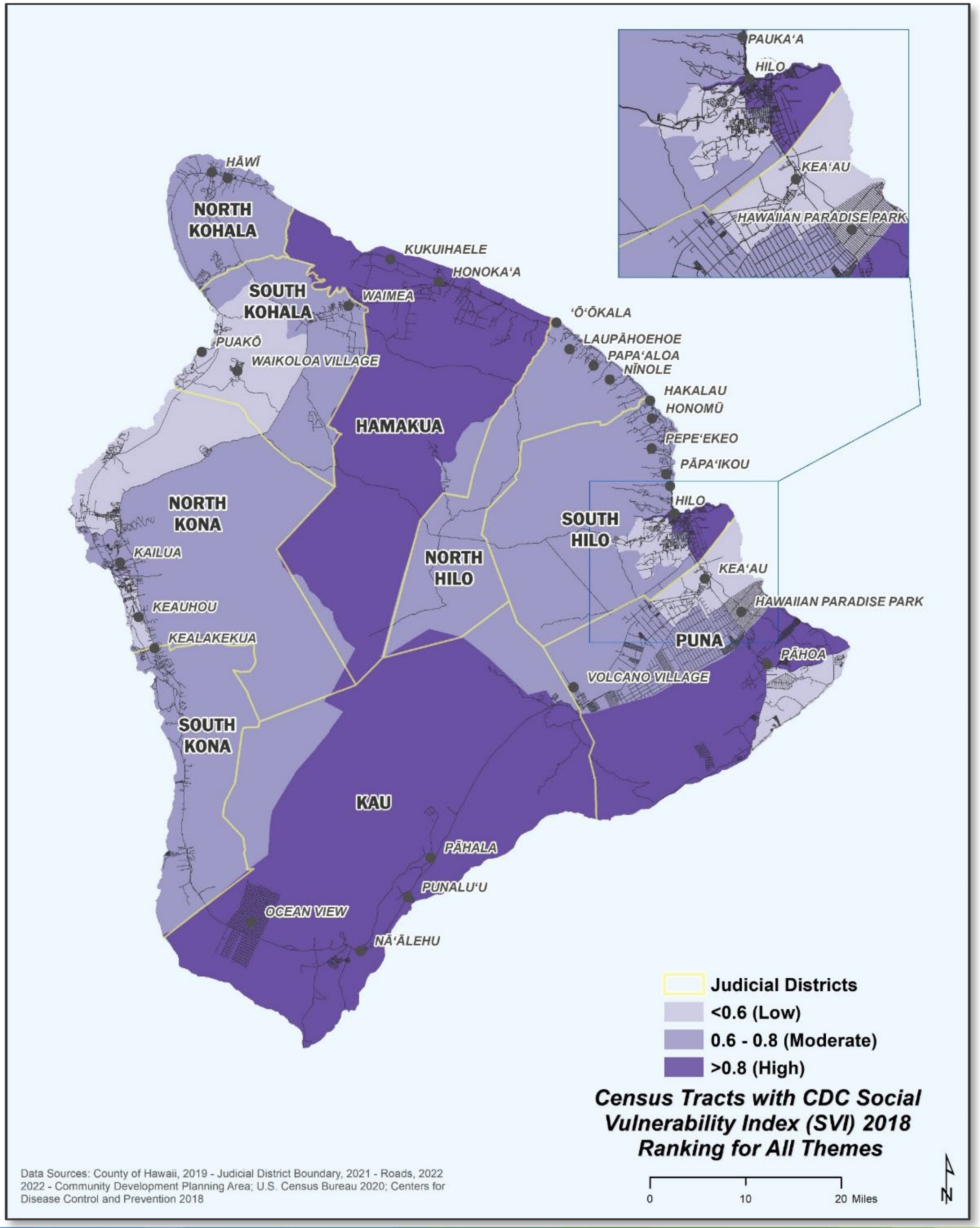
Social Vulnerability Honolulu County



Social Vulnerability Maui County



Social Vulnerability Hawai‘i County



Please “Raise Hand” in “Reactions” or type your question in “Chat”

Disasters Since 2018

Declaration Date	Disaster Number	Event	Federal Funding Obligations		
			Individual Assistance	Public Assistance	Hazard Mitigation Assistance
May 8, 2018	DR-4365	Kaua'i & O'ahu Flooding & Landslides	$1,593,486	$15,500,269	$2,791.984
May 11, 2018	DR-4366	Kīlauea Volcano Eruption and Earthquakes	$13,188,508	$123,675,352	$4,753,531
September 27, 2018	DR-4395	Hurricane Lane	-	$17,653,567	$2,222,398
October 23, 2019	FM-5294	Maui County Kahana Ridge Fire (HMGP Post Fire)	-	$110,837	-
April 1, 2020	DR-4510	COVID-19	$2,969,922	$219,474,425	-
July 9, 2020	DR-4549	Kaua'i Flood	-	$1,120,707	-
May 13, 2021	DR-4604	Maui Severe Storms, Flooding and Landslides	-	$5,965,731	-
August 1, 2021	FM-5404	Hawai'i County Mana Road Fire (HMGP Post Fire)	-	$1,097,960	-
February 15, 2022	DR-4639	Severe Storms, Flooding & Landslides (Kona Low)	-	$343,001	-
Total Funding Obligations 2018-2022			**$17,751,916**	**$384,941,849**	**$6,978,721**

Risk Assessment Analysis

Three levels of analysis were used depending on the data available for each hazard:

- **Qualitative Analysis and Historical Occurrences** —Qualitative assessments used best available data and professional judgement. Historic impacts were examined to understand potential future events of similar size.
- **Exposure Assessment**—Hazards with defined extent and locations were overlayed with assets in GIS to determine which assets are exposed to the hazard.
- **Hazus Loss Estimation**—Hazus modeling software was used to estimate potential losses for Earthquake, Flood, Hurricane, and Tsunami hazards.

Earthquake – Lānaʻi High & Elementary School, Lānaʻi

State of Hawaiʻi

Welcome | Draft Plan | Citizen Survey | Hazards

Earthquake

Earthquakes in Hawaiʻi are caused by eruptive processes within the active volcanoes or by deep structural adjustments due to the weight of the islands on Earth's underlying crust. Local or distant earthquakes can lead to tsunamis in the State. *ShakeMap* data prepared by the U.S. Geological Survey (USGS) and probabilistic earthquake data were used to assess the earthquake hazard. The evaluation of the following historic events utilizing the current environment provides an understanding of potential loss if the event were to happen today.

- The Kalapana 1975 M7.7 scenario with an epicenter approximately 26 miles south southeast of Hilo. This scenario represents the Kalapana M7.2 earthquake on November 29, 1975.

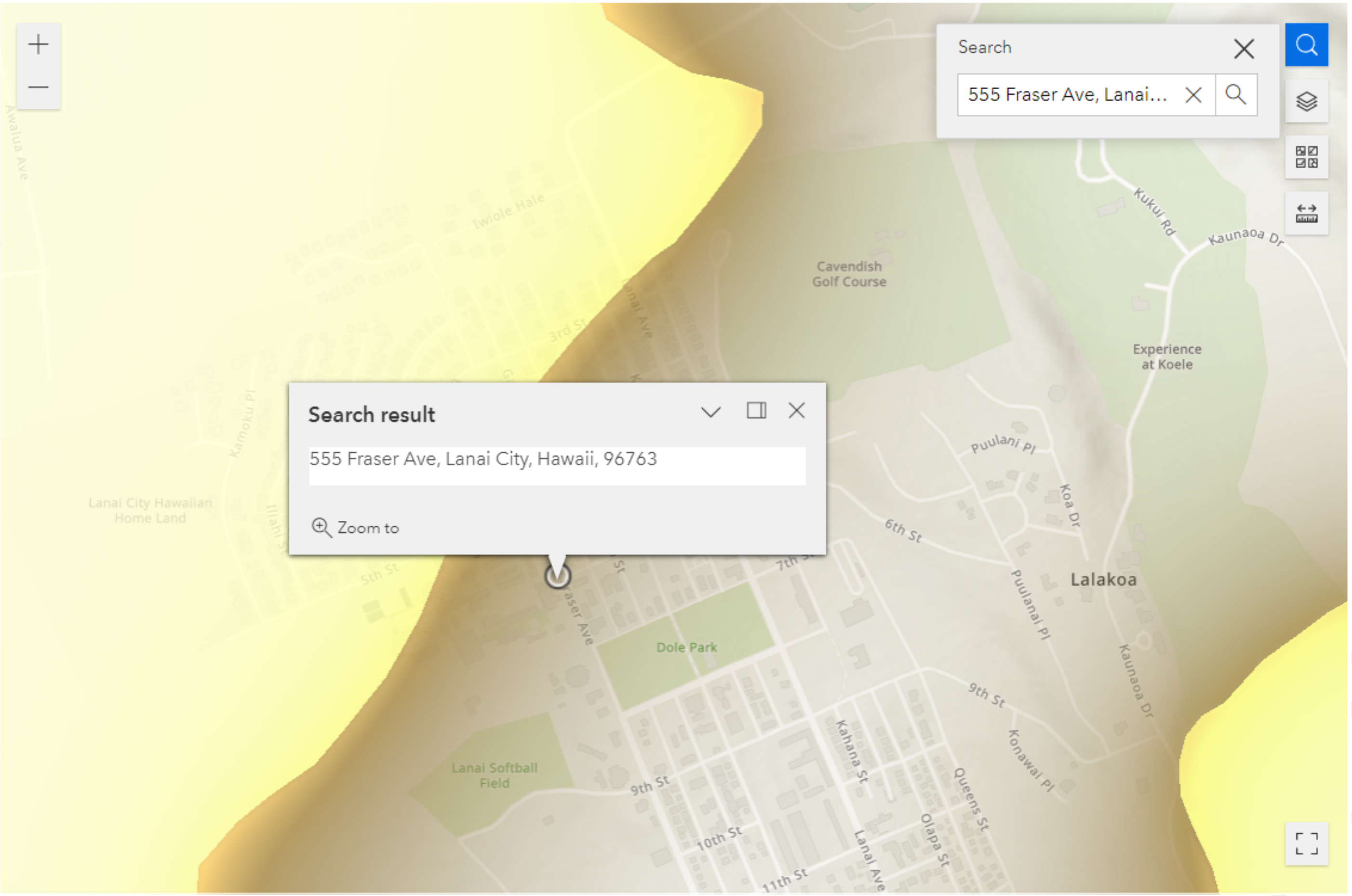
NEHRP Soils

Type

D

E

Hawaii Boundary



Flood – Ala Wai Elementary School, Honolulu

State of Hawai'i

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Flood

According to FEMA, floods occur in the United States more frequently than any other natural disaster. Because Hawai'i is surrounded by ocean, the state is susceptible to coastal and inland floods. Two types of flooding are represented in this map.

Chronic Coastal Flooding

Chronic coastal flooding is shown for the Sea Level Rise Exposure Area 1.1 (SLR-XA-1.1). SLR-XA-1.1 is defined as the combined effects of annual high wave flooding, passive flooding, and coastal erosion exacerbated by sea level rise. This hazard layer is defined in the 2017 Hawai'i Sea Level Rise Vulnerability and Adaptation Report. This hazard layer represents current conditions.

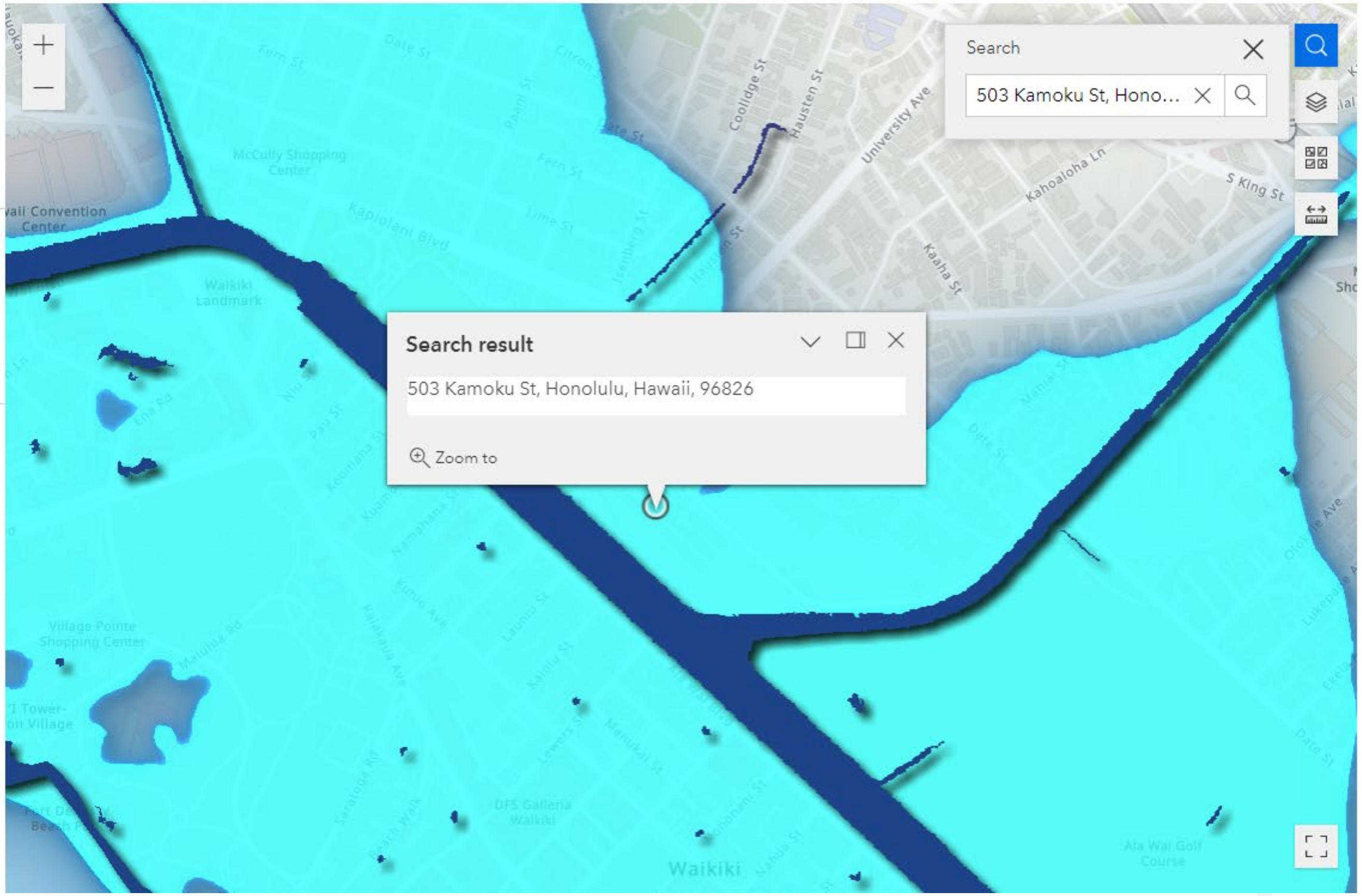
Event-Base Flooding

The quantitative risk assessment for the event-

Chronic Coastal Flood (SLR-XA 1.1 ft hazard area)

FEMA Flood Hazard Area (1-Percent Annual Chance Flood)

Hawaii Boundary



Infrastructure (Dam) Failure – Kōloa Elementary School, Kaua‘i

State of Hawai‘i

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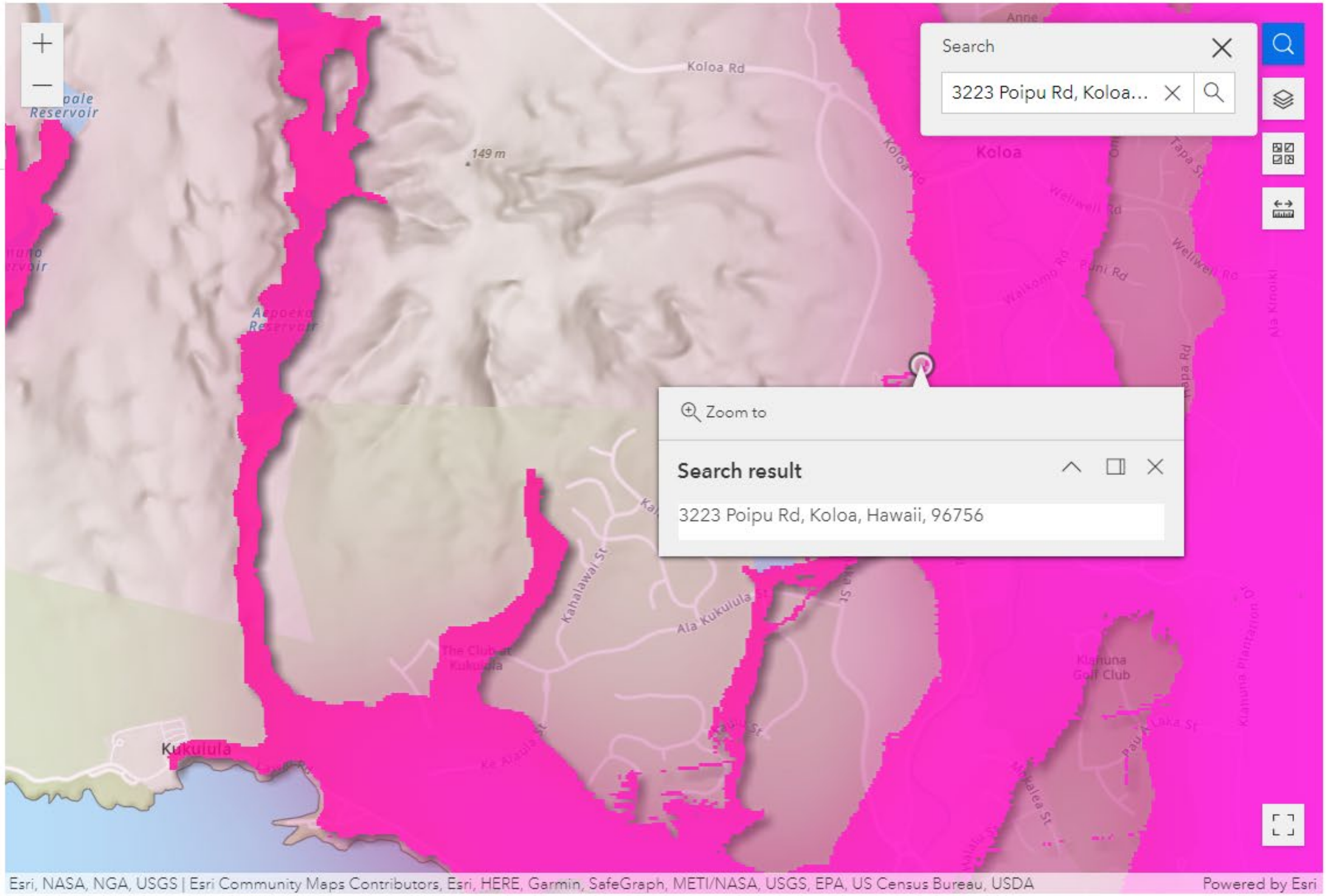
Infrastructure Failure

Dam failure is the mapped hazard for infrastructure failure. All high-hazard dam failure inundation areas in the state are shown on this map.

Access to additional dam information about dams in Hawai‘i can be found *here*.

Dam Inundation Hazard Area

Hawaii Boundary



Tsunami – Kīhei Elementary School, Maui

State of Hawaiʻi

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Tsunami

Tsunamis are a single wave or a series of waves caused by earthquakes, landslides, or other disturbances in or near large bodies of water like seas and oceans. Tsunami waves can travel at hundreds of miles per hour and create waves as tall as 100 feet when they reach the shore. Hawaiʻi's location in the Pacific Ocean, surrounded by the Circum-Pacific Belt (or the "ring of fire" – an earthquake-active region that encompasses much of the edges of the Pacific Ocean), makes it a likely target for earthquake-generated tsunamis throughout the Pacific. In the last 100 years, eight destructive tsunamis have affected the State, the worst of which came in 1946 and 1960.

Three scenarios were used to develop inundation area data for the tsunami hazard map:

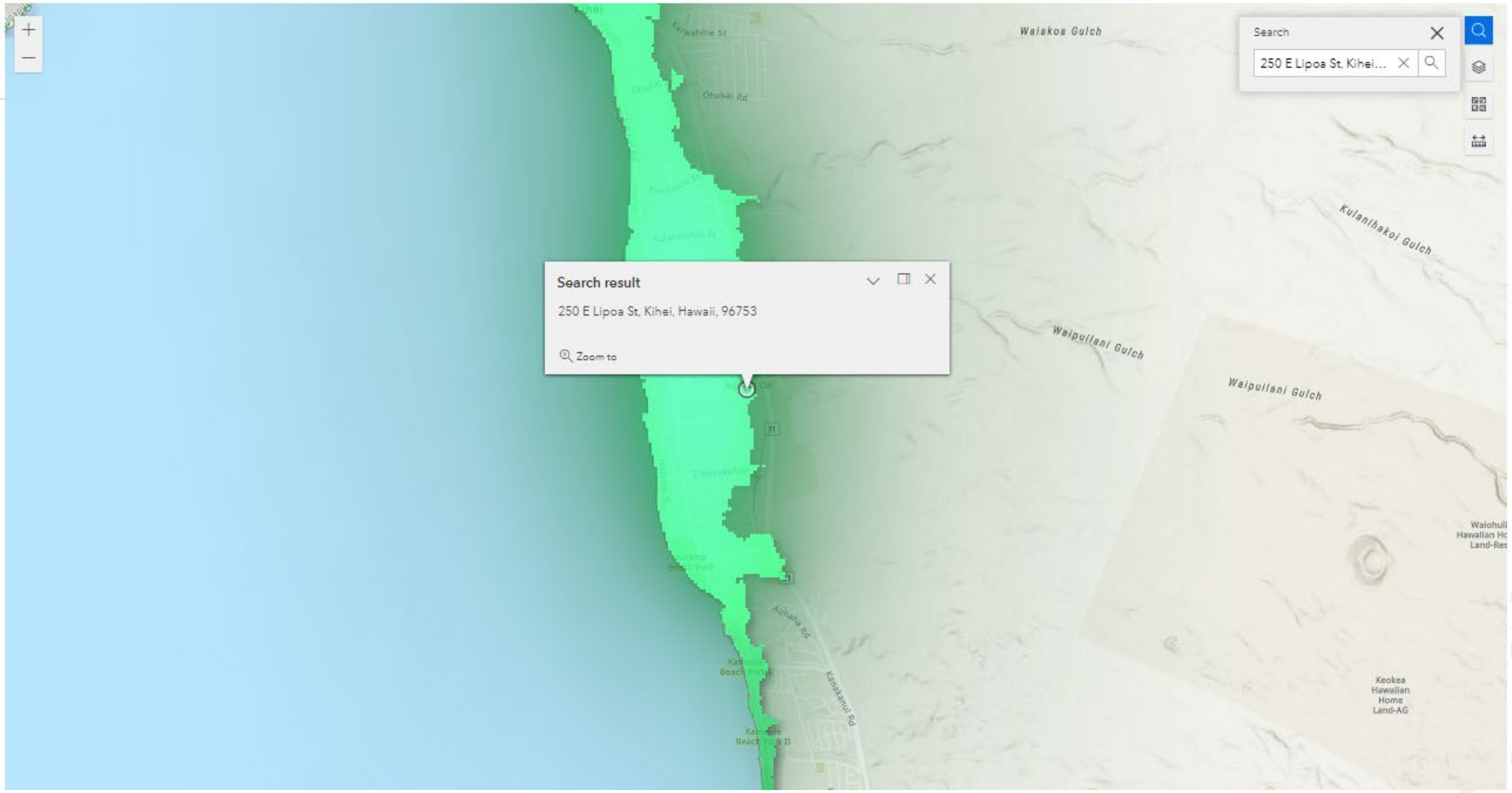
Great Aleutian Tsunami (GAT) (1,500-yr)

School of Ocean & Earth Science & Technology (SOEST) Historic (200-yr)

American Society of Civil Engineers (ASCE) Design Inundation Mapping (3,500-yr)

ASCE (3,500-yr)

Hawaii Boundary



Volcanic Hazards – Hilo Union School, Hawaiʻi

State of Hawaiʻi

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Volcanic Hazards

Volcanic hazards include lava flow and vog hazards. Mapping is based on the lava flow zones for the counties of Maui and Hawaiʻi. Flows typically erupt from a volcano's summit or along rift zones on its flanks, as seen in the 2022 Mauna Loa eruption. The USGS provides lava flow zones on Maui. The Hawaiʻi Statewide GIS program provides Hawaiʻi County's lava zones.

Volcanic Zones - Hawaiʻi County

Hazard Zone

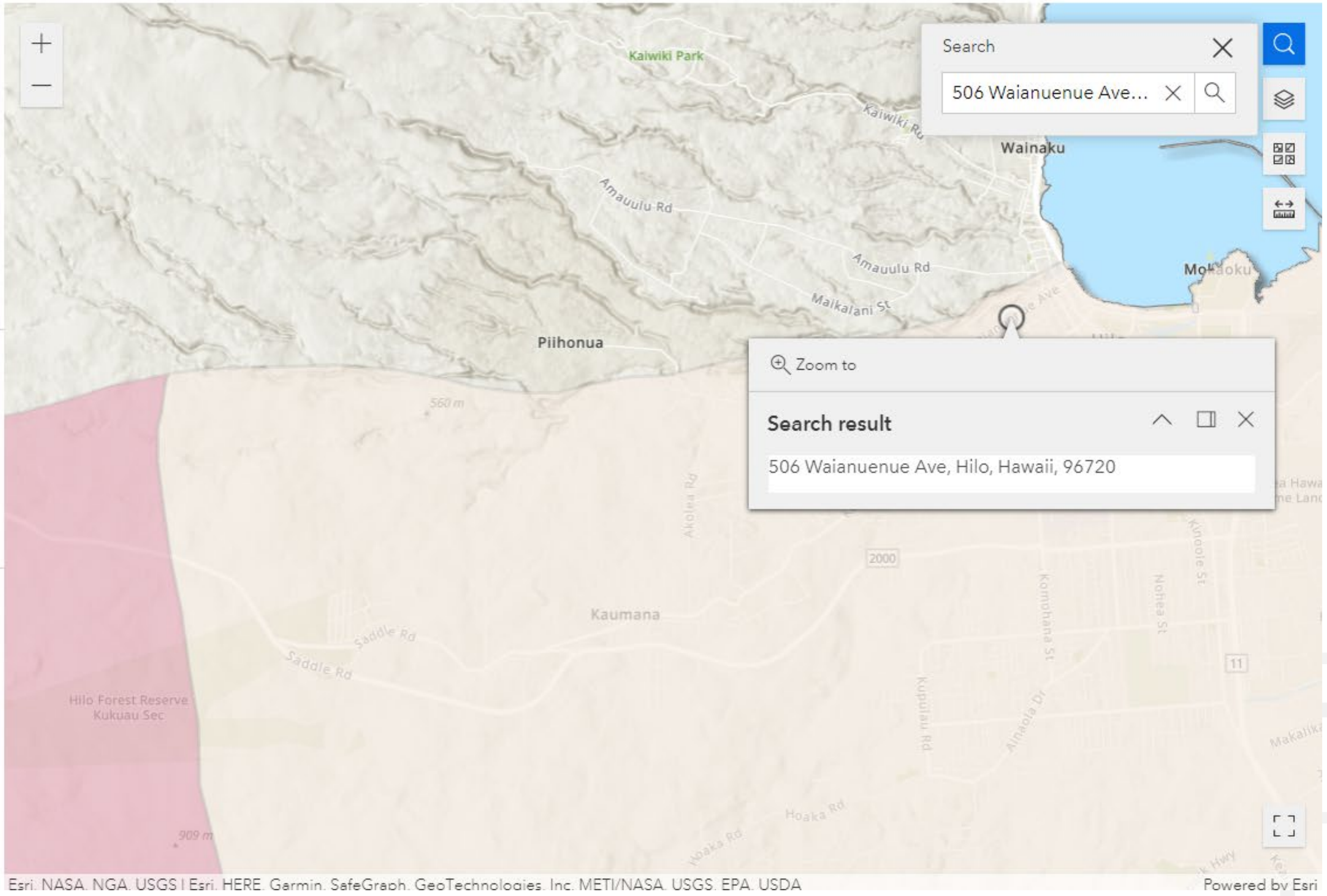
- Zone 1
- Zone 2
- Zone 3
- Zone 4

Volcanic Zones - Maui County

Hazard Zone

- Zone 1
- Zone 2

Hawaii Boundary



Wildfire – Molokaʻi High School

State of Hawaiʻi

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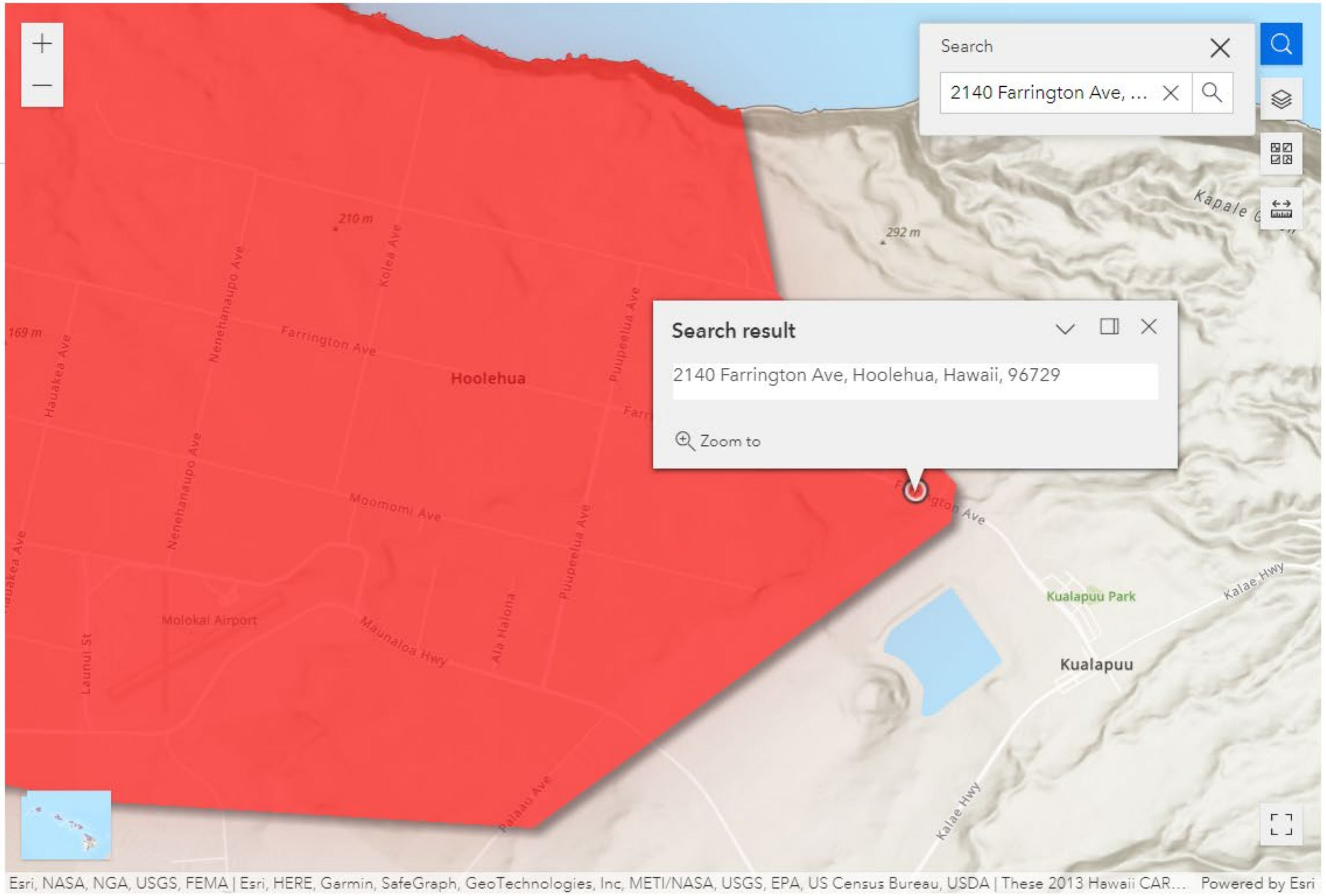
Wildfire

"Wildfire" describes any unwanted and unplanned fire burning in undeveloped land regardless of whether it is naturally or human-caused. Wildfires in Hawaiʻi destroy native forests, alter soil composition, and threaten human safety and infrastructure. The Hawaiʻi Wildfire Management Organization has developed mapping of Communities at Risk from Wildfire (CAR), which was used for the wildfire qualitative risk assessment. The high-risk wildfire area is shown on this map. More information on the Hawaiʻi Wildfire Management Organization can be found *here*.

High Risk Wildfire Hazard Area

Hawaii Boundary



Please “Raise Hand” in “Reactions” or type your question in “Chat”

Mahalo for participating to help build a safer Hawai‘i

Good Mitigation
Does not improve the Response
It lessens the Need
-D. Kennard

A.3.4 FEBRUARY 2023 MITIGATION ACTION ITEM DEVELOPMENT WORKSHOPS WITH INDIVIDUAL SECTORS

Figure A-5. Jamboard Input from the Capabilities and Mitigation Strategy Working Session on February 7, 2023

Figure A-6. Jamboard Input from the Housing & Health and Social Services Sector Meeting on February 8, 2023

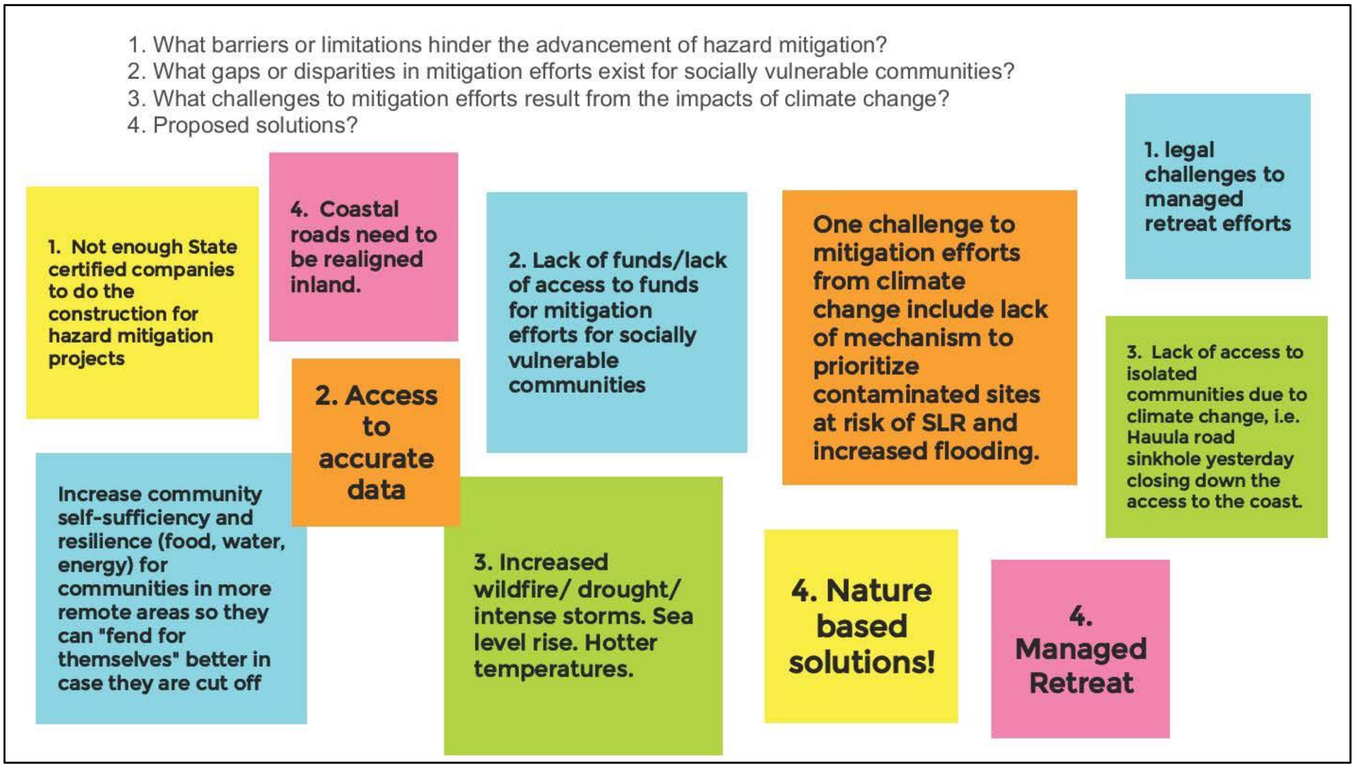


Figure A-7. Jamboard Input from the Emergency Management Sector Meeting on February 8, 2023

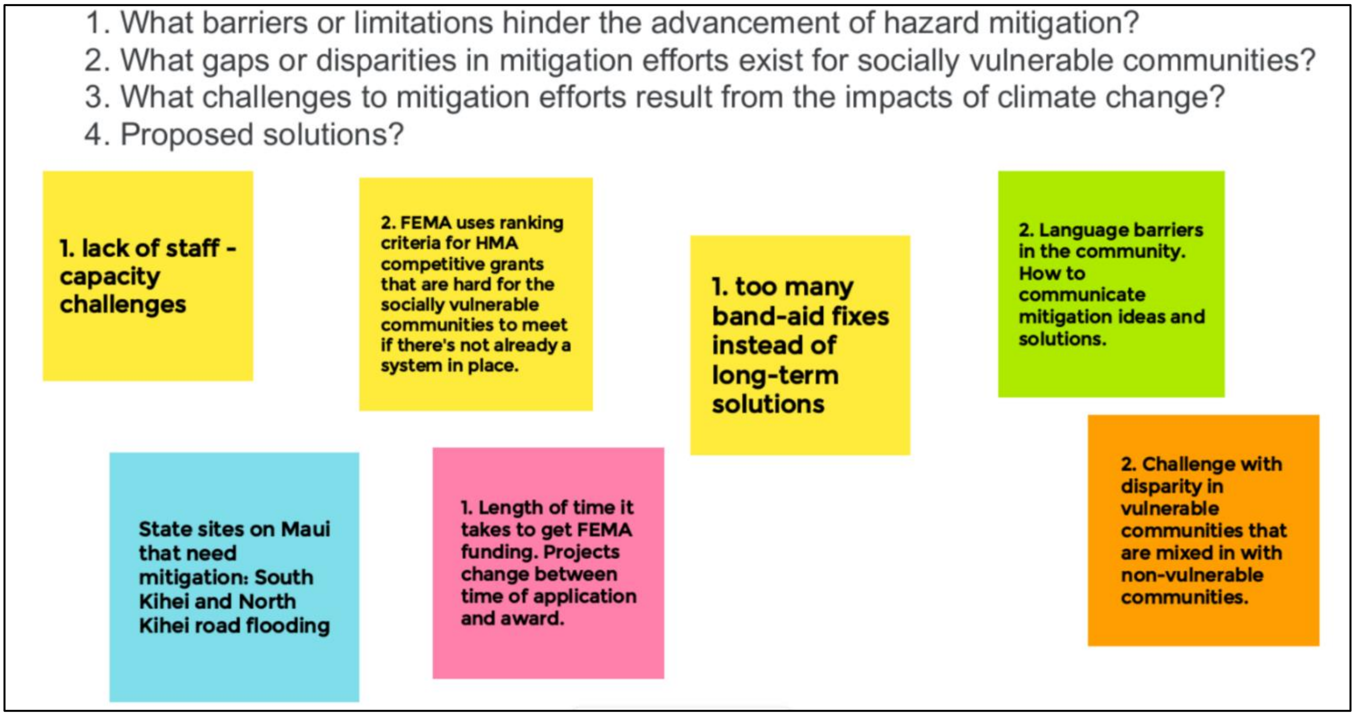


Figure A-8. Jamboard Input from the Infrastructure & Land Use and Development Sector Meeting on February 8, 2023

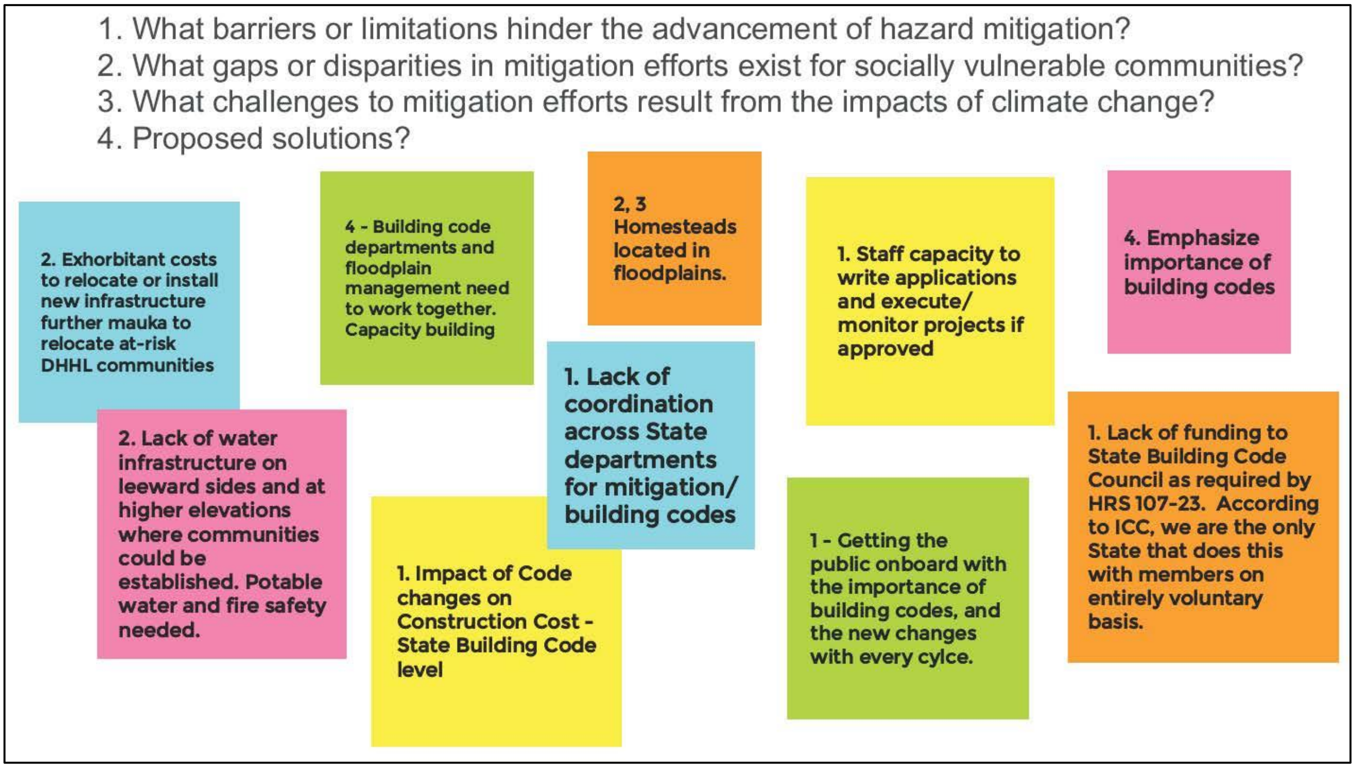


Figure A-9. Jamboard Input from the Economic Development Sector Meeting on February 8, 2023

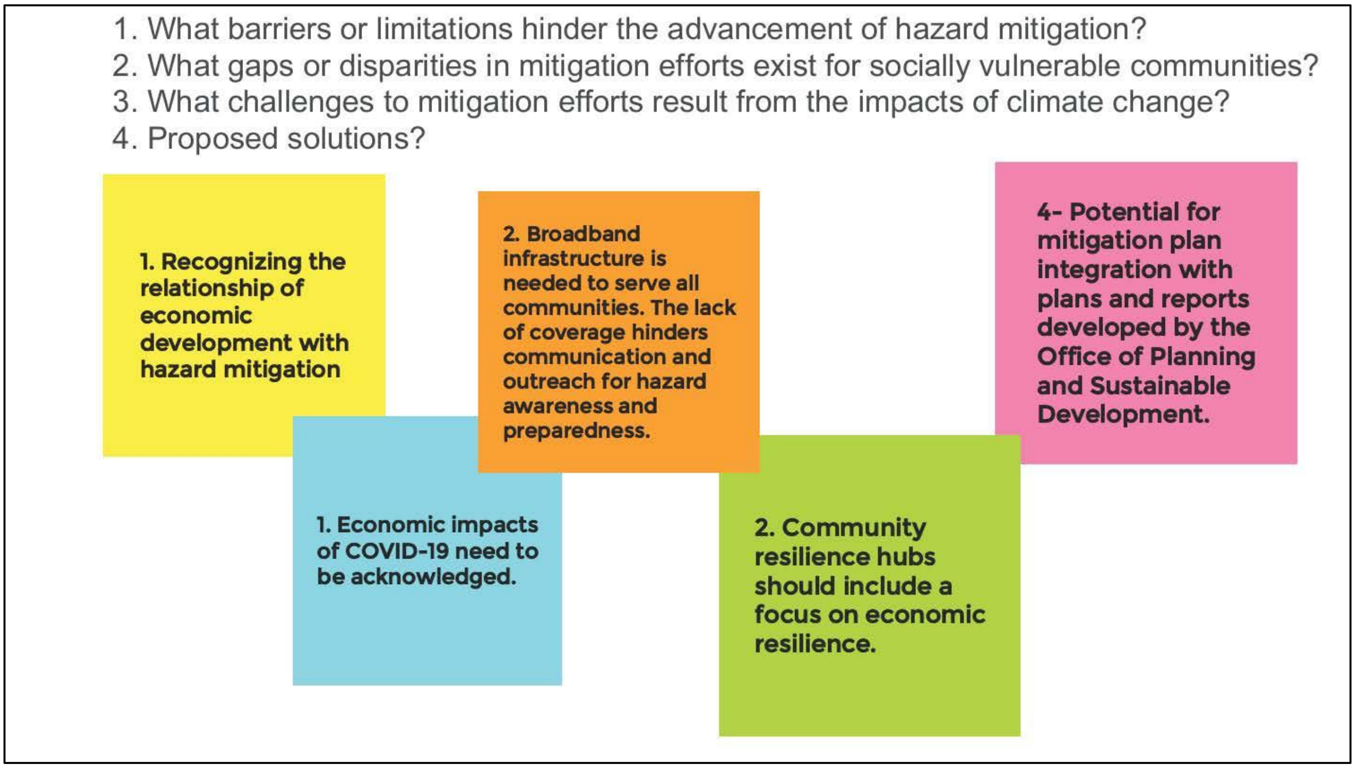
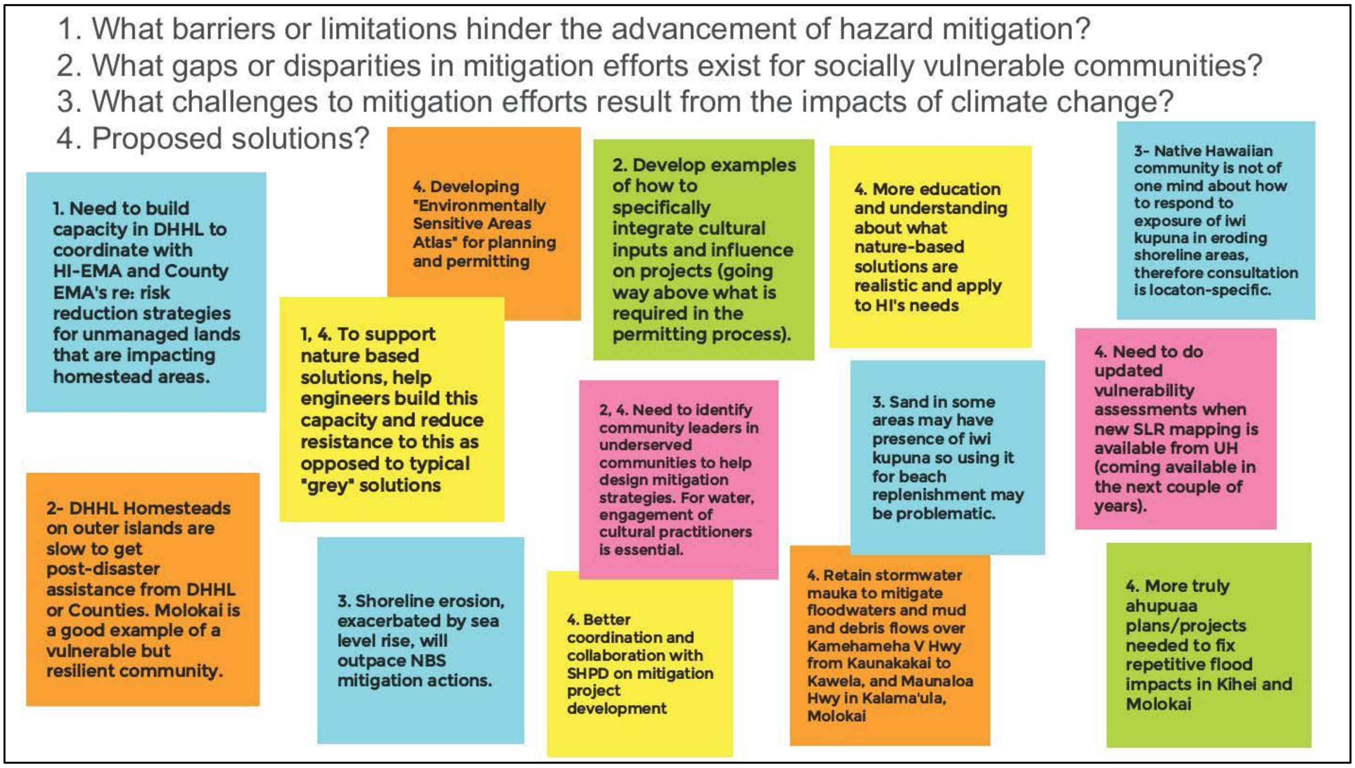


Figure A-10. Jamboard Input from the Natural and Cultural Resources Sector Meeting on February 9, 2023



State of Hawai‘i 2023 Hazard Mitigation Plan

Hawai‘i State Hazard Mitigation Forum Meeting March 23, 2023

Megan Brotherton
Tetra Tech, Inc.

Final Risk Assessment – Hazard Ranking Results

Hazard Rank	Hazard	Category									Relative Risk Factor
		Probability	Impact			Spatial Extent	Warning Time	Duration	Adaptive Capacity	Changing Future Conditions	
			Population	Assets/ Economy	Environmental Resources/ Cultural Assets						
High	Health Risks	3	3	3	0	3	3	3	2	0	5.6
High	Climate Change and Sea Level Rise	3	1	3	2	2	0	3	2	3	4.6
High	Hurricane	2	2	2	1	3	0	3	2	3	4.5
High	Tsunami	1	2	2	1	2	3	3	2	3	4.3
High	Earthquake	1	2	2	1	3	3	3	2	1	4.2
High	Volcanic Hazards	3	1	2	3	2	1	3	2	1	4.2
Medium	Flood	3	1	2	1	2	1	3	2	3	3.9
Medium	Wildfire	2	2	1	1	2	1	2	2	3	3.8
Medium	Landslide and Rockfall	2	1	1	3	2	3	3	2	3	3.8
Medium	Drought	3	1	1	1	3	0	3	2	3	3.5
Medium	Windstorm	2	1	1	1	3	0	3	2	2	3.2
Medium	Cyber Threat	2	1	1	1	3	3	1	3	0	3.0
Low	Infrastructure Failure	1	1	1	1	2	2	3	1	2	2.8
Low	Terrorism	1	1	1	1	3	3	1	2	0	2.7
Low	Hazardous Materials	2	1	1	1	1	3	1	2	0	2.6

Hazard Ranking Methodology

A Hazard Ranking is used to understand your vulnerabilities to hazards and to prioritize projects and activities for mitigation. It considers the following elements:

1. **Probability** of the hazard occurring
2. **Estimated impact** as a result of an event (population, assets/economy, environmental and cultural resources)
3. **Spatial extent** of the hazard (i.e., local, island-wide, statewide)
4. **Warning time** of the hazard in advance of an event occurring
5. **Duration of hazard event** from impact to time of full recovery
6. **Adaptive Capacity** is the State's ability to protect from or withstand a hazard event
7. **Changing future conditions** consider climate change projections and their associated confidence level regarding increase in severity/frequency

2023 Formula for Relative Risk = [(Probability × 0.25) + (Impact × 0.25) + (Spatial Extent × 0.15) + (Warning Time × 0.05) + (Duration × 0.1) + (Adaptive Capacity × 0.1) + (Changing Future Conditions × 0.1)]

Mitigation Strategy Additions

27 new mitigation actions have been proposed by state agencies and sector groups including:

- Coral reef restoration for flood risk reduction, with sites first prioritized by type of infrastructure protected and reef health conditions
- Actions to integrate economic mitigation planning across state agencies, led by DBEDT
- Residential hurricane retrofit program led by HI-EMA in cooperation with state agencies, county governments, and non-government organizations
- Strategy to establish and fund programs to implement managed retreat, led by the State Climate Commission
- Infrastructure project to mitigate storm damage to water transmission lines on Maui

Mitigation Strategy Additions

Additional mitigation actions can still be added to the SHMP.

Email new actions to:
Megan.Brotherton@TetraTech.com

Or add them to the BATool, if you already have a login.

Include:

- Project name and a brief description
- Lead agency
- Problem mitigated
- Hazards addressed
- Estimated costs
- Potential funding sources
- Estimated timeframe for completion

Draft Plan Overview – Section 1. Introduction

- Defines mitigation and the planning requirements for the Hawaiʻi State Hazard Mitigation Plan

- Discussed the 2023 SHMP Update organization and a summary of changes made during the planning process:
    - Aligns with 44 CFR 201.4 and the 2023 FEMA State Mitigation Planning Policy Guide
    - Provides an overview of the Emergency Management Accreditation Program (EMAP)

Draft Plan Overview – Section 2. Planning Process

- Documents the planning process, the agencies, stakeholders and subject-matter experts (SMEs) involved, and the manner of their involvement.

- Highlights the extended outreach efforts conducted to encourage participation and increased involvement during this 2023 SHMP update.

- Describes how the planning process has been integrated into ongoing federal and state programs and initiatives.

Draft Plan Overview – Section 3. State Profile

Description of the State of Hawai‘i:

- Physical setting
- Demographics
- Economy
- State assets
- Community lifelines and critical facilities
- Cultural assets
- Natural resources
- Land use and development

Draft Plan Overview – Section 4. Risk Assessment Enhancements

- Hazard categories align with HI-EMA's *Hazards and Vulnerabilities Overview* and *THIRA* documents
- Two additional tsunami hazard scenarios were modeled
- Community Lifelines and Critical Facilities were analyzed
- Socially Vulnerable Communities were analyzed for each mapped hazard
- Dashboard summary for each hazard

Draft Plan Overview – Section 4. Risk Assessment Enhancements

Example Hazard Dashboard

Draft Plan Overview – Section 4. Risk Assessment Enhancements

Last opportunity to send local photos of hazard events to include in the SHMP. Submit by Friday afternoon (March 24) to: Megan.Brotherton@TetraTech.com

Include a brief description and photo credits.

Example:
O‘ahu North Shore Coastal Erosion
DLNR

Draft Plan Overview – Section 5. Capability Assessment

State and local capabilities have been reviewed and updated:

- Legal
- Regulatory
- Policies
- Programs
- Administrative and Technical Staffing
- Funding
- People-powered (Volunteer Groups)

Capabilities were revised to meet FEMA guidance for alignment with:

- Social Vulnerability
- Climate Change
- Community Lifelines
- SHMP Goals

Draft Plan Overview – Section 6. Mitigation Strategy

The 2018 SHMP mitigation actions, updated risk assessment, updated capability assessment, and local HMP actions were used to identify mitigation actions for the 2023 SHMP Update.

Types of actions included:

- Planning and Regulations
- Structure and Infrastructure Projects
- Natural Systems Protection
- Education and Awareness

Actions are included to align with the new FEMA requirements to address socially vulnerable communities and climate change considerations.

Draft Plan Overview – Section 7. Plan Maintenance

- Updated maintenance strategy based on the effectiveness of the plan maintenance procedures outlined in the 2018 SHMP.

- Standardized grant funding prioritization framework.

- Each State mitigation action is now tracked in the Baseline Assessment Tool (BATool^{SM}) for streamlined monitoring, updating, and reporting.
    - On-line plan review service that will allow Forum members and other state agencies and stakeholders to login to a secure site and provide a status update to their mitigation actions.

Upcoming Opportunity for Forum Review and Comment on the Draft Plan

- The draft is nearly complete and is undergoing editorial review. It will be available for concurrent Forum and public review soon.

- Comments will be accepted via an online Survey Monkey electronic form. The link to comment will be shared by HI-EMA when the draft is available.

Hawaiʻi State Hazard Mitigation Plan (SHMP) Update 2023

Public Comment Survey

The State Hazard Mitigation Plan (SHMP) is Hawaiʻi's primary hazard mitigation document outlining our historical and current hazards, mitigation strategies, goals, and objectives. Most importantly, the SHMP reflects the State's commitment to reduce or eliminate potential risks and impacts of natural and human-caused disasters by making our ʻOhana, homes, and communities better prepared and more disaster-resilient. The SHMP is updated on a five-year cycle as required by the Robert T. Stafford Disaster Relief and Emergency Assistance Act.

Please use this form to submit your comments, feedback, and text edits on the draft 2023 SHMP.

This form does not require an answer to every question.

The questions are organized as follows:
-Volume 1, which contains the core plan, is organized by chapter. Put your comments in the section for the chapter you are commenting on.
-Volume 2 contains the appendices to the core plan. Put your comments in the section for the appendix you are commenting on.

For assistance accessing this survey or the SHMP document, pleas

Thank you for your participation and input in this planning process. Y
on (Date).

1. Enter your first and last name. (Optional) 0

2. What is your email address? (Optional) 0

10. If you wish to comment on Volume 1, Section 1. Introduction, note here 0

11. If you wish to comment on Volume 1, Section 2. Planning Process, note here 0

12. If you wish to comment on Volume 1, Section 3. Hawaiʻi State Profile, note here 0

April Public Open House Schedule

Honolulu County

Wednesday, April 5 from 4 – 5 p.m. at the HI-EMA Building 300 Gym

Hawaiʻi County

Hilo – Monday, April 17 from 5 – 6 p.m. at the Aupuni Center

Kona – Tuesday, April 18 from 5 – 6 p.m. at the West Hawaiʻi Civic Center

Maui County

Molokaʻi – Wednesday, April 19 from 5 – 6 p.m. at the Mitchell Pauole Community Center

Maui – Thursday, April 20 from 5 – 6 p.m. at the Kahului Community Center

Lānaʻi – Tuesday, April 25 TBD

Kauaʻi County

Monday, April 24 from 4 – 5 p.m. at the Moikeha Conference Room

Next Steps

Support and promote an open house in your county in April.

The open house will present:

- Purpose of the Hawaiʻi State Hazard Mitigation Plan
- Draft Plan Overview
- Mitigation Strategies Input
- Coordination with Other Planning Efforts

Share with HI-EMA how the meetings are promoted locally. Outreach will be summarized in the SHMP.

Help Build a Safer Hawaiʻi – On All Islands

Have you experienced impacts to your ʻOhana, your home, or your community from a:

Flood	Wildfire
Volcano	Landslide
Hurricane	Other Hazard

Hazard Mitigation planning develops strategies to minimize the impacts from hazards on the people and places we love.

The Hawaiʻi Emergency Management Agency (HI-EMA) is updating the State's Hazard Mitigation Plan and wants to hear from YOU!

Scan the QR code or click HERE for complete details about the in-person meetings hosted by HI-EMA in April on all the main islands.

Our team will share highlights from the draft plan, allow input from community members on the mitigation strategy, and share how the State Hazard Mitigation Plan can coordinate with local planning efforts.

Get involved today to make our communities more disaster resilient tomorrow!

Mahalo for your time and commitment
to help develop the
2023 Hawaiʻi State Hazard Mitigation Plan Update!

Good Mitigation
Does not improve the Response
It lessens the Need
-D. K.

State of Hawaiʻi
2023 Hazard Mitigation Plan

Public Meeting

For the City and County of Honolulu

April 5, 2023

Public Meeting Participants

- **James Barros**, Administrator, HI-EMA
- **Kelsey Yamanaka**, Acting State Hazard Mitigation Officer, HI-EMA
- **David Kennard**, Kaua‘i Emergency Management Agency (KEMA) Disaster Assistance Project Manager, State Hazard Mitigation Forum Chair
- **Megan Brotherton**, Lead Project Planner, Tetra Tech, Inc.
- and **YOU**!

Agenda and Participation Guidelines

- Purpose of the Hawai‘i State Hazard Mitigation Plan
- Draft Plan Overview
- Mitigation Strategies Input
- Coordination with Other Planning Efforts
- Public Questions and Comments

The second half of the meeting will allow for public participation. Please limit questions and comments to topics applicable to state or local hazard mitigation planning. Comments should be kept to 3 minutes, if additional input is needed, please submit your comment or question in writing.

HI-EMA and/or County agencies will follow up on all written comments!

Public Survey and Comment Form

Please use the link or scan the QR code to take a brief survey and share comments about the plan update.

https://www.surveymonkey.com/r/SaferHI

Contacts for Emergency Management Agencies

Hawai‘i Emergency Management Agency

HawaiiEMA@hawaii.gov

Honolulu Department of Emergency Management

dem@honolulu.gov

Purpose of the State Hazard Mitigation Plan (SHMP)

FEMA and the Emergency Management Community acknowledge that our communities are subject to natural hazards and recognize that Hazard Mitigation Planning provides a framework to:

- Identify the natural hazards and assess their impacts on the State and our communities,
- Assess State's capacity to respond to and recover from the impacts of the natural disasters,
- Develop strategies to reduce or eliminate these impacts on lives and property and to ensure the continued functionality of critical services, and
- Reduce the disaster assistance costs resulting from natural disasters

Purpose of the State Hazard Mitigation Plan (SHMP), cont.

FEMA emphasizes the importance of the SHMP by tying grant funding to an approved and adopted Plan

- Certain categories of Public Assistance (PA Categories C-G)
- Hazard Mitigation Grant Program (HMGP)
- Building Resilient Infrastructure and Communities (BRIC)
- Fire Management Assistance Grants (FMAG)
- Rehabilitation of High Hazard Potential Dam (HHPD)

SHMP Update Process and Timeline

FEMA and the Emergency Management Community recognize that Hazards, Capabilities and Strategies can change

- FEMA requires States to update the SHMP at least every 5 years
- HI-EMA and its Consultant (Tetra Tech) are finalizing the plan, which will soon be available for public comment
- Final draft SHMP Update ready for FEMA review and approval by October

SHMP Format

Volume 1	
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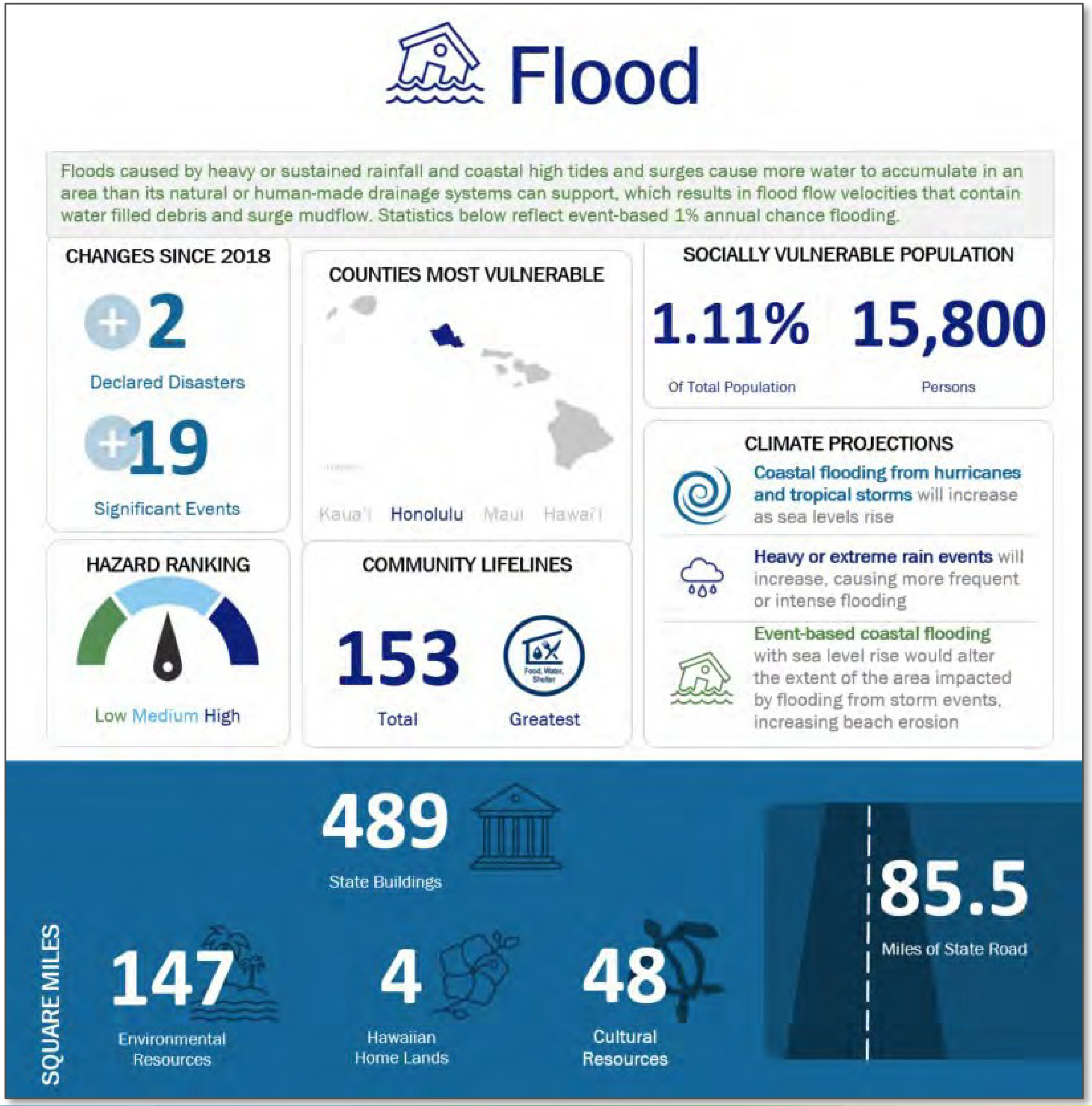
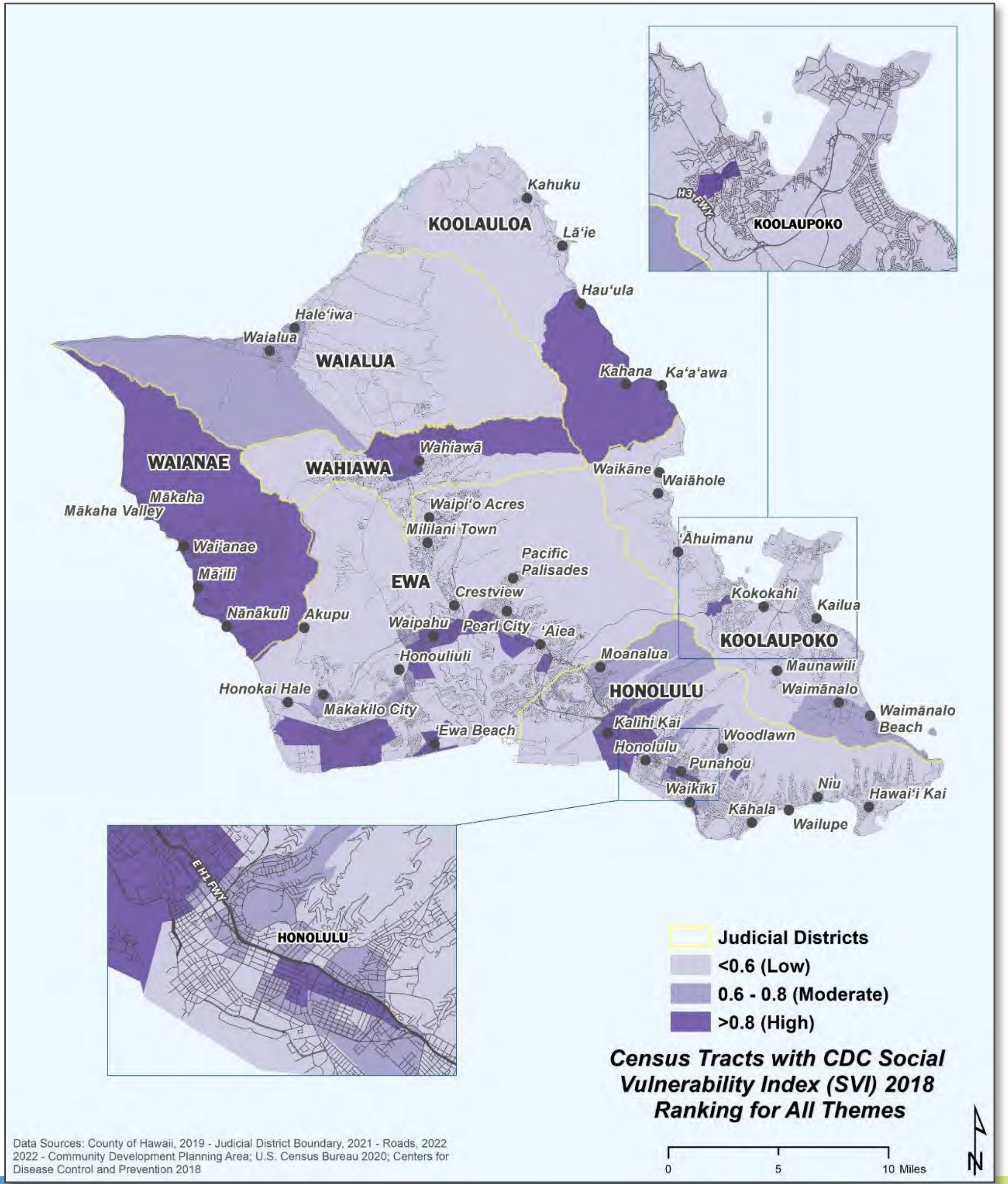
Volume 2	• **Appendices**

Hazard Dashboard



Social Vulnerability Honolulu County



Mitigation Strategy Success Story – CRS Program

The **City and County of Honolulu** included a mitigation strategy in its Local Hazard Mitigation Plan to work to qualify for participation in the CRS program. In April 2022, the City and County qualified at a Class 7 level, resulting in automatic flood insurance premium discounts of 10% for properties in the mapped floodplain area.

This resulted in a **savings of more than $2.3 Million each year** for City and County residents!

Mitigation Strategies Input

Submit your ideas for mitigation strategies. You may use the Survey Monkey tool, or email HI-EMA or the City and County DEM.

Categories for Mitigation:

- Local Planning and Regulations
- Structure and Infrastructure Projects
- Natural Systems Protection
- Education and Awareness Programs

Coordination with Other Planning Efforts

The Hawai'i State Hazard Mitigation Plan:

- Is the guiding document for Local Hazard Mitigation Plans (HMPs)
- Is integrated in the THIRA (Threat and Hazard Identification and Risk Assessment) and the SRP (Stakeholder Preparedness Review)

Local HMPs are used when developing or updating:

- Climate Adaptation Plans
- Community Wildfire Protection Plans
- Economic Recovery Plans
- General Plans
- And many more!

Questions?

Comments?

Limited to 3 minutes about hazard mitigation planning

Mahalo for participating to help build a safer Hawai‘i

Good Mitigation
Does not improve the Response
It lessens the Need
-D. Kennard

State of Hawai‘i 2023 Hazard Mitigation Plan

Public Meeting

For Hawai‘i County

April 17, 2023 (Hilo)

April 18, 2023 (Kona)

Public Meeting Participants

- **James Barros**, Administrator, HI-EMA
- **Kelsey Yamanaka**, Acting State Hazard Mitigation Officer, HI-EMA
- **David Kennard**, Kaua‘i Emergency Management Agency (KEMA) Disaster Assistance Project Manager, State Hazard Mitigation Forum Chair
- **Megan Brotherton**, Lead Project Planner, Tetra Tech, Inc.
- and **YOU**!

Agenda and Participation Guidelines

- Purpose of the Hawai‘i State Hazard Mitigation Plan
- Draft Plan Overview
- Mitigation Strategies Input
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Public Survey and Comment Form

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Hawai‘i Emergency Management Agency

HawaiiEMA@hawaii.gov

County of Hawai‘i Civil Defense

hccda@hawaiicounty.gov

Purpose of the State Hazard Mitigation Plan (SHMP)

FEMA and the Emergency Management Community acknowledge that our communities are subject to natural hazards and recognize that Hazard Mitigation Planning provides a framework to:

- Identify the natural hazards and assess their impacts on the State and our communities,
- Assess State's capacity to respond to and recover from the impacts of the natural disasters,
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Purpose of the State Hazard Mitigation Plan (SHMP), cont.

FEMA emphasizes the importance of the SHMP by tying grant funding to an approved and adopted Plan

- Certain categories of Public Assistance (PA Categories C-G)
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SHMP Update Process and Timeline

FEMA and the Emergency Management Community recognize that Hazards, Capabilities and Strategies can change

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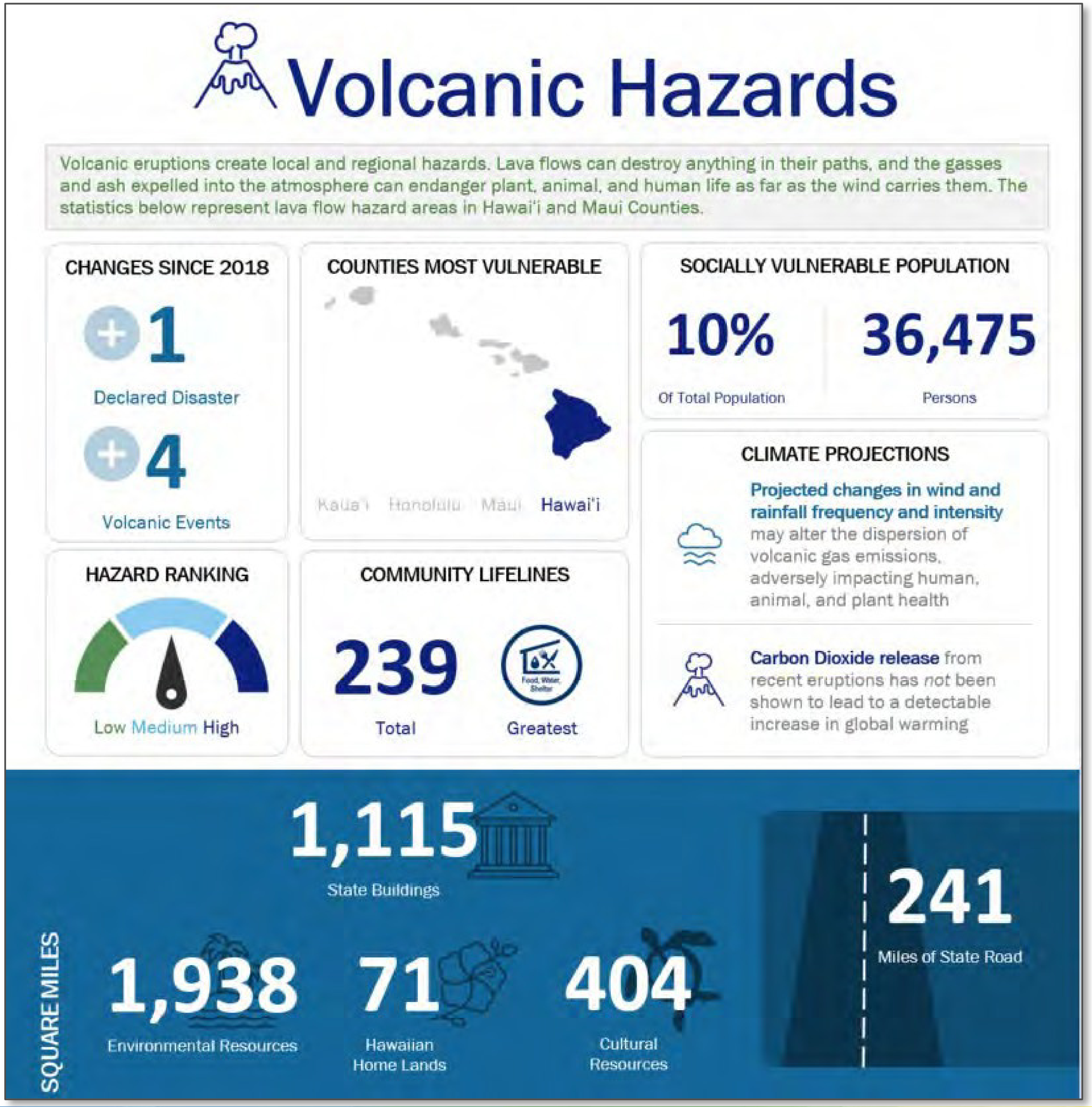
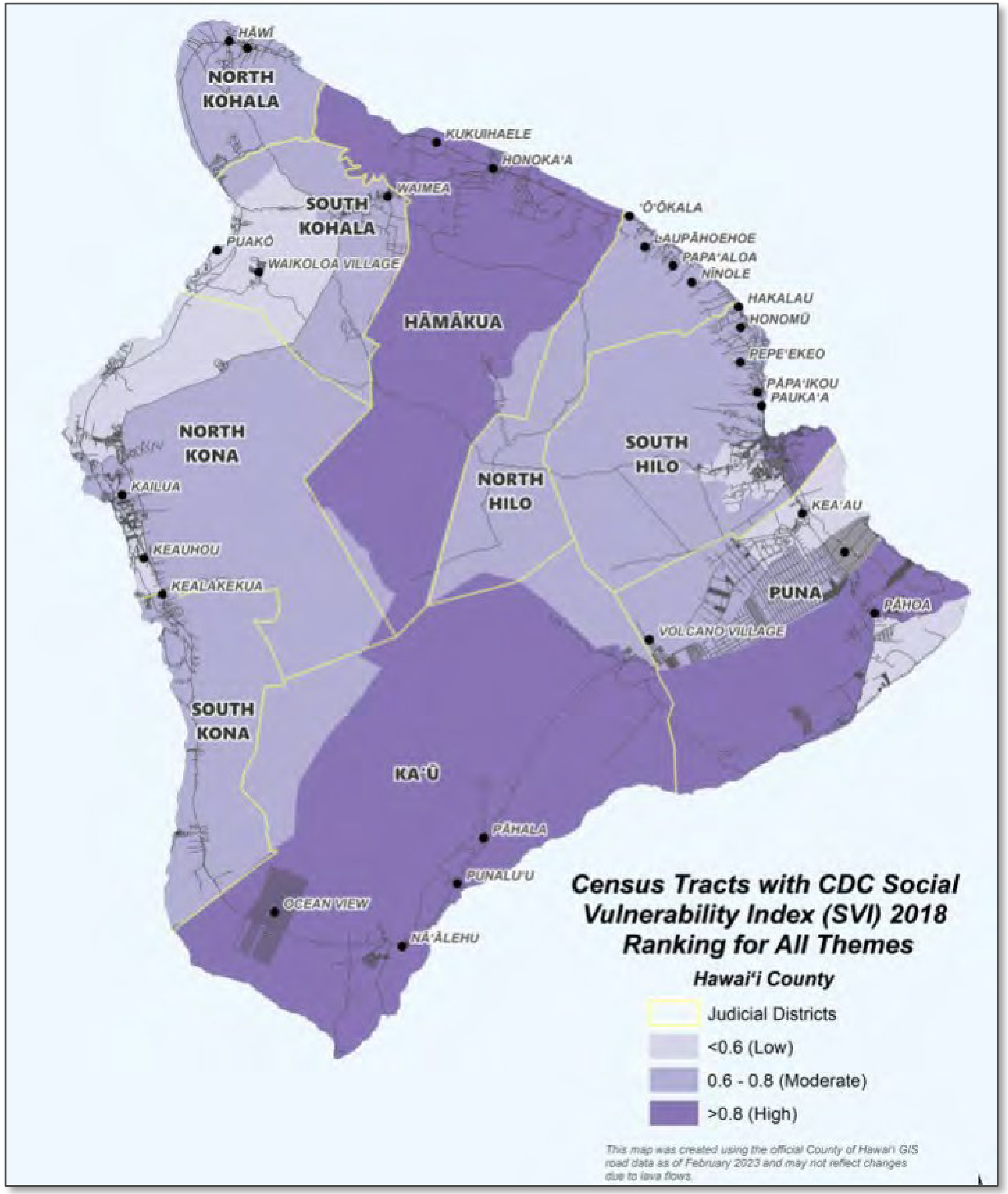


Social Vulnerability
Hawaiʻi County



Mitigation Strategy Success Story
Community Rating System

The **County of Hawaiʻi** has participated in the CRS program since 2011. The County is currently at a Class 7 level, resulting in automatic flood insurance premium discounts of 15% for properties in the mapped floodplain area.

This results in a **savings of more than $520,000 each year** for County residents!

Mitigation Strategy Success Story
Department of Water Supply Generator

The **2020 County of Hawai‘i Multi-Hazard Mitigation Plan** included a mitigation action to harden DWS potable water producing facilities by installing needed emergency generating infrastructure.

The project received nearly $174,000 of Federal grant funding to complete the mitigation action.

This allows DWS to better **protect the health and welfare** of our island community by continuing to supply potable water despite power outages.

Honokōhau Transfer Switch

Pi‘ihonua Transfer Switch and Terminal Box

Mitigation Strategies Input

Submit your ideas for mitigation strategies. You may use the Survey Monkey tool, or email HI-EMA or the Hawai‘i County Civil Defense.

Categories for Mitigation:

- Local Planning and Regulations
- Structure and Infrastructure Projects
- Natural Systems Protection
- Education and Awareness Programs

Coordination with Other Planning Efforts

The Hawaiʻi State Hazard Mitigation Plan:

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- Climate Adaptation Plans
- Community Wildfire Protection Plans
- Economic Recovery Plans
- General Plans
- And many more!

Questions?

Comments?

Limited to 3 minutes about hazard mitigation planning

Mahalo for participating to help build a safer Hawai‘i

Good Mitigation
Does not improve the Response
It lessens the Need
-D. Kennard

Figure A-11. Hilo Public Meeting in Hawai'i County, April 17, 2023

State of Hawai‘i 2023 Hazard Mitigation Plan

Public Meetings

For Maui County

April 19, 2023 (Moloka‘i)
April 20, 2023 (Maui Island)

Public Meeting Participants

- **James Barros**, Administrator, HI-EMA
- **Kelsey Yamanaka**, Acting State Hazard Mitigation Officer, HI-EMA
- **David Kennard**, Kaua‘i Emergency Management Agency (KEMA) Disaster Assistance Project Manager, State Hazard Mitigation Forum Chair
- **Megan Brotherton**, Lead Project Planner, Tetra Tech, Inc.
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Agenda and Participation Guidelines

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Hawai‘i Emergency Management Agency

HawaiiEMA@hawaii.gov

Maui Emergency Management Agency

emergency.management@mauicounty.gov

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Purpose of the State Hazard Mitigation Plan (SHMP), cont.

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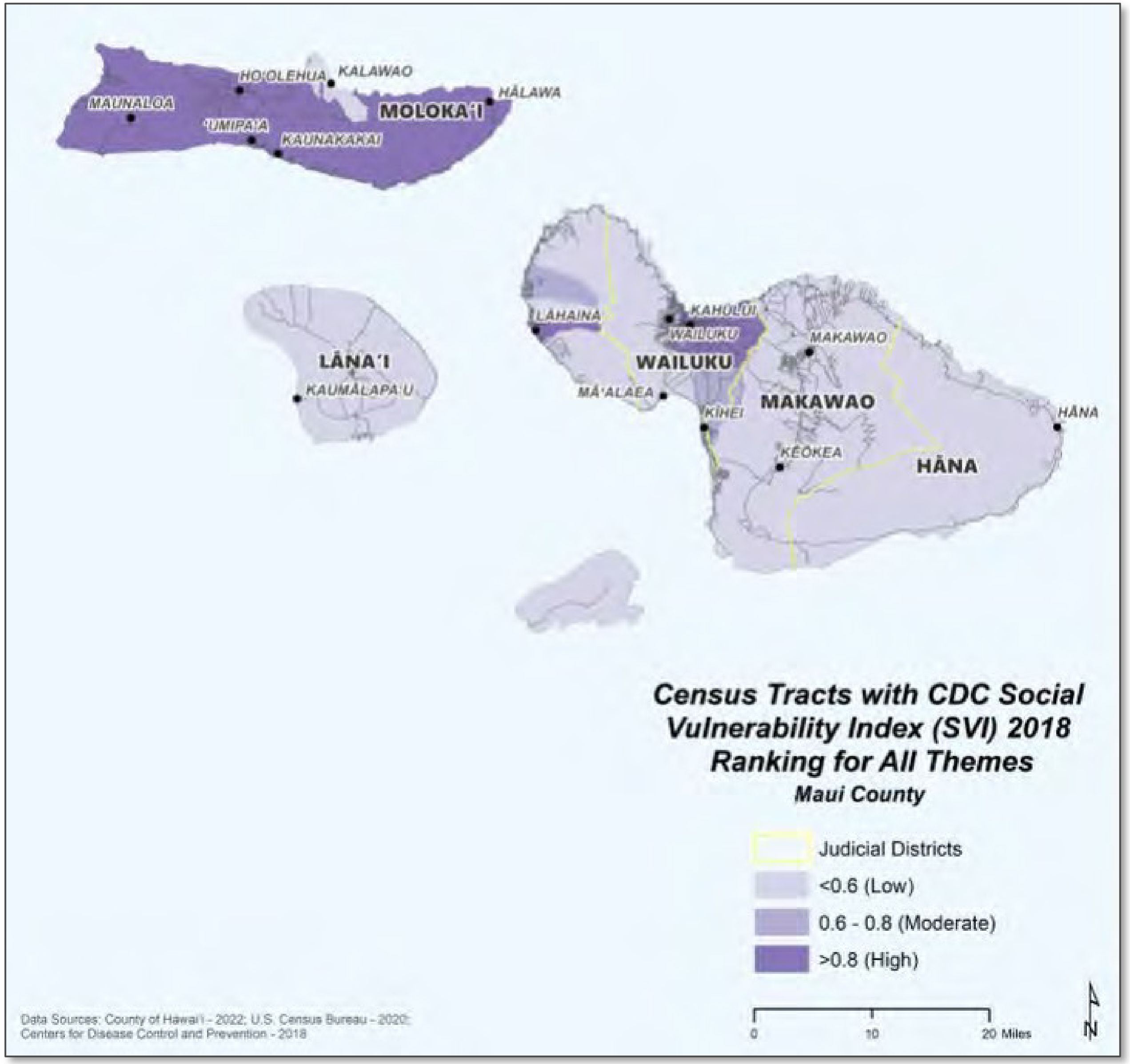
Social Vulnerability
Maui County



Mitigation Strategy Success Story
Community Rating System

The **County of Maui** has participated in the CRS program since 1995. The County is currently at a Class 7 level, resulting in automatic flood insurance premium discounts of 15% for properties in the mapped floodplain area.

This results in a **savings of more than $1.1 million each year** for County residents!

Mitigation Strategy Success Story
Maui Food Bank Generator

The **2020 County of Maui Hazard Mitigation Plan** included a mitigation action to acquire generators for critical facilities including the Maui Food Bank.

The project received nearly $94,000 of Federal grant funding to implement the mitigation action.

This allows the Maui Food Bank to better **serve the needs** of vulnerable members the community community by continuing to supply fresh food despite power outages.

MAUI FOOD BANK
Helping the Hungry

Mitigation Strategies Input

Submit your ideas for mitigation strategies. You may use the Survey Monkey tool, or email HI-EMA or the Maui Emergency Management Agency.

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- Structure and Infrastructure Projects
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Figure A-12. Kaunakakai Public Meeting on Moloka'i Island, April 19, 2023

Figure A-13. Kahului Public Meeting on Maui Island, April 20, 2023

State of Hawai‘i 2023 Hazard Mitigation Plan

Public Meeting

For Kaua‘i County

April 24, 2023

Public Meeting Participants

- **James Barros**, Administrator, HI-EMA
- **Kelsey Yamanaka**, Acting State Hazard Mitigation Officer, HI-EMA
- **David Kennard**, Kaua‘i Emergency Management Agency (KEMA) Disaster Assistance Project Manager, State Hazard Mitigation Forum Chair
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Hawaiʻi Emergency Management Agency

HawaiiEMA@hawaii.gov

Kauaʻi Emergency Management Agency

kema@kauai.gov

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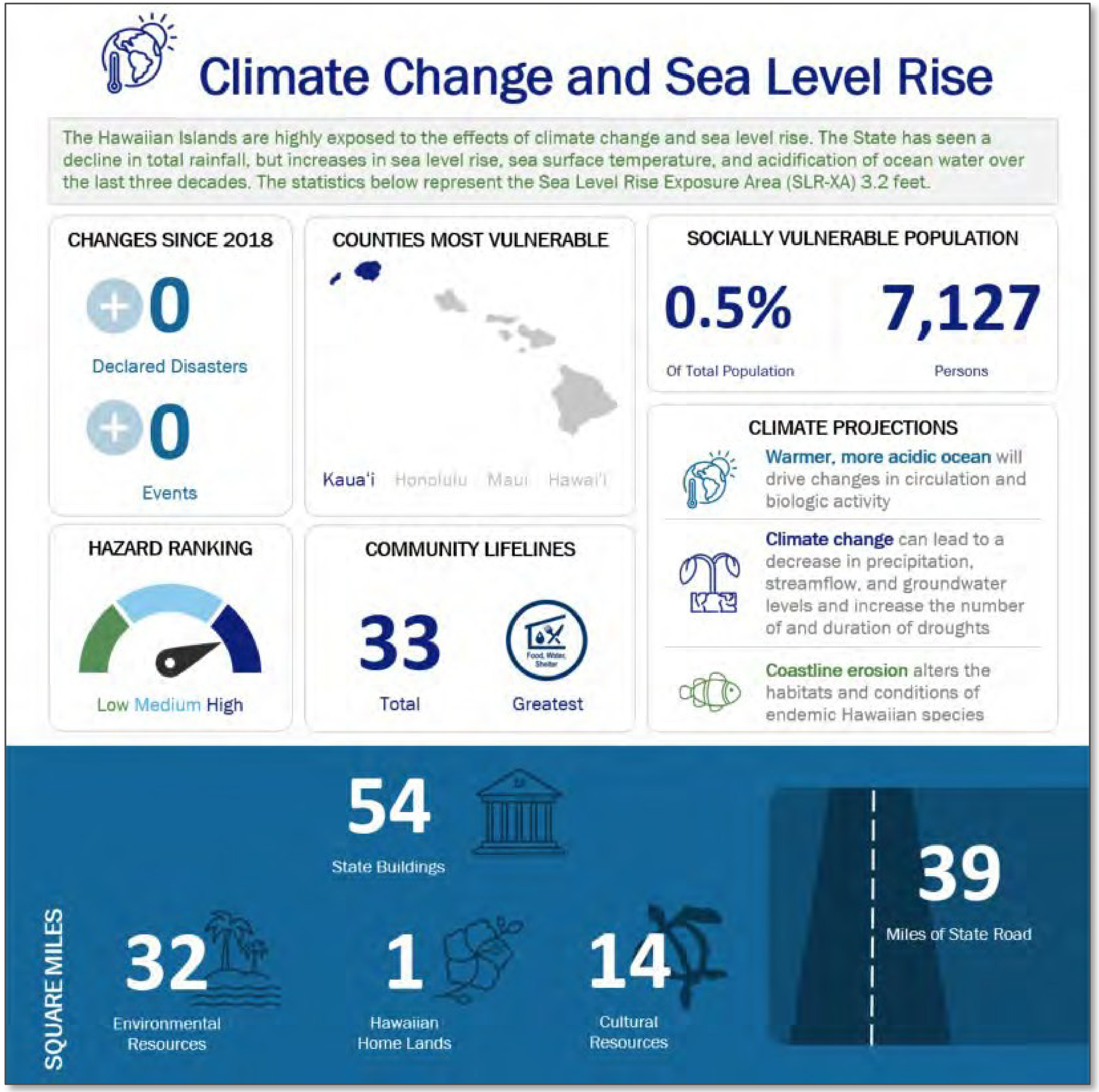
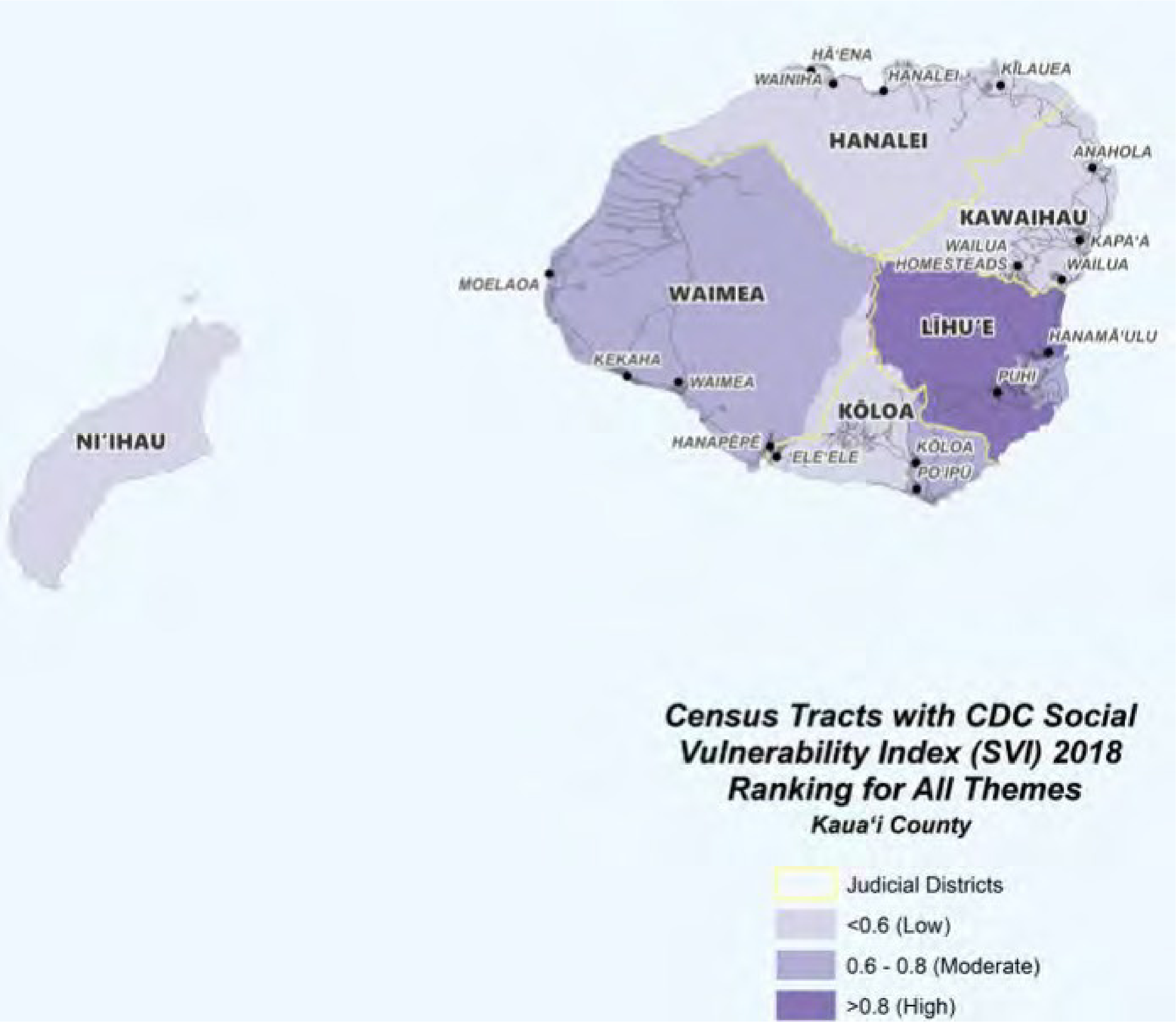


Social Vulnerability Kaua‘i County



Mitigation Strategy Success Story
Community Rating System

The **County of Kaua‘i** joined the CRS program in 2023, making Hawai‘i the **first state** in the nation to have all communities participating in the program! The County is currently at a Class 8 level, resulting in automatic flood insurance premium discounts of 10% for properties in the mapped floodplain area.

This results in a **savings of more than $370,000 each year** for County residents!

Mitigation Strategy Success Story

Wilcox Medical Center Generators

The **County of Kauaʻi** has included an ongoing mitigation action in each update of its plan to retrofit facilities to withstand hazard events, including installing emergency generation equipment.

The mitigation project to install emergency generators at Wilcox Medical Center received $4 million of Federal funding to complete the project!

This allows the hospital to better **care for the health and welfare** of our island community by continuing to supply critical medical services despite power outages.

Photo Credit: Dennis Fujimoto, The Garden Island

Mitigation Strategy Success Story

Weke Road Reconstruction

Weke Road was washed out by 2018 floodwaters in the Hanalei basin.
The recovery and mitigation project to reconstruct the road to standards that will better withstand future storm events received DR-4365 Federal funding to complete the project.

Photo credit: County of Kauaʻi

Mitigation Strategies Input

Submit your ideas for mitigation strategies. You may use the Survey Monkey tool, or email HI-EMA or the Kaua‘i Emergency Management Agency.

Categories for Mitigation:

- Local Planning and Regulations
- Structure and Infrastructure Projects
- Natural Systems Protection
- Education and Awareness Programs

Coordination with Other Planning Efforts

The Hawai‘i State Hazard Mitigation Plan:

- Is the guiding document for Local Hazard Mitigation Plans (HMPs)
- Is integrated in the THIRA (Threat and Hazard Identification and Risk Assessment) and the SRP (Stakeholder Preparedness Review)

Local HMPs are used when developing or updating:

- Climate Adaptation Plans
- Community Wildfire Protection Plans
- Economic Recovery Plans
- General Plans
- And many more!

Questions?

Comments?

Limited to 3 minutes about hazard mitigation planning

Mahalo for participating to help build a safer Hawaiʻi

Good Mitigation
Does not improve the Response
It lessens the Need
-D. Kennard

Figure A-14. Līhuʻe Public Meeting in Kauaʻi County, April 24, 2023

State of Hawai‘i
2023 Hazard Mitigation Plan

Statewide Hybrid Public Meeting
Kapolei and Microsoft Teams

May 3, 2023

Public Meeting Participants

- **James Barros**, Administrator, HI-EMA
- **Kelsey Yamanaka**, Acting State Hazard Mitigation Officer, HI-EMA
- **David Kennard**, Kaua‘i Emergency Management Agency (KEMA) Disaster Assistance Project Manager, State Hazard Mitigation Forum Chair
- **Megan Brotherton**, Lead Project Planner, Tetra Tech, Inc.
- and **YOU**!

If you are attending virtually, please sign in using the “Chat” feature. Add your name and the County you’re joining from.

In-person attendees can use the paper sheet to sign in.

Agenda and Participation Guidelines

- Purpose of the Hawai‘i State Hazard Mitigation Plan
- Draft Plan Overview
- Mitigation Strategies Input
- Coordination with Other Planning Efforts
- Public Questions and Comments

2023 Draft Plan Public Comment Form

Please use the link or scan the QR code to provide comments on the draft plan.

https://www.surveymonkey.com/r/HISHMP2023

Contacts for Emergency Management Agencies

Hawai‘i Emergency Management Agency

HawaiiEMA@hawaii.gov

Kaua‘i Emergency Management Agency

kema@kauai.gov

Honolulu Department of Emergency Management

dem@honolulu.gov

Maui Emergency Management Agency

emergency.management@mauicounty.gov

County of Hawai‘i Civil Defense

hccda@hawaiicounty.gov

Purpose of the State Hazard Mitigation Plan (SHMP)

FEMA and the Emergency Management Community acknowledge that our communities are subject to natural hazards and recognize that Hazard Mitigation Planning provides a framework to:

- Identify the natural hazards and assess their impacts on the State and our communities,
- Assess State's capacity to respond to and recover from the impacts of the natural disasters,
- Develop strategies to reduce or eliminate these impacts on lives and property and to ensure the continued functionality of critical services, and
- Reduce the disaster assistance costs resulting from natural disasters

Purpose of the State Hazard Mitigation Plan (SHMP), cont.

FEMA emphasizes the importance of the SHMP by tying grant funding to an approved and adopted Plan

- Certain categories of Public Assistance (PA Categories C-G)
- Hazard Mitigation Grant Program (HMGP)
- Building Resilient Infrastructure and Communities (BRIC)
- Fire Management Assistance Grants (FMAG)
- Rehabilitation of High Hazard Potential Dam (HHPD)

SHMP Update Process and Timeline

FEMA and the Emergency Management Community recognize that Hazards, Capabilities and Strategies can change

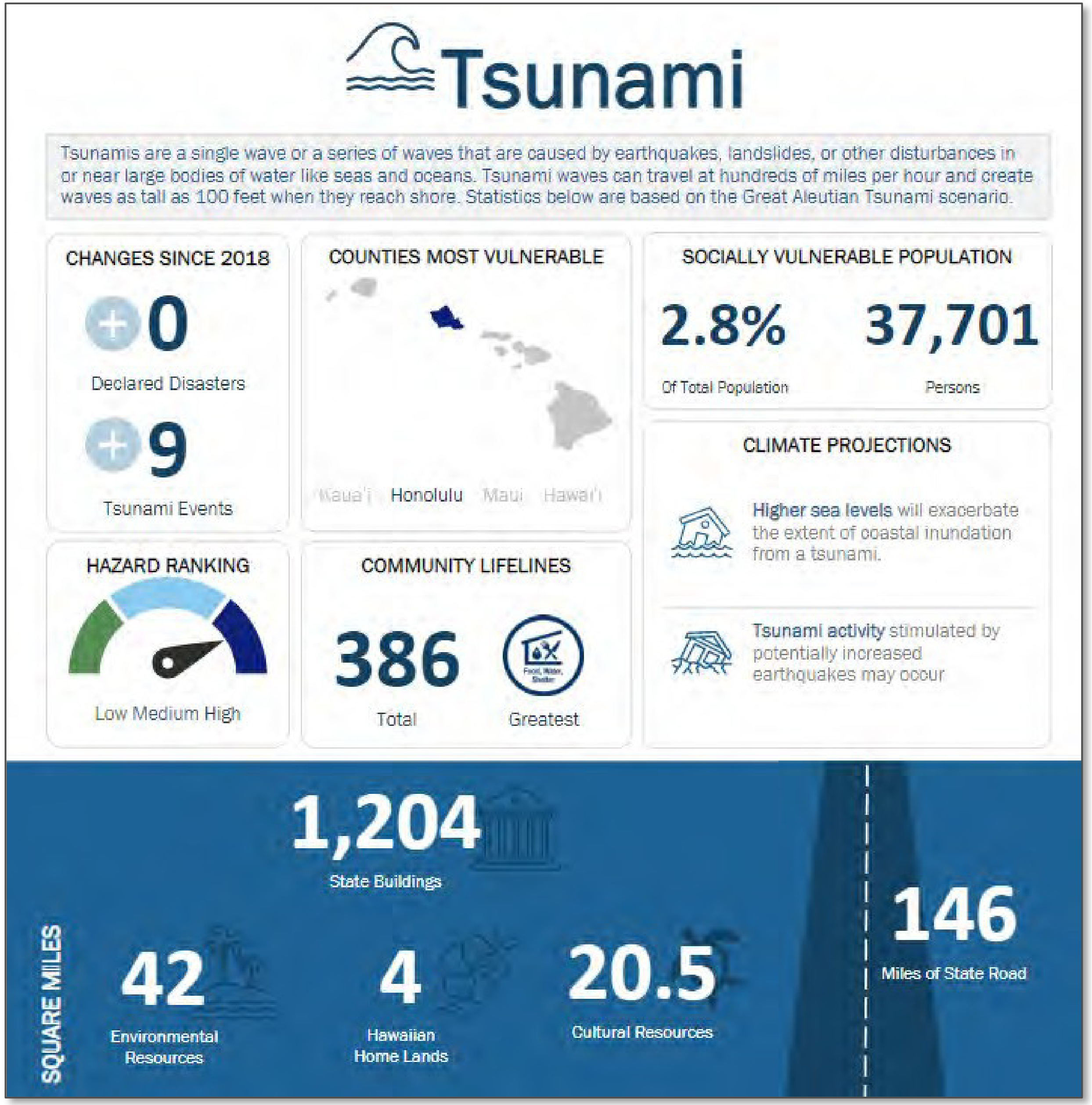
- FEMA requires States to update the SHMP at least every 5 years
- HI-EMA and its Consultant (Tetra Tech) finalized the draft plan, which is available for public comment
- Final draft SHMP Update ready for FEMA review and approval by October

SHMP Format

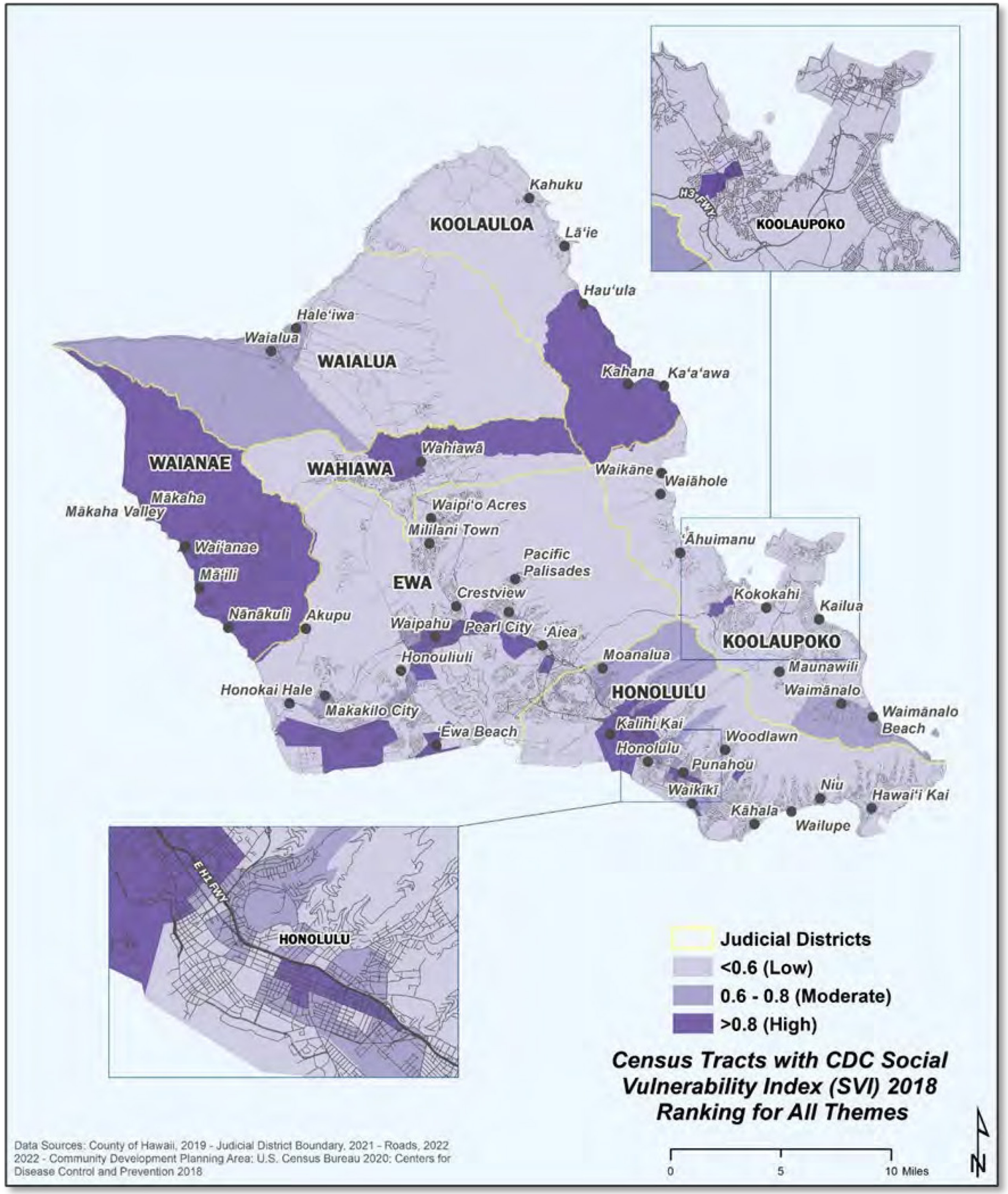
Volume 1	
	• **Introduction** • **Planning Process** • **Hawai‘i State Profile** • **Risk Assessment** (includes hazard profiles and vulnerability assessments for 15 hazards) • **Capability Assessment** • **Mitigation Strategy** • **Plan Maintenance**

Volume 2	• **Appendices**

Hazard Dashboard



Social Vulnerability Example: City and County of Honolulu



Kaua‘i County Mitigation Success Story
Weke Road Reconstruction

Weke Road was washed out by 2018 floodwaters in the Hanalei basin.

The recovery and mitigation project to reconstruct the road to standards that will better withstand future storm events received DR-4365 Federal funding to complete the project.

Photo credit: County of Kaua‘i

City and County of Honolulu Mitigation Success Story

CRS Program

The **City and County of Honolulu** included a mitigation strategy in its Local Hazard Mitigation Plan to work to qualify for participation in the CRS program. In April 2022, the City and County qualified at a Class 7 level, resulting in automatic flood insurance premium discounts of 10% for properties in the mapped floodplain area.

This resulted in a **savings of more than $2.3 Million each year** for City and County residents!

Maui County Mitigation Success Story

Maui Food Bank Generator

The **2020 County of Maui Hazard Mitigation Plan** included a mitigation action to acquire generators for critical facilities including the Maui Food Bank.

The project received nearly $94,000 of Federal grant funding to implement the mitigation action.

This allows the Maui Food Bank to better **serve the needs** of vulnerable members the community community by continuing to supply fresh food despite power outages.

MAUI FOOD BANK
Helping the Hungry

Hawaiʻi County Mitigation Success Story
Department of Water Supply Generators

The **2020 County of Hawaiʻi Multi-Hazard Mitigation Plan** included a mitigation action to harden DWS potable water producing facilities by installing needed emergency generating infrastructure.

The project received nearly $174,000 of Federal grant funding to complete the mitigation action.

This allows DWS to better **protect the health and welfare** of our island community by continuing to supply potable water despite power outages.

Honokōhau Transfer Switch

Piʻihonua Transfer Switch and Terminal Box

Mitigation Strategies Input

Submit your ideas for mitigation strategies to: HawaiiEMA@hawaii.gov

Categories for Mitigation:

- Local Planning and Regulations
- Structure and Infrastructure Projects
- Natural Systems Protection
- Education and Awareness Programs

Coordination with Other Planning Efforts

The Hawai‘i State Hazard Mitigation Plan:

- Is the guiding document for Local Hazard Mitigation Plans (HMPs)
- Is integrated in the THIRA (Threat and Hazard Identification and Risk Assessment) and the SRP (Stakeholder Preparedness Review)

Local HMPs are used when developing or updating:

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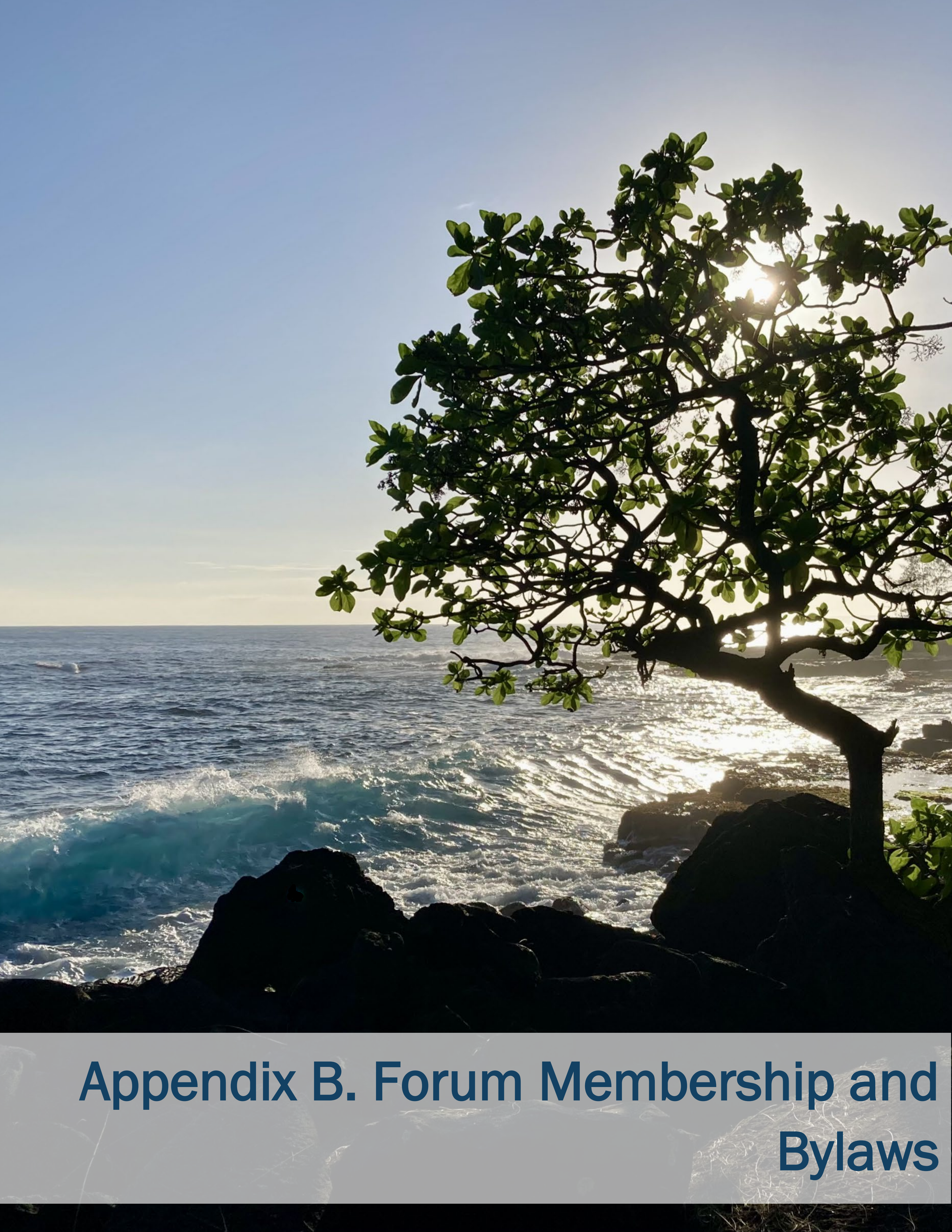


Appendix B. Forum Membership and Bylaws

CONTENTS

[1] *Section Cover Photo: Makuʻu Point Sunrise. Photo by Megan Brotherton*

APPENDIX B. STATE HAZARD MITIGATION FORUM MEMBERSHIP AND BYLAWS

This appendix includes the State Hazard Mitigation Forum Membership and Bylaws.

Table B-1. State Hazard Mitigation Forum Members

Agency	Name	Sector/Area of Expertise
Members		
Maui County Emergency Management Agency	Gina Albanese	County Emergency Management
State of Hawaiʻi Office of Planning and Sustainable Development	Danielle Bass	Land Use and Development
County of Maui Department of Planning	James Buika	County Land Use and Development, Building Codes
Hawaiʻi State Energy Office	Jonathan Chin	Infrastructure
Hawaiʻi State Climatologist, University of Hawaiʻi	Pao-Shin Chu, PhD	Natural and Cultural Resources, Climate Change, Natural Hazards
State of Hawaiʻi Office of Homeland Security	Jimmie Collins	Emergency Management, Terrorism and Cyber Threat
Hawaiʻi State Department of Health, State Toxicologist	Diana Felton	Health and Social Services, Hazardous Materials
City and County of Honolulu, Office of Climate Change, Sustainability and Resiliency	Sarah Harris	Natural and Cultural Resources, Land Use and Development; Climate Change
Kauaʻi Emergency Management Agency	David Kennard (Chair)	Emergency Management
County of Hawaiʻi Planning Department, Long Range Planning Division	Bethany Morrison	Land Use and Development
County of Kauaʻi Department of Public Works	Michael Moule	Infrastructure
Honolulu Board of Water Supply	Raelynn Nakabayashi	Infrastructure (Water)
University of Hawaiʻi	Tara Owens	Natural and Cultural Resources, Coastal Hazards
County of Hawaiʻi Civil Defense Agency	Barry Periatt	Emergency Management
State of Hawaiʻi Department of Transportation, Highways Division	Genevieve Sullivan	Infrastructure (Transportation)
County of Hawaiʻi Planning Department	April Surprenant	County Land Use and Development, Building Codes
Island Strategy LLC, Kauaʻi Island Utility Cooperative	Jan TenBruggencate	Infrastructure (Energy)
Hawaiʻi State Department of Business, Economic Development and Tourism	Amber Ternus	Economic Development
State of Hawaiʻi Department of Land and Natural Resources, Division of Forestry and Wildlife	Michael Walker	Natural and Cultural Resources
State of Hawaiʻi Office of Planning and Sustainable Development, Coastal Zone Management	Lisa Webster	Natural and Cultural Resources, Social Vulnerability

Agency	Name	Sector/Area of Expertise
Ex Officio Members		
Maui County Emergency Management Agency, Administrator	Herman Andaya	Emergency Management
Volunteer (former Hawaiʻi State Emergency Management Agency State Hazard Mitigation Officer)	Larry Kanda	Emergency Management
Honolulu Board of Water Supply	Ernest Lau	Infrastructure (Water)
County of Hawaiʻi Planning Department	Douglas Le	County, Land Use and Development
Hawaiʻi Emergency Management Agency	David Lopez	Emergency Management
County of Hawaiʻi Civil Defense Agency	Talmadge Magno	Emergency Management
State of Hawaiʻi Department of Land and Natural Resources, Engineering Division	Edwin Matsuda	Infrastructure
State of Hawaiʻi Office of Planning and Sustainable Development, Coastal Zone Management	Justine Nihipali	Land Use and Development
Volunteer	Ann Ogata-Deal	Land Use and Development
Hawaiʻi Emergency Management Agency	Jennifer Robertson	Emergency Management
Kauaʻi Emergency Management Agency	Chelsie Sakai	Emergency Management
City and County of Honolulu Department of Emergency Management	Hirokazu Toiya	Emergency Management
State of Hawaiʻi Department of Land and Natural Resources, Engineering Division; National Flood Insurance Program Coordinator	Carol Tyau-Beam	Infrastructure
Kauaʻi Emergency Management Agency, Administrator	Elton Ushiro	Emergency Management
Hawaiʻi Emergency Management Agency	Carmela Vigue	Emergency Management

Note: The State Hazard Mitigation Forum members listed in this table are current as of March 2023

BYLAWS

HAWAII STATE HAZARD MITIGATION FORUM

ARTICLE I – NAME and AUTHORITY

I-1. The name of this organization is the Hawaii State Hazard Mitigation Forum (Forum), hereinafter referred to as the "Forum."

I-2. As delegated by the Disaster Mitigation Act of 2000 Sec. 204, the State may coordinate and administer a committed mitigation grants and planning program. The key responsibilities of the State and local activities relating to hazard evaluation and mitigation are delegated as per 44 CFR 201.

I-3. The Forum is established under the authority contained in the Hawaii Revised Statutes Chapter 127A, which empowers the Hawaii Emergency Management Agency (HI-EMA) to carry out the emergency management program for the State of Hawaii.

ARTICLE II – MISSION and PURPOSE

II-1. The Forum mission is to promote a more disaster-resilient Hawaii.

II-2. The Forum shall advise and support HI-EMA Hazard Mitigation, on matters concerning planning, projects and policies for all natural and human-caused hazards. All Forum activities must meet the requirements stated in the Hawaii State Hazard Mitigation Plan (SHMP).

II-3. The Forum shall:

1. Implement the SHMP through the following actions:
    a. Evaluate and prioritize measures to mitigate the risks associated with Hawaii's hazards;
    b. Assist HI-EMA to solicit, review, and prioritize nominations for hazard mitigation projects to be included in the SHMP;
    c. Advise the selection of applicants for FEMA's Hazard Mitigation Assistance (HMA) funding, including the Building Resilient Infrastructure and Communities (BRIC), the Hazard Mitigation Grant Program (HMGP), and the Flood Mitigation Assistance(FMA) programs; and other Federal, State, and Private Grant Programs.
    d. Assist State and county agencies in obtaining other, non-FEMA funding to implement hazard mitigation projects;
    e. Develop a comprehensive public awareness program on the activities of the Forum, highlighting successful hazard mitigation projects; and
    f. Coordinate activities and hazard mitigation planning among other entities.
2. Review and update the SHMP, as required by federal law, or as needed.

ARTICLE III - DEFINITIONS

III-1. The following definitions are derived from statutory documents which have been accepted by all levels of government involved in emergencymanagement activities or operations:

1. Flood Mitigation Assistance: A Federal Emergency Management Agency (FEMA) grant program authorized by Section 1366 of the National Flood Insurance Act of 1968, as amended, with the goal of reducing or eliminating claims under the National Flood Insurance Program (NFIP). FMA provides funding to States, Territories, and local communities for projects and planning that reduces or eliminates long-term risk of flood damage to structures insured under the NFIP. FMA grants are awarded on a competitive basis and funding is appropriated by Congress annually.

2. Hazard Mitigation: Any action taken to reduce or permanently eliminate the long-term risk to human life and property loss or damage from hazards.

3. Hazard Mitigation Assistance: any of three programs administered by FEMA that providefunding for eligible mitigation planning and projects to reduce disaster losses and protectlife and property from future disaster damages. The programs are the Building Resilient Infrastructure and Communities (BRIC) Program, the Hazard Mitigation Grant Program (HMGP), and the Flood Mitigation Assistance (FMA) Program.

4. Building Resilient Infrastructure and Communities (BRIC) grant program: a FEMA grant program that provides funding to States, Territories, and local communities to implement a sustained pre-disaster natural hazard mitigation program. The goal is to reduce overall risk to the population and structures from future hazard events, while also reducing reliance on Federal funding in future disasters. This program awards planning and projectgrants and provides opportunities for raising public awareness about reducing future losses before disaster strikes. Planning is a key process used to break the cycle of disaster damage, reconstruction, and repeated damage. The BRIC program is funded annually by Congressional appropriations and grants are awarded on a nationally competitive basis.

5. Hazard Mitigation Grant Program (HMGP): A FEMA program involving a coordinated effort of State and county agencies and private organizations to reduce risks to people and property from natural hazards. During and after Presidentially declared disasters, the Stafford Act makes available federal funds up to 15 percent of the estimated aggregate amount of grants for emergencies and permanent repairs under the federally-declared disaster. The federal government may contribute up to 75 percent of any cost-effective measure while the State, county governments or private nonprofit organizations contribute the remaining 25 percent of the project costs.

6. Major Disaster: Any natural catastrophe, or, regardless of cause, any fire or explosion which, in the determination of the President, causes damage of sufficient severity and magnitude to warrant major disaster assistance under the Stafford Act to supplement the efforts and available resources of State and county governments and disaster relief organizations in alleviating the damage, loss, hardship, or suffering caused thereby.

7. Measure/Project: Any activity proposed to reduce risk of future damage, hardship, loss, or suffering from major disasters. The terms are used interchangeably.

8. Stafford Act: Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended, signed into law on November 23, 1988, amended the Disaster Relief Act of 1974, PL 93-288.

9. State Hazard Mitigation Officer: The officer who coordinates and monitors all State hazard mitigation programs. This responsibility has been placed in HI-EMA.

<u>ARTICLE IV - MEMBERSHIP</u>

IV-1. The Forum shall be composed of a minimum of 11 members and a maximum of 19 members, appointed by the HI-EMA Administrator. Each county shall be entitled to at least one member. If the county seat is filled by other than the County Civil Defense or Emergency Management Administrator (CA), the CA shall be a non-voting, ex-officio member. A FEMA representative shall be entitled to non-voting, ex-officio membership.

IV-2. Membership Terms:

1. Forum members shall serve three-year terms and may be reappointed.

2. Prior to the last meeting of each calendar year, members shall reaffirm willingness to remain on the Forum through written confirmation. HI-EMA will contact each Forum member and request their confirmation through a standardized consent form.

3. A member who has more than two absences from scheduled meetings per year without valid cause may be requested by the HI-EMA Administrator to forfeit membership. A member may be represented by an approved alternate at a specific meeting.

4. If a vacancy should occur, the remaining members may recommend to the HI-EMA Administrator a replacement to fill the vacancy. The Administrator shall appointment a replacement as soon as possible, but not more than four months from the vacancy. The appointee shall complete the term of the individual whose position was vacated.

IV-3. Forum members shall have experience and interest in hazard mitigation activities such as, but not limited to, the following areas of expertise: Risk Analysis, Hazard Analysis, Public Awareness, Education, Emergency Management, Environmental Studies or Protection, Structural Engineering, Seismology, Geology, Public Works, Public Utilities, Insurance, Planning, Flood Control, Land Utilization, Waste Management, Sheltering, Energy, Construction, Communications, Building Codes, Architecture, Coastal Zone Management, Resilience, and Grants Management. Members may be selected from governmentalagencies, the private sector, and the public at large, if one of the above qualifications ismet. Each county government will be insured of having at least one member.

IV-4. The opinions of Forum members need not represent the views of other organizations in which they have membership.

ARTICLE V - OFFICERS

V-1. The Forum shall elect a Chair and Vice Chair from among its members. The Executive Assistant(s) will be appointed by the HI-EMA Administrator and/or the SHMO.

V-2. The duties of the **Chair** shall be:

1. Preside at all meetings of the Forum;
2. Call for approval of the minutes of the preceding meeting when a quorum is present;
3. Announce the business before the Forum;
4. Receive all matters brought before the Forum, and to call for votes on matters that require an announcement of results;
5. Appoint members to all committees, subject to appeal by a majority of Forum members;
6. Authenticate, by signature, all acts of the Forum as may be required;
7. Make known all rules of orders when so requested and to decide all questions of order, subject to appeal to the Forum;
8. Act as spokesperson for the Forum;
9. Perform other duties as may be required of such office.

V-3. The duties of the **Vice Chair** shall be:

1. Act as the presiding officer in the absence or disability of the Chair;
2. Perform any special duties assigned by the Chair;
3. In case of resignation or incapacitation of the Chair, the Vice Chair shall become Chair for the unexpired part of the term.

V-4. The duties of the **Executive Assistant** shall be:

1. Keep accurate and current minutes of each meeting of the Forum, noting all actions taken, whether carried or lost;
2. Call the meeting to order in the absence of the Chair and Vice Chair and proceed with the election of a temporary Chair;
3. Prepare and disseminate correspondence as directed;
4. Send out all notices of meetings;
5. Keep an account of receipts and expenditures.
6. Work with the Chair and Vice Chair to develop an annual report of the Forum’s activities. Annual reports will be submitted the January following the end of each year.

ARTICLE VI - MEETINGS

VI-1. A majority of the entire voting Forum membership shall constitute a quorum.

VI-2. Members are strongly encouraged to attend in person. Meetings may be held in the State emergency operations facility that would allow attendance via secure video teleconferencing with the County emergency operations centers. Other technologies for hosting virtual meeting must be approved by the forum.

VI-3. Quorum is required to take any action.

VI-4. Regular meetings of the Forum shall be held quarterly. The Forum may also convene special meetings at any other times deemed appropriate.

VI-5. Special meetings may be called by the officers of the Forum.

VI-6. Any Forum member may request that a matter be placed on the agenda by notifying the Executive Assistant 15 calendar days before the date of a meeting.

VI-7. The Forum requests prior notification of dissenting opinions when such opinions are made public. The Forum shall not prohibit the expression of dissenting opinions.

VI-8. The Forum shall be notified of any solicitation of outside party review of Forum work. The reviewer shall be notified when their request has reached the Forum.

VI-9. The Executive Assistant will prepare the minutes of all meetings and disseminate them to all members prior to the next scheduled meeting.

ARTICLE VII - COMMITTEES

VII-1. The Forum should utilize the work of established committees, boards, councils, etc., which are involved in hazard mitigation affairs such as the Hawaii Earthquake and Tsunami Advisory Committee to facilitate its own actions and to maximize available resources and expertise.

VII-2. The Forum may establish sub-committees whose members are appointed by the Chair.

ARTICLE VIII

PETITION FOR ADOPTION, AMENDMENT, OR REPEAL OF BYLAWS

VIII-1. Any voting Forum member may petition the Forum requesting adoption, amendment, or repeal of any articles of the Bylaws.

VIII-2. Bylaws may be adopted, amended, or repealed by the vote of a majority of the voting membership of the Forum.

VIII-3. Subject to Article XI, changes to the Bylaws shall become effective at the next regularly scheduled meeting.

ARTICLE IX - PARLIAMENTARY AUTHORITY

IX-1. Robert's Rules of Order, revised, shall govern the Forum in such case that actions are not consistent with these Bylaws.

ARTICLE X - VALIDITY

X-1. If any section or part of the Bylaws is held to be invalid for any reason whatsoever, such invalidity shall not affect the validity of the remaining sections of the Bylaws.

ARTICLE XI - EFFECTIVE DATE

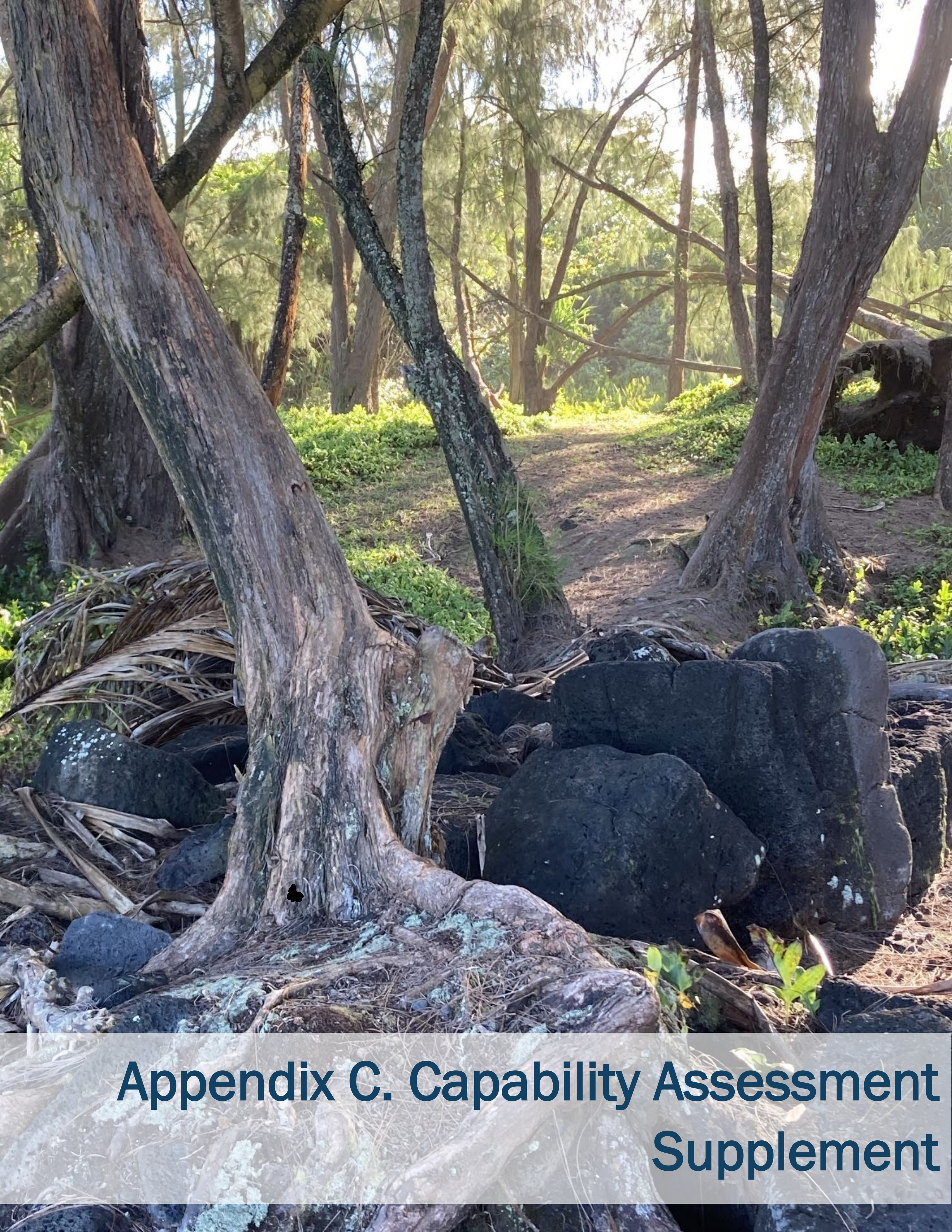
XI-1. These Bylaws shall become effective upon approval of the Administrator of HI-EMA.

L

______________________________ Mar 2, 2022 ______________________________

Luke P. Meyers
Administrator
Hawaii Emergency Management Agency
State of Hawaii Department of Defense

DATE



Appendix C. Capability Assessment Supplement

CONTENTS

TABLES

[1] *Section Cover Photo: Ironwood Forest. Photo by Megan Brotherton*

APPENDIX C. CAPABILITY ASSESSMENT SUPPLEMENT

This appendix includes detailed information that supports the Capability Assessment discussion presented in Section 5 (Capability Assessment) of this document.

C.1 State Capability Assessment Detailed Tables

The following sections include the detailed capability assessment that is summarized in Section 5 (Capability Assessment) of the SHMP. The goal of this assessment was not to identify all capabilities an agency may have, but only those that are currently used or could be used to support mitigation efforts. Capabilities are generally arranged by agency; however, in some instances, capabilities listed are closely associated with the agency/department, but do not fall under their explicit authority. Information is provided for each capability as appropriate:

- **Capability Category and Description**—Lists which capability category the capability best aligns with (i.e., Planning and Regulatory; Administrative and Technical; Capital Projects and Maintenance; Financial; Education, Outreach, and Capacity Building; Disaster Response/Recovery) and a brief, succinct description of the capability
- **Notable changes**—Description of any significant changes that have impacted the capability since the 2018 SHMP was developed. Changes include but are not limited to plan updates, change in staff/resources, change in administrative rules or amendment to law, etc.
- **Challenges**—Describes any issues with implementing the capability, capability effectiveness or any aspects of the capability that conflict with hazard mitigation goals. Challenges include but are not limited to a lack of staffing or funding for implementation, outdated information or protocols, etc.
- **Opportunities**—Describes identified opportunities to address challenges, integrate mitigation goals, or otherwise enhance capabilities
- **Effect on Future Conditions**—Describes how the capability integrates future conditions (i.e., climate change)
- **Equitable Outcomes**—Describes how the capability helps advance equitable outcomes for socially vulnerable populations
- **Community Lifelines**—Lists which community lifeline(s) the capability supports (i.e., Safety and Security; Food, Water, Shelter; Health and Medical; Energy; Communications; Transportation; and/or Hazardous Materials)
- **Hazards**—Lists the hazard(s) of concern that the capability addresses
- **State HMP Goals**—Lists the SHMP goal(s) the capability advances
- **Type of Hazard Management Capability**—Indicates whether the capability applies pre- or post-disaster
- **Effect on Loss Reduction**—Indicates if the capability supports, facilitates or conflicts with hazard mitigation goals.
- **Funding**—Indicates if the capability provides funding for mitigation

C.1.1 DEPARTMENT OF ACCOUNTING AND GENERAL SERVICES

Table C-1 includes information on hazard mitigation related capabilities for the Department of Accounting and General Services (DAGS). Table C-2 includes information on hazard mitigation related capabilities for the Structural Engineers Association of Hawaiʻi (SEAOH).

Table C-1. Department of Accounting and General Services Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Description: *DAGS, is headed by the State Comptroller, who concurrently serves as the director of DAGS. The department is responsible for managing and supervising a wide range of state programs and activities.*								
State-owned Building Insurance	**Capability Category and Description:**	Administrative and Technical; Financial; Disaster Response/Recovery DAGS works with the insurance industry to make sure that the state-owned buildings and facilities (more than 7,500) have insurance in case of emergencies and hazards, and works with FEMA, Hawaiʻi Emergency Management Agency (HI-EMA), and the insurance industry during declared disasters to conduct damage assessments.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security; Food, Water, Shelter; Health and Medical; Energy; Communications; Transportation; Hazardous Material						
	Hazards:	Flood, Infrastructure Failure, Earthquake, Windstorm, Hurricane, Landslide and Rockfall, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	1, 3	◆	◆		◆		
Land Acquisition Program	**Capability Category and Description:**	Planning and Regulatory The Public Works Division of DAGS plans, coordinates, organizes, directs and controls a variety of engineering and architectural services for the state including land acquisition. Funds for land acquisition are appropriated by the legislature through the Capital Improvement Program. Land acquisition is conducted in partnership with the DLNR Land Division.						
	Notable Changes:	None identified.						
	Challenges:	DAGS does not have funding budgeted for this purpose, so all funding would need to come from the legislature.						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Opportunities:	Properties that have experienced repetitive losses from hazard events could be acquired though willing seller programs (i.e., Action 2023-2018-054).						
	Effect on Future Conditions:	Buyouts in areas affected by hazards such as sea level rise.						
	Equitable Outcomes:	Provide means for disadvantaged persons to leave hazard-prone locations.						
	Community Lifelines:	Food, Water, Shelter						
	Hazards:	Drought, Climate Change, Tsunami, Flood						
	State HMP Goals:	1, 2		◆		◆		◆
Shelter Upgrade Program [b]	**Capability Category and Description:**	Capital Projects and Maintenance The Public Works Division of DAGS takes the lead in implementing sheltering upgrades for public facilities to withstand disasters. Funds for shelter upgrades are appropriated by the legislature through the Capital Improvement Program.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	Future disasters may be exacerbated by climate change; shelters need to upgrade to withstand increased risk						
	Equitable Outcomes:	Provides safe location during a disaster						
	Community Lifelines:	Food, Water, Shelter						
	Hazards:	Hurricane						
	State HMP Goals:	1,2	◆		◆	◆		◆
Damage Assessments [b]	**Capability Category and Description:**	Disaster Response/Recovery The Public Works Division of DAGS has architectural and engineering staff capable of supporting damage assessments to buildings and structures damaged after an event.						
	Notable Changes:	None identified.						
	Challenges:	Staff workload would need to be managed for this additional task. Staff time would need to be reimbursed.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	May prevent damages from higher intensity storms						
	Equitable Outcomes:	None identified.						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Community Lifelines:	Food, Water, Shelter; Safety and Security						
	Hazards:	Earthquake, Hurricane						
	State HMP Goals:	3		◆	◆	◆		
Building Code Council [c]	**Capability Category and Description:**	Planning and Regulatory The State Building Code Council (the Council) which is administratively attached to the Department of Accounting and General Services and is authorized by Section 107-22, Hawaiʻi Revised Statues. The purpose of the Council is to establish a state building code through the timely adoption of national building codes and would include the latest fire code as adopted by the State Fire Council, the latest edition of the International Building Code, the latest edition of the Uniform Plumbing Code, and Hawaiʻi design standards to implement Act 5, Special Session Laws, 2005 as applicable to emergency shelters and essential government facilities. HAR §3-180 sets forth the State Building Code. Counties may make local amendments						
	Notable Changes:	None identified.						
	Challenges:	Work on the adoption and implementation of modern building codes for all counties is still ongoing. The 2018 IBC is still pending for some counties. The 2018 codes have some HI-specific amendments that are focused on wind that are important. DAGS has a mitigation grant to facilitate the adoption of amendments. Challenges have involved some changes in legislation that impact the logistical aspects of the adoption process. Adoption is expected to move forward in the short-term.						
	Opportunities:	The American Society of Civil Engineers (ASCE)'s 2016 edition of ASCE 7 Standard Minimum Design Loads and Associated Criteria for Buildings and Other Structures includes a unified set of analysis and design methodologies for tsunami forces and effects on critical and essential facilities, and tsunami evacuation centers for the states of Alaska, Washington, Oregon, California, and Hawaiʻi. The standards can also be applied to other multi-story buildings, as determined by the local jurisdiction. The standard's methods are consistent with state-of-the-art tsunami physics, and utilizes probabilistic hazard analysis and structural target reliability analysis similar to the methods underlying earthquake design in ASCE 7. In addition to the standards, ASCE developed Tsunami Design Zone Maps which graphically depict the extent of inundation for a 1 in 2,500 annual chance Maximum Considered Tsunami (MCT) along the coastlines of the five applicable states, including the State of Hawaiʻi (Chock, Wei, Cox 2016). These maps provide the default design maps, are being replaced by high-resolution maps with finer spatial resolution as local Hawaiʻi map amendments for application in state building codes (Chock 2016). These provisions are currently required in the State of Hawaiʻi for all new construction of critical and essential buildings and facilities within the Tsunami Design Zone, as well as regular buildings that exceed 75 feet in height, including hotels, condominiums, office buildings, etc. The next edition of the ASDCE 7 standard was published in 2022 and retains all of these tsunami design requirements, while the Tsunami Design Zone maps of Oʻahu and portions of Hawaiʻi Island have been updated with high-resolution maps. High resolution maps for Maui and Kauaʻi are currently being developed for potential inclusion in the 2028 edition of ASCE 7 (i.e., Actions 2023-2018-049 and 2023-2018-050). Increase capacity to adopt new building codes in a timely manner (i.e., Action 2023-2013-004)						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction [a]: Support	Effect on Loss Reduction [a]: Facilitate	Effect on Loss Reduction [a]: Conflict	Provides Funding for Mitigation
	Effect on Future Conditions:	May prevent damages from higher intensity storms and hazards						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Food, Water, Shelter						
	Hazards:	Earthquake, Flood, Windstorm, Hurricane, Landslide and Rockfall, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	1, 2, 3	◆		◆	◆		

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*
b. *Identified by the department/agency as one of the most effective capabilities for achieving mitigation goals.*
c. *Identified by a stakeholder group as presenting an opportunity to improve effectiveness at meeting hazard mitigation goals. In this instance, opportunity primarily lies with adoption and enforcement at the local level.*

Table C-2. Structural Engineers Association Capabilities

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction [a]: Support	Effect on Loss Reduction [a]: Facilitate	Effect on Loss Reduction [a]: Conflict	Provides Funding for Mitigation
Description: *SEAOH is the Structural Engineers Association of Hawai`i, a charter member of the National Council of Structural Engineers Association (NCSEA). SEOAH is a non-profit, member-driven organization that pursues the common interests of practicing structural engineers and others sharing an interest in the activities of structural engineers.*								
Disaster Response Committee	**Capability Category and Description:**	Disaster Response/Recovery The purpose of the SEAOH Disaster Response Committee (DRC) is to consider and coordinate activities the structural engineering community can do before and after disasters occur. The DRC maintains a list of SEAOH member volunteers who: (1) want to participate in Pre-disaster Organization and Training and (2) can be called upon to act as Post-Disaster Volunteer Engineers.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community	Safety and Security; Food, Water, Shelter						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Lifelines:							
	Hazards:	Infrastructure Failure, Earthquake, Flood, Hurricane, Landslide and Rockfall, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	2, 3, 4	◆	◆		◆		
Building Code Committee	**Capability Category and Description:**	Planning and Regulatory One member of the State Building Code Council is a member of the SEAOH. The committee reviews the International Building Code and International Residential Code in support of this role.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Food, Water, Shelter						
	Hazards:	Flood, Infrastructure Failure, Earthquake, Flood, Windstorm, Hurricane, Landslide and Rockfall, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	2, 3, 4	◆		◆	◆		

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*

C.1.2 DEPARTMENT OF BUDGET AND FINANCE

Table C-3 includes information on hazard mitigation related capabilities for the Department of Budget and Finance (DBF).

Table C-3. Department of Budget and Finance Capabilities

<table>
<tr><th colspan="3" rowspan="2">Capability</th><th colspan="2">Type of Hazard Management Capability</th><th colspan="3">Effect on Loss Reduction a</th><th rowspan="2">Provides Funding for Mitigation</th></tr>
<tr><th>Pre-Disaster</th><th>Post-Disaster</th><th>Support</th><th>Facilitate</th><th>Conflict</th></tr>
<tr><td colspan="9">Description: The Department of Budget and Finance (DBF), headed by the Director of Finance, administers the state budget, develops near- and long-term financial plans and strategies for the state, and provides programs for the improvement of management and financial management of state agencies.</td></tr>
<tr><td rowspan="4">Capital Improvements Budget</td><td>Capability Category and Description:</td><td colspan="7">Financial
Project appropriation proposals submitted by state and county agencies are reviewed, prioritized, and evaluated to ensure conformity with statewide planning goals and objectives and executive priorities, and an estimate of the operational costs for each proposed capital improvement project is provided to the governor for consideration for possible inclusion in the executive capital improvement project budget that is to be presented to the legislature. The department also reviews, analyzes, and reports on state and county capital improvement project appropriation proposals that extend over wide geographical areas of the state and that have significant impacts upon economic development, land use, environmental quality, construction employment, and executive policy directions.
Act 286 (HRS § 226-109) adopting Climate Change Adaptation Priority Guidelines as a policy of the Hawai‘i State Planning Act mandates that all county and state agency actions consider climate change adaptation in capital improvement.</td></tr>
<tr><td>Notable Changes:</td><td colspan="7">None identified.</td></tr>
<tr><td>Challenges:</td><td colspan="7">None identified.</td></tr>
<tr><td>Opportunities:</td><td colspan="7">Projects identified in capital budgets can be submitted for consideration in federal grant programs. Opportunities to integrate hazard mitigation goals, should be included in capital project review and development.
This source of funding may be used for mitigation, including:
Wildfire
Nursery improvements needed to provide native plants for green breaks, which help shade out grass to break the grass fire cycle, by replacing non-native, invasive grasses and shrubs with mostly native plants and trees (i.e., Action 2023-2018-026); and
Development of water sources, including installation of water storage structures and improvements to existing water storage structures (i.e., Action 2023-2018-027)
Rockfall
Rockfall and slope stabilization projects are included in the capital budget.</td></tr>
</table>

Capability			Type of Hazard Management Capability		Effect on Loss Reduction a			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						
	Hazards:	Flood, Climate Change and Sea Level Rise, Infrastructure Failure, Drought, Earthquake, Hazardous Materials, Landslide and Rockfall, Wildfire						
	State HMP Goals:	1, 2, 5	◆		◆	◆		◆

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*

C.1.3 DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT AND TOURISM

The Department of Business, Economic Development and Tourism (DBEDT) is a large department with many mitigation-related capabilities. Table C-4 includes information on hazard mitigation related capabilities for the Hawaiʻi Community Development Authority (HCDA), Table C-5 includes information for the Hawaiʻi Tourism Authority (HTA), Table C-6 includes information for the Hawaiʻi State Energy Office, and Table C-7 includes information for the Office of Planning and Sustainable Development (OPSD).

Table C-4. Hawaiʻi Community Development Authority Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Description: *The Hawaiʻi Community Development Authority (HCDA) is a public entity created by the Hawaiʻi State Legislature to establish community development plans in community development districts; determine community development programs; and cooperate with private enterprise and the various components of federal, state, and county governments to bring community development plans to fruition. The HCDA's work should result in economic and social opportunities and aim to meet the highest needs and aspirations of Hawaii's people.*								
Community Development District Program	**Capability Category and Description:**	Planning and Regulatory At the time of this plan update there are three community development districts in the state: Kakaʻako, Kalaeloa and Heʻeia						
	Notable Changes:	None identified. Annual reports are available online at: http://dbedt.Hawaiʻi.gov/hcda/hcda-annual-reports/						
	Challenges:	None identified.						
	Opportunities:	As a community development planning agency, HCDA has the opportunity to integrate natural hazard mitigation goals and strategies into its development programs and districts.						
	Effect on Future Conditions:	Integration of natural hazard mitigation goals and strategies into its development programs and districts						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security; Food, Water, Shelter; Health and Medical; Energy; Communications; Transportation						
	Hazards:	Flood, Climate Change and Sea Level Rise, Infrastructure Failure, Drought, Earthquake, Hazardous Materials, Health Risks, Windstorm, Hurricane, Landslide and Rockfall, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	3, 6	◆		◆	◆		

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*

Table C-5. Hawai'i Tourism Authority Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Description: *HTA works closely with state and county safety and security agencies to ensure visitor safety remains a top priority. To accomplish this, HTA utilizes technology to reach and deliver safety messages directly to visitors in times of danger or potential danger. Visitor Assistance Programs (VAPs) in all four counties provide assistance with aloha to visitors in need.*								
GoHawai'i Mobile App	**Capability Category and Description:**	Education, Outreach, and Capacity Building In 2016 HTA developed the GoHawai'i mobile app – the State of Hawaii's first destination app – which offers safety information available in English, Chinese, Korean, Japanese and German to educate visitors on enjoying the Hawaiian Islands safely. Additionally, the app's push notification capability enables HTA to send messages directly to users, alerting them of dangerous or hazardous situations (HTA 2016).						
	Notable Changes:	This is a new capability.						
	Challenges:	None identified.						
	Opportunities:	Expand the GoHawai'i mobile app information to address all hazards of concern for Hawai'i.						
	Effect on Future Conditions:	Notifies visitors of hazardous conditions						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security; Communications						
	Hazards:	Flood, Earthquake, Health Risks, Hurricane, Landslide and Rockfall, Tsunami						
	State HMP Goals:	5, 7	◆	◆		◆		

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*

Table C-6. Hawai'i State Energy Office Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Description: *As the designated agency for energy, HSEO works closely with many government and industry emergency management and security partners to lower vulnerabilities, deter threats, minimize the consequences of energy disruptions, and enhance recovery of Hawaii's energy systems.*								
Energy Assurance Program	**Capability Category and Description:**	Administrative and Technical Hawaii's Energy Assurance Program provides organizational and planning support for energy emergency management. The program aims to facilitate the rapid restoration of Hawaii's energy systems and mitigate the impact of energy shortages. The concept of operations for the program includes energy emergency preparedness; response and restoration; monitoring, reporting, and analysis; coordination and outreach; and energy assurance planning.						
	Notable Changes:	Through a FEMA Hazard Mitigation Advance Assistance grant project, HSEO has engaged private and public owners and operators of the state's critical energy infrastructure and community lifelines to conduct risk assessments, characterize dependencies, develop an energy common operating picture, and identify energy hazard mitigation actions and strategies to make the energy system more resilient.						
	Challenges:	None identified.						
	Opportunities:	At the conclusion of the Advance Assistance project, several viable energy hazard mitigation actions and strategies will have been identified for consideration and inclusion in the next Hazard Mitigation Plan update. The relevant agencies and stakeholders can and should pursue funding to implement projects. HSEO is tracking and supporting opportunities from IIJA and IRA concerning grid resilience as well as annual funding opportunities through programs such as Building Resilient Infrastructure and Communities (BRIC).						
	Effect on Future Conditions:	Seeks to mitigate energy shortages in the event of a disaster						
	Equitable Outcomes:	Seeks to mitigate energy shortages in the event of a disaster						
	Community Lifelines:	Safety and Security; Energy						
	Hazards:	Climate Change, Infrastructure Failure, Earthquake, Flood, Windstorm, Hurricane, Landslide and Rockfall, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	1, 3, 4, 6	◆	◆		◆		

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*

Table C-7. Office of Planning and Sustainable Development Capabilities

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation [b]
STATE LAND USE LAW [d]								
Description: *The State Land Use Law (Chapter 205, Hawai`i Revised Statutes) was adopted in 1961, establishing a framework of land use management and regulation in which all lands in the State of Hawai'i are classified into one of four land use districts. The Land Use Division of the Office of Planning and Sustainable Development represents the state's interests as they pertain to District Boundary Amendments, Special Permits, and Important Agricultural Lands. Land Use Division staff ensure petitions for boundary amendments meet the land use commission decision-making criteria, address impacts to state infrastructure, and evaluate whether the proposed project complies with the Hawai'i State Plan.*								
Land Use Districts	**Capability Category and Description:**	Planning and Regulatory All lands in the State of Hawai'i are classified in one of the four land use districts: urban, rural, agricultural, and conservation. County governments have regulatory authority over Urban District lands and shared authority over Agricultural and Rural District Lands. Conservation District lands are regulated and managed by the State Department of Land and Natural Resources.						
	Notable Changes:	None identified.						
	Challenges:	Use of agricultural lands for non-farm uses, expansion of permissible uses in Chapter 205 for non-farm uses, subdivision and use of condominium property regimes for residential developments without active farming remain challenges for managing agricultural lands.						
	Opportunities:	OPSD will be conducting a soil classification study in 2023 to determine how soil quality data and ratings, particularly with respect to agricultural productivity, might be better used in land use regulation. This affords an opportunity to examine how different soil characteristics and conditions might be susceptible to natural hazards and whether mitigation measures are effectively applied in accommodating land uses on such soils. Support mitigation action 2013-2013-035 to analyze soils for seismic modeling by sharing applicable data from the OPSD soil classification study.						
	Effect on Future Conditions:	Land districts can influence the damages felt following a disaster.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security; Food, Water, Shelter						
	Hazards:	Flood, Climate Change, Infrastructure Failure, Drought, Earthquake, Windstorm, Hurricane, Landslide and Rockfall, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	1, 2	◆		◆			

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation [b]
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Periodic Boundary Review	**Capability Category and Description:**	Planning and Regulatory Hawai'i Revised Statutes § 205-18 called for the periodic "review of the classification and districting of all lands in the state." Such reviews have been conducted in 1969, 1974, and 1990.						
	Notable Changes:	Chapter 205 was amended in 2021 to remove the requirement for periodic Boundary Reviews to simply state that OPSD may undertake a boundary review.						
	Challenges:	Boundary reviews have been used in the past to identify those lands that are more suitable in another district due to their physical characteristics or emerging threats or opportunities for lands within each district.						
	Opportunities:	Future Reviews can include issues such as sustainability and climate change issues.						
	Effect on Future Conditions:	Land districts can influence the damages felt following a disaster.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security; Food, Water, Shelter; Health and Medical; Energy; Communications; Transportation						
	Hazards:	Flood, Landslide and Rockfall, Tsunami, Volcanic Hazards						
	State HMP Goals:	1, 2	◆		◆			
Land Use Commission	**Capability Category and Description:**	Planning and Regulatory The Land Use Commission (LUC) administers the Land Use Law. The LUC is composed of nine members, one from each county and five members appointed at large. The Land Use Commission Rules outline standards for determining district boundaries, which include consideration of some natural hazards.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	Land districts can influence the damages felt following a disaster.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security; Food, Water, Shelter; Health and Medical; Energy; Communications; Transportation; Hazardous Materials						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation [b]
	Hazards:	Flood, Landslide and Rockfall, Tsunami, Volcanic Hazards						
	State HMP Goals:	1, 2	◆		◆			
COASTAL ZONE MANAGEMENT PROGRAM [b, c, d]								
Description: *The Hawai'i Coastal Zone Management Program (CZM Program) was approved in 1977 and is responsive to the Federal CZM Act of 1972. It serves as the state's resource management policy umbrella and the guiding perspective for the design and implementation of allowable land and water use activities throughout the state. All agencies must assure their statutes, ordinances, rules and actions comply with the CZM's ten objectives and related policies. The coastal zone in the State of Hawai'i consists of the entire state and the area extending seaward to the limit of the state's police power and management authority. The Office of Planning and Sustainable Development administers the Coastal Zone Management Law through the Coastal Zone Management Program and sub-programs; however, 14 agencies have responsibilities relating to marine and coastal zone management.*								
Hawai'i CZM Program Document	**Capability Category and Description:**	Planning and Regulatory Approved by NOAA in 1990, the Hawai'i Coastal Zone Management Program document provides a description of the Hawai'i Coastal Zone Management Program including links between the federal, state, and county governments, Hawaii's land use and environmental management systems, and special components of the Hawai'i CZM program (OPSD, 1990). In 2011 a supplemental document describing the CZM program as it existed in 2011 was produced, but it is not intended to be a replacement for the 1990 program document. Reducing hazard to life and property from tsunami, storm waves, stream flooding, erosion, subsidence, and pollution is a stated objective of the program and four policies have been developed to support this objective (OPSD 2011).						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						
	Hazards:	Flood, Climate Change, Hurricane, Tsunami						
	State HMP Goals:	3	◆		◆			
Coastal Nonpoint Pollution Control Program (CNPCP)	**Capability Category and Description:**	Planning and Regulatory The purpose of this program is "to develop and implement management measures for nonpoint source pollution to restore and protect coastal waters." Projects to address polluted runoff control are outlined in the Coastal Nonpoint Pollution Control Management Plan						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation [b]
		(CNPCP) and Hawaiʻi Nonpoint Source Management Plan and are eligible for Clean Water Act section 319 funding. The State of Hawaii's CNPCP is co-implemented by the Department of Health and is a requirement of the 1990 Coastal Zone Act Reauthorization Amendments (16 U.S.C. – 1455b).						
	Notable Changes:	The State of Hawaii's Nonpoint Source Management Plan update was published for 2021-2025. In 2020, the Hawaiʻi CZM Program received approval from NOAA/EPA for a 5-year Workplan containing interim benchmarks and a timeline for meeting the outstanding conditions of the conditionally approved CNPCP. In 2021, Hawaiʻi has achieved obtaining a total of 54 Management Measures and Administrative Elements preliminarily approved by NOAA/EPA. In 2022, HAR 11-56 Nonpoint Source Pollution Control was adopted to provide the regulatory framework for the prevention, abatement, and control of new and existing nonpoint sources of pollution.						
	Challenges:	319 grant funding is limited with $167.9 million available in 2017 and projects must meet pollution reduction objectives. NO dedicated funding from CZM.						
	Opportunities:	While the focus of the program is on pollution control, some projects, such as those addressing urban stormwater runoff and water source protection, may also help meet mitigation goals and objectives. There may be an opportunity to align and leverage program objectives at the time of the next update.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security; Hazardous Materials						
	Hazards:	Climate Change, Flood, Health Risks						
	State HMP Goals:	1, 2	◆			◆		◆ (F)
Marine and Coastal Zone Advocacy Council (MACZAC)	**Capability Category and Description:**	Planning and Regulatory MACZAC is a public advisory body to assist the Hawaiʻi CZM Program toward the implementation of an integrated and comprehensive management system for marine and coastal zone resources, consistent with the objectives and policies of the Hawaiʻi Coastal Zone Management Act. Comprised of twelve advisory members recruited from the Islands of Kauaʻi, Oʻahu, Maui, Molokaʻi, Lānaʻi, and Hawaiʻi, MACZAC members have diverse backgrounds in business, environment, native Hawaiian practices, terrestrial and marine commerce, recreation, research, and tourism. The council's mission statement is to "Advocate for a comprehensive management system which restores, preserves and protects Hawaii's marine and coastal environment."						
	Notable Changes:	None identified.						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation [b]
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Challenges:	Capabilities are limited to the statutory role to advise and evaluate the CZM program.						
	Opportunities:	MACZAC may be a venue to have community discussion(s) on coastal hazards.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						
	Hazards:	Flood, Climate Change, Hurricane, Tsunami						
	State HMP Goals:	3, 4, 5	◆			◆		
Special Management Area (SMA) Permits	**Capability Category and Description:**	Planning and Regulatory The SMA permit is a management tool designed to assure that developments in the SMA are designed and carried out in compliance with the CZM objectives, policies, and SMA guidelines. The SMA permitting system regulates development within county designated SMAs extending from the shoreline inland (OPSD 2012). OPSD plays a lead role in the administration and management of the program, oversees the consistency of the permit system, provides training sessions to county SMA personnel and the County Planning Commissions, provides SMA permit guidance, and conducts SMA use review and approval for development within the SMA of community development districts. SMA permits were established as part of the Shoreline Protection Act of 1975. County authorities administer SMA permits and may amend their boundaries as necessary; however, boundary contractions are subject to OPSD's review. Trainings are generally offered for Planning Commissions and City/County Councils, particularly when there are new members. Trainings are requested by the County Planning Department and are typically conducted as a portion of a public meeting and are, therefore, open to the public. In general, these trainings are requested once per year and focus on the SMA basics, including the review criteria regarding coastal hazards.						
	Notable Changes:	None identified.						
	Challenges:	Not all activity in the SMA is required to obtain an SMA permit. SMA permitting definitions exclude certain activities related to: agriculture, interior alterations or non-structural improvements, and underground utilities.						
	Opportunities:	Opportunities to analyze hazard mitigation in the decision-making process can be integrated into SMA trainings offered by OPSD.						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation [b]
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Effect on Future Conditions:	Limiting development in areas which may be susceptible to hazards may reduce the amount of damages						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						
	Hazards:	Flood, Climate Change, Hurricane, Tsunami						
	State HMP Goals:	1, 2, 4	◆		◆			
Federal Consistency	**Capability Category and Description:**	Planning and Regulatory The State CZM Program reviews federal actions affecting any coastal use or resource to ensure that proposed activities are consistent with state enforceable policies, which include provisions for coastal hazards. Federal consistency is required under the national Coastal Zone Management Act (CZMA), Section 307. Procedures and requirements are established in the Code of Federal Regulation, 15 CFR 930.						
	Notable Changes:	A list of current federal license, permit, and financial assistance activities subject to federal consistency is available on the Office of Planning and Sustainable Development website.						
	Challenges:	None identified.						
	Opportunities:	The State CZM Program regularly reviews statutes and ordinances for inclusion as enforceable policies as part of the CZM program and be considered during the federal consistency review.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						
	Hazards:	Flood, Climate Change, Hurricane, Tsunami						
	State HMP Goals:	1, 2, 3	◆		◆			
Coastal Zone Enhancement Program	**Capability Category and Description:**	Planning and Regulatory State CZM program changes addressing one or more enhancement areas (wetlands, coastal hazards, public access, marine debris, cumulative and secondary impacts, special area management planning, ocean/great lakes resources, energy and government facility						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation [b]
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
		siting, and aquaculture) are eligible for Section 309 funding once an approved Assessment and Strategy has been completed. Past projects included education and outreach materials developed for distribution at community fairs and other public events. The CZM Program took the lead to align its FY2015-2020 coastal hazards strategy with a priority action under the 2013 SHMP to seek funding for and develop probabilistic design zone mapping for O'ahu, Maui, and Kaua'i. This project is slated for completion in 2023.						
	Notable Changes:	The Assessment and Strategy was updated over the performance period of the plan for FY 2021-2025, approved on June 30, 2020. Strategies for implementation in the updated plan include completing the Probabilistic Tsunami Design Zone Maps for the State, Coastline adaptation, and implementation of the Ocean Resources Management Plan (CZM Program 2015b). Document FY21-25 A&S is dated May 2020.						
	Challenges:	This is a fairly small fund.						
	Opportunities:	An update of the Assessment and Strategy will be required during the performance period of the SHMP. There will be an opportunity to identify additional strategies that meet both CZM and hazard mitigation goals and objectives.						
	Effect on Future Conditions:	Projects can educate individuals on risks associated with hazards, including how climate change may intensify an/or exacerbate the impacts and risks						
	Equitable Outcomes:	Projects can educate individuals on risks associated with hazards, including how climate change may intensify an/or exacerbate the impacts and risks						
	Community Lifelines:	Safety and Security; Transportation; Energy						
	Hazards:	Flood, Climate Change, Hurricane, Tsunami						
	State HMP Goals:	2, 4, 5, 7	◆			◆		◆ (F)
Cumulative & Secondary Impact: Stormwater Impact Assessment	**Capability Category and Description:**	Education, Outreach, and Capacity Building Document that provides easy to follow guidance on assessing stormwater impacts in the planning phase of project development and suggests the incorporation of appropriate mitigation strategies.						
	Notable Changes:	None identified.						
	Challenges:	The guidance document does not impose any legally binding requirements on county, state or federal agencies.						
	Opportunities:	Document could be updated/amended to include guidance on how to incorporate expected/possible changes in stormwater impacts because of climate change.						
	Effect on Future Conditions:	Document could be updated/amended to include guidance on how to incorporate expected/possible changes in stormwater impacts because of climate change.						
	Equitable	None identified.						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation [b]
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Outcomes:							
	Community Lifelines:	None identified.						
	Hazards:	Flood						
	State HMP Goals:	1, 2	◆		◆			
Hawai'i Coastal and Estuarine Land Conservation Program	**Capability Category and Description:**	Planning and Regulatory The Hawai'i Coastal and Estuarine Land Conservation Plan (CELCP) serves as the initial action toward eligibility for the federal Coastal and Estuarine Land Program, which enables permanent protection of coastal and estuarine lands by providing matching funds for community-based projects to acquire property from willing sellers through fee simple purchases or conservation easements.						
	Notable Changes:	None identified.						
	Challenges:	President's budget has not funded CELCP program at the federal level on a regular annual basis.						
	Opportunities:	Although the focus on the program is on protecting resource value associated with ecological value, conservation value, cultural value, recreational value and aesthetic value, there may be overlap between these values and mitigation goals. The Infrastructure Investment and Jobs Act will fund projects under this program during the performance period of the SHMP.						
	Effect on Future Conditions:	Would enable permanent protections of lands, reducing potential future damages						
	Equitable Outcomes:	Could provide means for disadvantaged persons to leave hazard-prone locations.						
	Community Lifelines:	Safety and Security; Food, Water, Shelter						
	Hazards:	Flood, Climate Change, Hurricane, Tsunami						
	State HMP Goals:	1, 2	◆		◆	◆		
Hawai'i Community Stewardship Directory	**Capability Category and Description:**	Education, Outreach, and Capacity Building Developed as an implementation tool for the Hawai'i Ocean Resources Management Plan to help community groups and organizations connect with each other to share their experiences and lessons learned in natural and cultural resources management.						
	Notable Changes:	None identified.						
	Challenges:	Organizations in the Directory have no official capacity to address natural hazards in terms of emergency management.						
	Opportunities:	None identified.						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation [b]
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	Community groups sharing knowledge may be able to assist disadvantaged communities						
	Community Lifelines:	Communications						
	Hazards:	Flood, Climate Change, Infrastructure Failure, Drought, Earthquake, Hazardous Materials, Health Risks, Windstorm, Hurricane, Landslide and Rockfall, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	3, 4	◆	◆	◆			
Low Impact Development: A Practitioner's Guide	**Capability Category and Description:**	Education, Outreach, and Capacity Building This workbook provides information on better site design principles, along with best management practices (BMPs) for stormwater and wastewater management that minimize the impacts to environmental resources. The design requirements for stormwater BMPs are based on the climate and rainfall characteristics experienced in the State of Hawaiʻi, taking into account the variability in rainfall with elevation and with the windward and leeward sides of the islands (CZM Program 2006).						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	Workbook could be amended/updated to incorporate design considerations for the likely impacts of climate change.						
	Effect on Future Conditions:	Implementation of the principles can minimize the impacts to environmental resources						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Communications						
	Hazards:	Drought, Flood						
	State HMP Goals:	1, 2, 4	◆		◆			
Shoreline Setback Area	**Capability Category and Description:**	Planning and Regulatory Establishes shoreline setbacks of 20 to 40 feet from the shoreline. Counties may expand the setback area beyond the minimum requirements. Established under HRS Section 205A-43 and 205A-45.						
	Notable Changes:	Act 16 Session Laws of Hawaiʻi, 2020 amended HRS Chapter 205A and increased the statewide minimum shoreline setback from 20 to 40						

Capability			Type of Hazard Management Capability: Pre-Disaster	Post-Disaster	Effect on Loss Reduction: Support	Facilitate	Conflict	Provides Funding for Mitigation [b]
		feet.						
	Challenges:	None identified.						
	Opportunities:	Some counties have chosen to expand setback area requirements above the minimum set forth by the State.						
	Effect on Future Conditions:	Decreases the likelihood of structural impact from climate change's influence on sea level rise						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						
	Hazards:	Flood, Climate Change						
	State HMP Goals:	2	◆	◆		◆		
Ocean Resources Management Plan	**Capability Category and Description:**	Planning and Regulatory Statewide plan that sets forth the State's ocean and coastal resources management priorities. The ORMP works by identifying three Focus Areas and five Management Priorities for the next five-year planning period, by identifying responsible agencies and resources, and by providing a method for performance measures and reporting. The ORMP is required under HRS Section 205A-62(1). The current plan was completed in July 2020 and includes coastal hazards, sea level rise, and coastal erosion as well as climate change adaptation: disaster preparedness and community resilience as pressures on the ocean and critical issues that need to be addressed.						
	Notable Changes:	The ORMP Dashboard was recently updated and moved to the Esri Hub platform. The Dashboard provides information on the progress of implementing the ORMP. See the following sites: https://ormp.hawaii.gov/ https://planning.hawaii.gov/czm/ormp/						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	Addresses climate change adaptation						
	Equitable Outcomes:	Addresses community resilience to climate change						
	Community Lifelines:	Safety and Security						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation [b]
	Hazards:	Flood, Climate Change, Hurricane, Tsunami						
	State HMP Goals:	2	◆		◆			
Council on Ocean Resources	**Capability Category and Description:**	Planning and Regulatory Established in 2013 by directors of state and county agencies, with unanimous support of federal and community partners, the Council facilitates greater coordination and implementation of the State's shared ocean and coastal resource management priorities.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						
	Hazards:	Flood, Climate Change, Hurricane, Tsunami						
	State HMP Goals:	2, 3	◆			◆		
HAWAIʻI STATE PLANNING ACT **Description:** *All state agencies are guided by the Hawaiʻi State Planning Act, which is a broad policy document that sets the table for all activities, programs, and decisions made by local and state agencies. The Hawaiʻi State Planning Act was signed into law in 1978 to "improve the planning process in this state, to increase the effectiveness of government and private actions, to improve coordination among different agencies and levels of government, to provide for wise use of Hawaii's resources and to guide the future development of the state" (HRS § 226-1). The Act is codified under HRS Chapter 226. The State Plan is divided into three parts: Overall theme, goals, objectives and policies; planning coordination and implementation; and priority guidelines.*								
Statewide Planning System	**Capability Category and Description:**	Planning and Regulatory Coordinates and guides all major state and county activities and implements the overall theme, goals, objectives, policies, and priority guidelines. The system implements the state plan through the development of functional plans and county general plans.						
	Notable Changes:	The State has developed 17 functional plans. Of these only one has been developed and/or updated since 1991. The *Housing State Functional Plan* was completed in February 2017 (Hawaiʻi Housing Finance and Development Commission 2017).						
	Challenges:	None identified.						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation [b]
	Opportunities:	As functional plans are updated, they can be reviewed and enhanced to ensure consistency with hazard mitigation goals.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security; Food, Water, Shelter						
	Hazards:	Flood, Climate Change, Infrastructure Failure, Drought, Earthquake, Windstorm, Hurricane, Landslide and Rockfall, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	2, 3, 4	◆		◆			
Priority Guidelines	**Capability Category and Description:**	Planning and Regulatory As part of the Statewide Planning System, the guidelines establish priorities to address areas of statewide concern: economic development, population growth and land resource management, affordable housing, crime and criminal justice, and quality education. Established in HRS § 226-59						
	Notable Changes:	None identified.						
	Challenges:	Priority guidelines serve primarily as aspirational or advisory and do not have any clear enforcement mechanisms from which to derive authority.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	Climate change may cause guidelines to be changed, especially in regard to economic development and land resource management						
	Equitable Outcomes:	Guidelines establish priorities to address affordable housing and quality education						
	Community Lifelines:	Safety and Security; Food, Water, Shelter						
	Hazards:	Flood, Climate Change, Dam Failure, Drought, Earthquake, Windstorm, Hurricane, Landslide and Rockfall, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	1, 7	◆	◆	◆			
Hawaiʻi State Plan Update Phase I	**Capability Category and**	Planning and Regulatory A comprehensive review of the State Planning Act is underway. Phase 1 of the update involves inventorying and reviewing all state						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation [b]
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Description:	department plans, strategic plans, functional plans, and capital improvement plans; identifying common themes and policy directions; developing findings as to the overall status of the plans and preparing findings and recommendations for next steps in the update of the State Planning Act.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	The update of the State Plan provides an opportunity to fully integrate the hazard mitigation plan with the State Plan.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						
	Hazards:	Flood, Climate Change, Infrastructure Failure, Drought, Earthquake, Hazardous Materials, Health Risks, Windstorm, Hurricane, Landslide and Rockfall, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	4, 6	◆	◆		◆		
HAWAIʻI STATEWIDE GEOGRAPHIC INFORMATION SYSTEM PROGRAM								
Hawaiʻi Statewide Geographic Information System Program	**Capability Category and Description:**	Administrative and Technical The program leads a multi-agency effort to establish and promote the use of GIS technology in State Government. A centralized database enables agencies to share information while reducing the development of redundant databases, helps standardize the information being analyzed by decision makers and serves as a means for collecting and distributing the best available geospatial data. The program manages and maintains the Hawaiʻi Open Geospatial Data Portal, and provides mapping, analysis, and consultation to State agencies, various map tools and applications, and other resources.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	Map tools and applications can continue to be expanded to support statewide planning efforts as well as support hazard mitigation related education and outreach activities. Program capabilities could also be expanded to help support mitigation activities through projects such as maintaining the Hazus-MH model developed as a part of this plan update.						
	Effect on Future Conditions:	GIS provides the ability to introduce climate change impacts to analyses						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation [b]
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security; Food, Water, Shelter; Health and Medical; Energy; Communications; Transportation; Hazardous Materials						
	Hazards:	Flood, Climate Change, Dam Failure, Drought, Earthquake, Hazardous Materials, Health Risks, Windstorm, Hurricane, Landslide and Rockfall, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	3, 4	◆		◆			

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*
b. *(F) = Federal grant funding*
c. *Identified by the department/agency as one of the most effective capabilities for achieving mitigation goals.*
d. *Identified by a stakeholder group as presenting an opportunity to improve effectiveness at meeting hazard mitigation goals.*

C.1.4 DEPARTMENT OF COMMERCE AND CONSUMER AFFAIRS

Table C-8 includes information on hazard mitigation related capabilities for the Department of Commerce and Consumer Affairs (DCCA).

Table C-8. Department of Commerce and Consumer Affairs Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
REAL ESTATE BRANCH								
Description: *The Real Estate Branch, as part of the Professional and Vocational Licensing Division, assists the Real Estate Commission in carrying out its responsibility for the education, licensure and discipline of real estate licensees; registration of condominium projects, condominium associations, condominium managing agents, and condominium hotel operators; and intervening in court cases involving the real estate recovery fund.*								
Mandatory Seller Disclosures in Real Estate Transactions	**Capability Category and Description:**	Planning and Regulatory Requires seller disclosures in residential real property sales including if the residential property lies within the boundary of a special flood hazard area and/or within the anticipated inundation areas designated on the department of emergency management tsunami inundation maps. (HRS §508D)						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	Legislation could be amended to require mandatory disclosure of location in a sea level rise exposure area.						
	Effect on Future Conditions:	Reduces risk for potential buyers						
	Equitable Outcomes:	Reduces risk for potential buyers						
	Community Lifelines:	Food, Water, Shelter; Safety and Security						
	Hazards:	Flood, Tsunami						
	State HMP Goals:	1, 2	◆		◆			

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*

C.1.5 DEPARTMENT OF HAWAIIAN HOME LANDS

Table C-9 includes information on hazard mitigation related capabilities for the Department of Hawaiian Home Lands (DHHL).

Table C-9. Department of Hawaiian Home Lands Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Description: *The primary responsibilities of the Department of Hawaiian Home Lands (DHHL) are to serve its beneficiaries and manage its extensive land trust. The land trust consists of over 200,000 acres on the Islands of Hawaiʻi, Maui, Molokaʻi, Lānaʻi, Oʻahu, and Kauaʻi. These lands are developed and distributed to native Hawaiian beneficiaries by way of residential, agricultural, and pastoral leases for 99-year terms with lease payments of $1.00 per year. Some parcels are designated for income-producing purposes and are general leased for industrial, retail, or other uses.*								
DHHL Land Trust	**Capability Category and Description:**	Planning and Regulatory Much of the properties originally designated as Hawaiian Home Lands were in remote or otherwise undesirable locations, and prone to natural and man-made hazards. Therefore, during the planning and design of subdivisions, the department evaluates the potentials for hazards, (such as flooding, rockfalls, lava flows, contamination from prior agricultural uses, unexploded ordinance (UXO) from former military uses) and ensures that proper mitigation measures are taken before awarding leases. DHHL coordinates with other federal, state and county agencies to address problems that span beyond the boundaries of Hawaiian Home Lands. Examples are the Waianae Coast Emergency Access Road and Secondary Access Road; flooding in Mapunapuna, Oʻahu, and Kalamaula, Molokaʻi; reservoir and dam inspections and repairs in Anahola, Kauaʻi and elsewhere. DHHL is not subject to State Land Use Laws and County zoning regulations. Otherwise development complies with Federal, State, and County requirements – especially where health and safety are concerned.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	Reduces the likelihood for impacts of climate change to be felt by residents and visitors						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Food, Water, Shelter; Safety and Security; Hazardous Material; Safety and Security						
	Hazards:	Flood, Climate Change, Infrastructure Failure, Drought, Earthquake, Hazardous Materials, Health Risks, Windstorm, Hurricane, Landslide and Rockfall, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	1, 2, 3	◆		◆	◆		

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*

C.1.6 DEPARTMENT OF HEALTH

The Department of Health is a large department with many mitigation-related capabilities. Table C-10 includes information on hazard mitigation related capabilities for the Environmental Management Division (EMD), Table C-11 includes information for the Health Resources Administration (HRA), Table C-12 includes information on the Office of Public Health Preparedness, Table C-13 includes information for the Office of Environmental Quality Control.

Table C-10. Environmental Health Administration Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
ENVIRONMENTAL MANAGEMENT DIVISION **Description:** *EMD is responsible for implementing and maintaining statewide programs for controlling air and water pollution, for assuring safe drinking water, and for the proper management of solid and hazardous waste. The division also regulates the state's wastewater.*								
CLEAN WATER BRANCH **Description:** *The Clean Water Branch (CWB) protects the public health of residents and tourists who enjoy playing in and around the State of Hawaii's coastal and inland water resources. The CWB also protects and restores inland and coastal waters for marine life and wildlife. This is accomplished through statewide coastal water surveillance and watershed-based environmental management through a combination of permit issuance, monitoring, enforcement, sponsorship of polluted runoff control projects, and public education.*								
NPDES Wastewater Discharge Permits	**Capability Category and Description:**	Planning and Regulatory Issues National Pollution Discharge Elimination System (NPDES) wastewater discharge permits for industries discharging wastewater/ process water to surface waters of the state to ensure compliance with state and federal water quality standards for environmental health and recreation purposes.						
	Notable Changes:	Office moved to 2827 Waimano Home Road, Pearl City, HI 96782.						
	Challenges:	Establish and fill vacant positions. Permits contested by permittees. Finish workplan commitments.						
	Opportunities:	Standardize procedures, process, requirements, and conditions; Factor in considerations of sea level rise and updated flood plain and storm surge maps into the development of permit conditions to reduce instances of illicit discharge of wastewater pollutants because of flooding.						
	Effect on Future Conditions:	Reduces likelihood of contaminants in flood waters						
	Equitable Outcomes:	Reduces potential exposure to contaminants						
	Community Lifelines:	Health and Medical; Hazardous Material; Safety and Security						
	Hazards:	Flood, Hazardous Materials, Health Risks						
	State HMP Goals:	1, 2	◆			◆		

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Clean Water Act Section 401 Water Quality Certifications	**Description**	Planning and Regulatory Issues Clean Water Act Section 401 water quality certifications for federal permit for construction in nearshore and inland waters. Identifies sources of water pollution through area surveillance, routine inspections, and compliant investigations.						
	Notable Changes:	Notify public when beach fecal testing result exceeds 130 CFU/100ml by email, website update and posting sign.						
	Challenges:	Establish and fill vacant positions. Permits contested by permittees. Finish workplan commitments.						
	Opportunities:	None identified						
	Effect on Future Conditions:	Reduces likelihood of contaminants in waters						
	Equitable Outcomes:	Reduces potential exposure to contaminants						
	Community Lifelines:	Health and Medical; Hazardous Material; Safety and Security						
	Hazards:	Flood, Hazardous Materials, Health Risks						
	State HMP Goals:	1, 2		◆	◆			
Polluted Runoff Control Program	**Capability Category and Description:**	Planning and Regulatory The Polluted Runoff Control Program's mission is to protect and improve the quality of Hawaii's water resources by preventing and reducing nonpoint source pollution. To achieve its mission, the PRC Program updates and implements Hawaii's Nonpoint Source Management Plan (2015-2020). Each year, the PRC Program uses Clean Water Act Section 319(h) funds to provide grants for polluted runoff projects in Hawai'i.						
	Notable Changes:	None identified.						
	Challenges:	Grant recipients must provide 25% matching funds or in-kind contributions from non-federal sources for the 319(h) grant program.						
	Opportunities:	Although primarily focused on water quality, runoff control projects may also aid in mitigation-related goals.						
	Effect on Future Conditions:	Reduces likelihood of contaminants in waters						
	Equitable Outcomes:	Reduces potential exposure to contaminants						
	Community Lifelines:	Health and Medical; Hazardous Material; Safety and Security						
	Hazards:	Drought, Flood						
	State HMP Goals:	1, 2	◆			◆		◆ (F)

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
WASTEWATER BRANCH								
Description: *The Wastewater branch oversees several programs including water pollution control and municipal and private wastewater treatment works.*								
Act 125 and Cesspool Pilot Grant Program (CPGP)	**Capability Category and Description:**	Planning and Regulatory Act 125 was passed in the 2017 legislative session and require the replacement of all cesspools by 2050. It directs the Hawaiʻi Department of Health (DOH) to evaluate residential cesspools in the state, develop a Report to the Legislature that includes a prioritization method for cesspool upgrades, and work with the Department of Taxation on possible funding options to reduce the financial burden on homeowners. The purpose of CPGP is to assist low- and moderate-income property owners with converting, upgrading or connecting cesspools to a more environmentally appropriate method of managing and treating wastewater.						
	Notable Changes:	None identified.						
	Challenges:	Legacy cesspools – 88,000 cesspools identified across the state that pose a significant risk to safe drinking water quality standards and are impacting near shore marine ecosystems						
	Opportunities:	Fully implement the public-private cost share program to incentivize upgrades (i.e., Action 2023-2018-033).						
	Effect on Future Conditions:	Reduces likelihood of contaminants in waters						
	Equitable Outcomes:	Reduces financial burden of cesspools and upgrades to a more environmentally appropriate method of managing and treating wastewater						
	Community Lifelines:	Health and Medical; Hazardous Material; Safety and Security; Food, Water, Shelter						
	Hazards:	Hazardous Materials						
	State HMP Goals:	1, 2, 7	◆		◆			◆
SOLID AND HAZARDOUS WASTE BRANCH								
Description: *The Solid and Hazardous Waste branch oversees several programs including the hazardous waste section and underground storage tank section.*								
Underground Storage Tank Section Regulations	**Capability Category and Description:**	Planning and Regulatory Regulates underground storage tanks that store petroleum or hazardous substances.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	Reduces likelihood of hazardous contaminants						
	Equitable Outcomes:	Reduces likelihood of exposure to hazardous contaminants						
	Community Lifelines:	Health and Medical; Hazardous Material; Safety and Security						
	Hazards:	Drought, Flood, Health Risks						
	State HMP Goals:	1	◆		◆			

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction[a]: Support	Effect on Loss Reduction[a]: Facilitate	Effect on Loss Reduction[a]: Conflict	Provides Funding for Mitigation
SAFE DRINKING WATER BRANCH **Description:** *Assess and determine the integrity of drinking water supply and distribution system infrastructure, ensure drinking water supplies comply with safe drinking water quality standards, and identify alternative safe drinking water supplies if water quality is compromised.*								
Safe Drinking Water Emergency FAQs	**Capability Category and Description:**	Education, Outreach, and Capacity Building Frequently asked questions pertaining to drinking water during emergencies.						
	Notable Changes:	These FAQs are periodically updated.						
	Challenges:	During a large-scale statewide disaster, limited technical staff are mostly located on Oʻahu.						
	Opportunities:	The SDWB has proactively developed disaster FAQs (coordinated with County water supply entities) relating to drinking water treatment, use of alternative supplies, and posted them on their website: http://health.Hawaii.gov/sdwb/files/2014/08/DrinkWaterFAQinEmergency.pdf						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	Provides answers to potential questions regarding drinking water						
	Community Lifelines:	Health and Medical; Hazardous Material; Safety and Security						
	Hazards:	Health Risks						
	State HMP Goals:	1, 5		◆		◆		
ENVIRONEMTRNAL HEALTH SERVICES DIVISION (EHSD) **Description:** *EHSD is responsible for implementing and maintaining statewide programs to assure the safety of food and drugs, control noise and radiation, and improve indoor air quality. The division is also responsible for lead abatement, sanitation, and vector control (rats, mosquitoes, and other public health threats).*								
SANITATION BRANCH **Description:** *Protects and promotes the health and well-being of Hawaii's residents and visitor with professionalism, integrity and fairness through education and regulation in the areas of food safety, disease prevention, community sanitation and emergency response*								
Mass Feeding Operations	**Capability Category and Description:**	Disaster Response/Recovery Ensure sanitation of food supply and handling for mass feeding operations as a function of emergency shelter support						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	Opportunities may present themselves as political climates change.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	Increases food safety if disadvantaged individuals need the use of emergency sheltering						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction[a]: Support	Effect on Loss Reduction[a]: Facilitate	Effect on Loss Reduction[a]: Conflict	Provides Funding for Mitigation
	Community Lifelines:	Health and Medical; Hazardous Material; Safety and Security; Food, Water, Shelter						
	Hazards:	Health Risks						
	State HMP Goals:	4, 5		◆		◆		
INDOOR AND RADIOLOGICAL HEALTH BRANCH **Description:** *The Indoor and Radiological Health Branch is responsible for the implementation of diverse, statewide programs in community noise, radiation control, air-conditioning/ventilation, indoor air quality, asbestos, and lead-based paint."*								
Radiation Section-Radiation Assessment Team (RAT)	**Capability Category and Description:**	Disaster Response/Recovery Radiological emergency response, WMD/CBRNE emergency response and rapid assessment of radiation exposure and environmental contamination. Assist in radiological decontamination.						
	Notable Changes:	In process of developing radiological response public health emergency response annex to the Department of Health's All-Hazards Emergency Response Plan						
	Challenges:	None identified						
	Opportunities:	None identified						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	Reduces likelihood of exposure to hazardous contaminants						
	Community Lifelines:	Health and Medical; Hazardous Material; Safety and Security						
	Hazards:	Hazardous Materials, Health Risks (Radiological exposure and contamination)						
	State HMP Goals:	5		◆	◆			
VECTOR CONTROL BRANCH								
Vector Control Program	**Capability Category and Description:**	Planning and Regulatory Strategically aims to lessen risks of arboviral and vector borne diseases by suppressing vector populations (organisms capable of transmitting disease or parasites from one animal to another)						
	Notable Changes:	Since the State's response to the 2015 Dengue outbreak on the Big Island, HDOH has created a total of 30 new positions statewide to restore the capabilities of the Vector Control Program that had been substantially impacted by budget cuts in 2008. The program has additionally upgraded its inventory of pesticidal abatement products and various types of equipment used for vector control. Additionally, the program has expanded its preventative measures to include routine larval breeding source reduction and surveillance at ports of entry, vector suppression activities in weeks preceding major events that attract large and international crowds, door-to-door						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction[a]: Support	Effect on Loss Reduction[a]: Facilitate	Effect on Loss Reduction[a]: Conflict	Provides Funding for Mitigation
		public education, and mosquito suppression activities in areas of high concentrations of elderly populations and around schools.						
	Challenges:	Public perception and resistance to pesticide applications utilized in vector control efforts; Conflicts of interest with organic farmers						
	Opportunities:	Increased availability of pesticides for mosquito abatement that meet organic certification requirements						
	Effect on Future Conditions:	Reduces likelihood of disease transmission as temperatures increase with climate change						
	Equitable Outcomes:	Reduces likelihood of exposure to disease						
	Community Lifelines:	Health and Medical; Hazardous Material; Safety and Security						
	Hazards:	Health Risks (Vector borne diseases)						
	State HMP Goals:	5	◆	◆	◆	◆		
HAZARD EVALUATION AND EMERGENCY RESPONSE OFFICE (HEER) Description: *The HEER Office is responsible for responding to releases, threats of releases, or discoveries of hazardous substances, including oil, that present a substantial endangerment to public health or the environment. Maintains environmental response programs for planning for, responding to, and preventing releases of hazardous substances into the environment*								
Hawai`i Emergency Planning and Community Right to Know Act (HEPCRA)	**Capability Category and Description:**	Planning and Regulatory HEPCRA establishes requirements for State, local and industry regarding emergency planning and "Community Right-to-Know" reporting required on hazardous and toxic chemicals. There are four major provisions: Emergency Response Planning, Emergency Release Reporting, Hazardous Chemical Storage and Tier II Reporting, and Toxic Release Inventory Reporting. The HEPCRA establishes the Hawai`i State Emergency Response Commission and the Local Emergency Planning Committees.						
	Notable Changes:	None identified						
	Challenges:	None identified						
	Opportunities:	None identified						
	Effect on Future Conditions:	None identified						
	Equitable Outcomes:	Informs communities of potential likelihood of exposure to hazardous contaminants						
	Community Lifelines:	Health and Medical; Hazardous Material; Safety and Security						
	Hazards:	Hazardous Materials						
	State HMP Goals:	3, 5	◆	◆	◆	◆		
Red Hill FAQs	**Capability Category and Description:**	Education, Outreach, and Capacity Building Frequently asked questions pertaining to the Red Hill Water Contamination are posted on the main DOH Red Hill website.						
	Notable Changes:	FAQs posted and updated after each Red Hill fuel or chemical spill.						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Challenges:	Information is often classified by the U.S. Navy, so FAQs do not provide answers to all health concerns.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	Provides answers to potential questions regarding water contamination						
	Community Lifelines:	Health and Medical; Hazardous Material; Safety and Security; Food, Water, Shelter						
	Hazards:	Health Risks						
	State HMP Goals:	1, 5		◆	◆			
On-Scene Coordinators	**Capability Category and Description:**	Disaster Response/Recovery HEER has State On-Scene Coordinators, also known as Environmental Emergency Responders, who are primary responders/cleanup coordinators to any hazardous material releases caused by natural or human-caused hazards.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Health and Medical; Hazardous Material; Safety and Security						
	Hazards:	Earthquake, Flood, Health Risks, Tsunami, Volcanic, Wildfire, Windstorm						
	State HMP Goals:	3		◆	◆			
STATE LABORATORIES DIVISION Description: *State Laboratories Division (SLD) conducts laboratory testing in support of environmental and public health programs statewide. SLD also conducts research, laboratory science investigations, and participates in emergency response efforts such as bioterrorism preparedness and monitoring for environmental contaminants.*								
Laboratory Preparedness and Response Program	**Capability Category and Description:**	Administrative and Technical Conducts analysis in support of laboratory preparedness programs for bioterrorism and chemical terrorism, environmental health and communicable disease monitoring and control activities and investigations						
	Notable Changes:	None identified						
	Challenges:	Aging physical infrastructure						
	Opportunities:	Harden state laboratory facilities (i.e., Action 2023-2018-034)						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Health and Medical; Hazardous Material; Safety and Security						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Hazards:	Hazardous Materials, Health Risks, Terrorism (Bioterrorism, chemical terrorism, infectious disease, and environmental health risks)						
	State HMP Goals:	3,4	◆	◆		◆		

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*
b. *(F) = Federal grant funding supports in full or in part*

Table C-11. Health Resource Administration Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
DISEASE OUTBREAK CONTROL DIVISION Description: *The Disease Outbreak Control Division (DOCD) comprises the Disease Investigation Branch and Immunization Branch. These programs work together to monitor, investigate, prevent, and control infectious diseases in Hawai`i, especially those preventable through immunizations, and to ensure Hawaii's ability to respond to emergencies that threaten the public's health.*								
DISEASE INVESTIGATION BRANCH								
Epidemiological Surveillance	**Capability Category and Description:**	Administrative and Technical Conducts surveillance monitoring, investigation, and control of infectious diseases and potential acts of terrorism throughout the State (conducted jointly with the CDC)						
	Notable Changes:	The COVID-19 pandemic has brought increases in temporary staffing. The Disease Investigation Branch has developed the capacity to rapidly scale contract tracing and case investigation. This could be useful in future pandemics assuming adequate funding and procurement support. Development of the Health Care Associated Infections and Data Science Office Teams with plans to reorganize into branches and offices as appropriate. Continued improvement of the Hawaiʻi Electronic Disease Surveillance System (HI-EDSS/Maven) Continued improvement of the Hawaiʻi Electronic Laboratory Reporting System (ELR)						
	Challenges:	• Anticipated federal funding to pre-pandemic levels. • Position vacancies due to staff turnover and challenges in recruitment. • Fluctuations in federal funding. • Lack of adequate fiscal/administrative support personnel. • Competing priorities of disease outbreaks.						
	Opportunities:	• State funding for key personnel currently federally funded which in nature fluctuates and can be unstable (e.g., epidemiologists, data scientists, infection preventionists.) State funding for additional fiscal/administrative support personnel • State funding for additional investigative personnel on neighboring islands.						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
		• State funding for maintenance, support, and improvements to information technology systems - e.g., HI-EDSS, ELR						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Health and Medical; Hazardous Material; Safety and Security						
	Hazards:	Health Risks (Infectious Diseases)						
	State HMP Goals:	3, 4	◆		◆			
IMMUNIZATIONS BRANCH **Description:** *Promotes immunization of public, both adults and children, against vaccine preventable diseases.*								
Immunization Programs	**Capability Category and Description:**	Administrative and Technical Facilitates access to vaccines for protection of persons not able to pay for vaccines. Continue to grow and maintain complex vaccine distribution processes for multiple federal vaccination programs (e.g. COVID 19, mpox, VFC). Currently have over 200 established federal vaccine providers and over 300 specialty vaccine providers (e.g. COVID 19, mpox.) Distributes federal resources and establishes contracts for emergency vaccine administration and distribution						
	Notable Changes:	During the COVID 19 pandemic the program has distributed / administered over 2.8 million doses of COVID 19 vaccines. This is equivalent to over 12 years of routine vaccine distribution. The Hawaiʻi immunization registry became functional in early 2021 in capturing provider vaccine administration data. This continues to build the information sharing capacity of providers with state and federal entities to identify vaccine deserts for equitable distribution and administration. The annual Stop Flu at School program was stopped due to increased community provider capacity to engage schools due to the COVID 19 pandemic.						
	Challenges:	Unstable funding – While COVID 19 has brought increased federal funding this is anticipated to return to pre-pandemic levels. The pandemic emphasized populations at greater risk of infection due to limited immunization resources. State funding will be essential to continuing to reduce these disparities by supporting the vaccine infrastructure, community and provider outreach, and education. Position vacancies - The immunization program continues to face challenges in recruiting and retaining immunization staff and experts due to the nature of federal funding and the state hiring system. Competing priorities with outbreaks of vaccine-preventable diseases, such as mpox, hepatitis A and mumps, which divert staff resources to concentrate on the outbreak leaving little time to concentrate fully on other immunization activities.						
	Opportunities:	State general funding would provide continuity of staffing and infrastructure capacity as federal funding fluctuates and will diminish from pandemic levels Continued exploration of recruitment and retention efforts is needed. Exploring private public partnership for mobile and fixed site vaccination.						
	Effect on Future Conditions:	None identified.						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction[a]: Support	Effect on Loss Reduction[a]: Facilitate	Effect on Loss Reduction[a]: Conflict	Provides Funding for Mitigation
	Equitable Outcomes:	Access to vaccinations						
	Community Lifelines:	Health and Medical; Hazardous Material; Safety and Security						
	Hazards:	Health Risks (Infectious diseases)						
	State HMP Goals:	3, 4	◆			◆		

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*

Table C-12. Office of Public Health Preparedness Capabilities

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction[a]: Support	Effect on Loss Reduction[a]: Facilitate	Effect on Loss Reduction[a]: Conflict	Provides Funding for Mitigation
Description: *Responsible for coordinating the department's all-hazards emergency preparedness and response planning efforts; facilitating training and exercising for the entire department to ensure the department's ability to respond to and support recovery from public health emergencies.*								
Department of Health All-Hazards Training and Exercise Program	**Capability Category and Description:**	Disaster Response/Recovery Facilitates training and exercises for the entire department to ensure the department's ability to respond to and support recovery from public health emergencies						
	Notable Changes:	None identified						
	Challenges:	Staffing vacancies, unstable funding						
	Opportunities:	Public Health Preparedness Branch is internally being reorganized as an office under the Director of Health						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Health and Medical; Safety and Security						
	Hazards:	Flood, Climate Change, Infrastructure Failure, Drought, Earthquake, Hazardous Materials, Health Risks, Windstorm, Hurricane, Landslide and Rockfall, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	2, 3, 4, 5	◆	◆	◆	◆		◆
Medical Countermeasure (MCM) Points of Distribution (PODs)	**Capability Category and Description:**	Disaster Response/Recovery HDOH Public Health Preparedness Branch manages the receipt and distribution of the Strategic National Stockpile (SNS), a repository of antibiotics, vaccines, chemical antidotes, antitoxins, and other critical medical equipment necessary for a public health emergency (e.g., infectious disease outbreak or chemical attack)						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Notable Changes:	HDOH has increased the number of partnerships with key business sectors and industries across the state to provide Closed Points of Distribution (PODs) to enhance the efficiency of prophylaxis distribution, reduce volume of population reliant upon Open PODs operated by the state, and increase the continuity and resilience of key businesses and sectors during a public health emergency (i.e. infectious disease outbreak)						
	Challenges:	Limited HDOH staff resources available for rapid distribution and staffing of PODs						
	Opportunities:	Continue to build partnerships and establish Closed PODs for major industries and sectors necessary to maintain critical functions of government and commerce necessary for emergency response and recovery efforts. Expand inventory of locations capable of supporting Open PODs and agreements with other agencies for staffing.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Health and Medical; Hazardous Material; Safety and Security						
	Hazards:	Health Risks (Infectious disease/ chemical-biological attack response)						
	State HMP Goals:	3		◆	◆			
Hospital Preparedness Program (HPP)	**Capability Category and Description:**	Disaster Response/Recovery Supports the continuity of healthcare system operations during emergencies that exceed the day-to-day capacity of health and emergency response systems through the development and sustainment of a regional health care coalition that incentivizes healthcare organizations to work together to maintain essential capabilities of statewide healthcare services.						
	Notable Changes:	None identified.						
	Challenges:	Unstable federal funding						
	Opportunities:	None identified.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	Continues access to medical assistance if needed						
	Community Lifelines:	Health and Medical; Safety and Security						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Hazards:	Health Risks						
	State HMP Goals:	2, 3	◆	◆		◆		◆

Table C-13. Office of Environmental Quality Control Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Hawai`i Environmental Policy Act (HEPA)	**Capability Category and Description:**	Planning and Regulatory Requires an environmental review process for state agency actions. This review process includes consideration of sensitive areas (such as floodplains and geologically hazardous areas).						
	Notable Changes:	None identified						
	Challenges:	None identified						
	Opportunities:	None identified						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						
	Hazards:	Flood, Earthquake, Landslide and Rockfall, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	1, 2	◆		◆			

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*

C.1.7 DEPARTMENT OF LABOR AND INDUSTRIAL RELATIONS

The tables below includes information on hazard mitigation related capabilities for the Department of Labor and Industrial Relations (DLIR). Table C-14 includes information for the Office of Community Services (OCS) and Table C-15 includes information for the State Fire Council (SFC).

Table C-14. Office of Community Services Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Weatherization Assistance Program	**Capability Category and Description:**	Financial The OCS administers the Weatherization Assistance Program (WAP) under a grant from the U.S. Department of Energy (DOE). WAP helps low-income families and individuals reduce their energy bill by installing weatherization measures into their homes and by providing education to the participants and community about energy efficiency.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	Low-flow showerheads and faucet aerators are pre-approved on the Hawaii's Weatherization Assistance Program Priority List for Single-Family Homes.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	Provides community members with funds to reduce their energy bill by installing weatherization measures into their homes						
	Community Lifelines:	Energy; Food, Water, Shelter						
	Hazards:	Drought						
	State HMP Goals:	7	◆		◆	◆		◆ (F)

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b. (F) = Federal grant funding supports in full or in part

Table C-15. State Fire Council Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
State Fire Council	**Capability Category and Description:**	Administrative and Technical The State Fire Council (SFC) is an administrative agency attached to the State of Hawai'i, Department of Labor and Industrial Relations and recognized, for all intents and purposes, as Hawaii's equivalent of the State Fire Marshal's Office. Comprised of the four county Fire Chiefs and an administrative support staff, the SFC's primary mission is to develop and support a comprehensive fire service emergency management network for the protection of life, property, and the environment for the State. Through a collaborative and unified approach, the SFC promotes the standardization of fire service reporting, training, sharing of technology, resources, and best practices. In accordance with Hawai'i Revised Statutes (HRS) §132, the SFC is tasked with the adoption of the State Fire Code and the support and assistance with federal grant programs for the fire service in Hawai'i. The SFC may advise and assist the county fire departments where appropriate; prescribe standard procedures and forms related to inspections, investigations, and reporting of fires; and advise the Governor and State Legislature on issues relating to fire prevention and protection, life safety, and other functions or activities of the various county fire departments.						
	Notable Changes:	None identified						
	Challenges:	None identified						
	Opportunities:	The SFC has identified several continuous improvement initiatives including several that are particularly relevant for hazard mitigation: • Develop or adopt a Statewide Interagency Wildfire Mitigation Plan, which may include mutual aid agreements, hazard identification and monitoring systems, training, and public awareness/education programs • Develop or update as needed mutual aid plans and agreements to assist the fire service during statewide technological and/or natural disasters.						
	Effect on Future Conditions:	None identified						
	Equitable Outcomes:	None identified						
	Community Lifelines:	Safety and Security; Communications						
	Hazards:	Wildfire						
	State HMP Goals:	1, 2	◆	◆	◆	◆		

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*

C.1.8 DEPARTMENT OF LAND AND NATURAL RESOURCES

The Department of Land and Natural Resources is a large department with many mitigation-related capabilities. Table C-16 includes information on hazard mitigation related capabilities for the Commission on Water Resource Management (CWRM), Table C-17 includes information for the Division of Forestry and Wildlife, Table C-18 includes information for the Engineering Division, Table C-19 includes information for the Historic Preservation Division (SHPD), Table C-20 includes information on the Land Division, Table C-21 includes information on the Office of Conservation and Coastal Lands, and Table C-22 includes information on the State Board of Land and Natural Resources.

Table C-16. Commission on Water Resources Management Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Commission on Water Resources Management	**Capability Category and Description:**	Administrative and Technical The CWRM works to preserve and enhance water resources. It provides staffing and technical support for the Hawai'i Drought Council and its various task forces and committees and works with the Board of Water Supply, the counties, and the DOFAW to develop drought and wildland fire response, preparedness, and mitigation plans.						
	Notable Changes:	The Hawai'i Drought Plan was updated in 2017						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	None identified						
	Equitable Outcomes:	None identified						
	Community Lifelines:	Food, Water, Shelter						
	Hazards:	Drought, Wildfire						
	State HMP Goals:	1, 2, 3	◆	◆	◆			

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*

Table C-17. Division of Forestry and Wildlife

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Description: *The mission of DLNR's Division of Forestry and Wildlife is to responsibly manage and protect watersheds, native ecosystems, and cultural resources and provide outdoor recreation and sustainable forest products opportunities, while facilitating partnerships, community involvement and education. Mālama i ka ʻāina.*								
FORESTRY PROGRAM								
Forest Reserve System (FRS)	**Capability Category and Description:**	Education, Outreach, and Capacity Building The Forest Reserve System (FRS) was created by the Territorial Government of Hawaiʻi through Act 44 on April 25, 1903. It accounts for more than 678,612 acres of state management land. The Division of Forestry and Wildlife (DOFAW) provides recreational and hunting opportunities; aesthetic benefits; watershed restoration; native, threatened, and endangered species habitat protection and management; cultural resources; and fire protection among many other things. Freshwater replenishment is a key component of the FRS.						
	Notable Changes:	Growth in FRS through acquisitions of private lands.						
	Challenges:	Nearly half of Hawaii's native forests have been lost due to invasive species (DOFAW 2017). Forest loss continues due to conversion to other uses and/or impact by grazing animals.						
	Opportunities:	Carbon sequestration for climate change mitigation. Protection of watersheds						
	Effect on Future Conditions:	None identified						
	Equitable Outcomes:	None identified						
	Community Lifelines:	Safety and Security						
	Hazards:	Climate Change, Drought, Hurricane, Wildfire						
	State HMP Goals:	2	◆		◆			
Hawaiʻi Forest Action Plan	**Capability Category and Description:**	Planning and Regulatory The DLNR-DOFAW is the lead agency in the development of the Hawaiʻi Forest Action Plan. The plan identifies nine priority areas for Hawaii's forests that include: water quality and quantity; forest health, invasive species, insects and disease; wildfire; urban and community forestry; climate change and sea level rise; conservation of native biodiversity; hunting, nature-based recreation, and tourism; forest products and carbon sequestration; and US tropical island state and territorial issues (DOFAW, 2016).						
	Notable Changes:	The Hawaiʻi Statewide Assessment of Forest Conditions and Trends (2010) was updated and renamed the Hawaiʻi Forest Action Plan (2016)						
	Challenges:	Data gaps						
	Opportunities:	Plan will be revisited in 2021.						
	Effect on Future Conditions:	Addresses reduction of wildfire threat						
	Equitable Outcomes:	None identified						
	Community Lifelines:	Safety and Security; Food, Water, Shelter						
	Hazards:	Climate Change, Drought, Flood, Hurricane, Landslide and Rockfall, Tsunami, Wildfire						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction[a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	State HMP Goals:	2	◆		◆			
Conservation Reserve Enhancement Programs (CREP)	**Capability Category and Description:**	Financial The Conservation Reserve Enhancement Program (CREP) is a federal-state natural resources conservation program that addresses state and nationally significant agricultural related environmental concerns. Through CREP, program participants receive financial incentives from U.S. Department of Agriculture (USDA) and the State to voluntarily enroll in the Conservation Reserve Enhancement Program in contracts of 15 years. Participants are asked to convert degraded lands to native trees, shrubs, and grasses. The primary goals of the project are to enhance wildlife habitat and control invasive species, as well as improve water quality and quantity, increase groundwater recharge, improve near shore coral reef health and diversity by filtering agricultural runoff and increasing water condensation in the uplands.						
	Notable Changes:	The program seeks to enroll 15,000 acres of eligible land in 15-year agreements within the following counties: Hawai'i, Maui, Kaua'i, and City and County of Honolulu. As of January 2017, 1,168 acres of land have been enrolled in the program.						
	Challenges:	Flooding, landslides, climate change						
	Opportunities:	Agricultural diversification, climate mitigation through carbon sequestration						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security; Food, Water, Shelter						
	Hazards:	Drought, Flood, Wildfire						
	State HMP Goals:	1, 2, 3	◆			◆		◆ (F)
Hawai'i Forest Legacy Program	**Capability Category and Description:**	Financial Protects private forestlands from being converted to non-forest uses via a federal grant program. This program provides willing private landowners the opportunity to sell fee simple property, or conservation easement use-rights on their land to the State of Hawai'i for the purpose of preserving or restoring uniquely forested areas. The Forest Legacy Program targets forest land as identified in the Assessment of Needs (AON).						
	Notable Changes:	The AON was first established in 1994, amended in 2004 and again in 2017 and is in the final draft form at the time of the hazard mitigation plan update (DOFAW 2017b).						
	Challenges:	Volunteer program, competing land uses, funding						
	Opportunities:	Preservation of threatened forest land from conversion						
	Effect on Future Conditions:	Reduces threat of wildfire to structures						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Food, Water, Shelter						
	Hazards:	Climate Change, Wildfire						
	State HMP Goals:	1, 2, 5	◆			◆		◆
Kaulunai Urban &	**Capability Category**	Financial						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Community Forestry Program	**and Description:**	Focuses on improving the health and viability of trees in Hawaiʻi communities through educational programs; financial support in the form of cost-share grants; technical training; Arbor Day promotions and public/private partnerships. Funding comes from the State and Private Forestry Branch of the USDA Forest Service. Since its inception in Hawaiʻi as of 1992, Kaulunani has awarded more than $2.6 million to more than 400 organizations across the state, in the form of cost-share grants that were matched with $7.1 million in cash and in-kind contributions. The program is guided by the Forest Action Plan.						
	Notable Changes:	The Forest Action Plan details all of the notable changes in program strategies (Issue 4 pg. 128-155) including discussion on wildland-urban interface, emergency management and response, hazards, climate change.						
	Challenges:	Green Infrastructure and trees are often not considered in preparations for emergency response or during emergency response; significant loss of urban tree cover in the City and County of Honolulu in the past 4 years (approximately 5% loss)						
	Opportunities:	An urban Forestry Emergency operations Planning Guide for Storm Response is available and could be used to develop emergency response plans/procedures in Hawaiʻi - http://www.smarttreespacific.org/urban-forestry-emergency-operations-planning-guide/ Increase urban forestry (i.e., Action 2023-007)						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	None identified.						
	Hazards:	Climate Change, Drought, Tsunami, Wildfire, Windstorm						
	State HMP Goals:	2, 3, 5	◆		◆	◆		◆
Forest Stewardship Program (FSP)	**Capability Category and Description:**	Financial Hawaii's Forest Stewardship Program (FSP), administered by the Department of Land and Natural Resources, Division of Forestry and Wildlife (DLNR-DOFAW), provides technical and financial assistance to owners of nonindustrial private forest land that are interested in conservation, restoration, and/or timber production. Management objectives include fire pre-suppression, watershed, riparian, and/or wetland protection and improvement, windbreaks, among others. The Forest Stewardship Program leverages from $80,000 to $200,000 per year in U.S. Forest Service funding support to administer the program. Further, since 1990 State funds for this program have leveraged a total of $6,639,847 in private funds as a direct match spent on sustainable forest management.						
	Notable Changes:	In Fiscal year 2017, the State, through support by the Hawaiʻi Association of Conservation Districts, received a contribution agreement award from NRCS to continue the existing Hawaiʻi CREP Planner position. The Hawaiʻi CREP Planner position was created as a solution to address the need for dedicated positions to alleviate the backlog of potential projects, engage landowners, and increase participation in the program.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future	None identified.						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction[a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Conditions:							
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Food, Water, Shelter						
	Hazards:	Drought, Flood, Wildfire, Windstorm						
	State HMP Goals:	1, 2, 3	◆			◆		◆
Hawaiʻi Tree Canopy Viewer	**Capability Category and Description:**	Education, Outreach, and Capacity Building This map viewer displays a complete tree canopy layer for the state with other information—such as the extent of impervious surfaces, socioeconomic and health data, and urban heat severity maps, to name a few. These layers provide information to help us understand differences in canopy across communities. They can also aid in the process of prioritizing urban greening goals (e.g., tree planting and tree maintenance) through a lens of equity with the goal that all communities will experience the benefits that tree canopy offers. [Division of Forestry and Wildlife: Forestry Program | Tree Canopy Viewer Hawaiʻi (hawaii.gov)]						
	Notable Changes:	This is a new capability identified for the 2023 SHMP. The canopy viewer aims to build upon previous understanding of tree canopy in Hawaiʻi.						
	Challenges:	None identified.						
	Opportunities:	Increase urban forestry (i.e., Action 2023-007)						
	Effect on Future Conditions:	Understanding the extent and location of a tree canopy can help a community design and implement sound management practices to maximize prioritizing locations for tree planting, establishing urban forestry master plans and sustainability plans, and managing threats to canopy loss to mitigate the effects of extreme heat, drought, and the impacts of severe storms.						
	Equitable Outcomes:	The viewer could also be used to prioritize tree planting and maintenance where it can have the most impact for communities disproportionately burdened by risks that urban tree cover may help ameliorate.						
	Community Lifelines:	Food, Water, Shelter; Energy						
	Hazards:	Climate Change, Drought, Flood, Hurricane, Wildfire, Windstorm						
	State HMP Goals:	4, 5	◆	◆	◆			
FIRE PROGRAM								
Fire Management Program	**Capability Category and Description:**	Planning and Regulatory DLNR-DOFAW is statutorily mandated by the Land Fire Protection Law, Chapter 185, Hawaiʻi Revised Statutes, to take measures for the prevention, control, and extinguishment of wildfires on lands managed by DOFAW, which accounts for 26% of the land statewide. DOFAW is also required to cooperate for these purposes with county fire departments and federal agencies to an additional 32% which is determined by Mutual Aid Agreements and Memoranda of Agreement or Understanding. DOFAW supports prevention, pre-suppression, and suppression activities, including mitigation, such as maintaining fire and fuel breaks/access roads, reducing and/or converting hazard fuels through the green breaks, living breaks, managed grazing, and as necessary, prescribed burns. DOFAW is also the State Liaison to the Firewise USA program, which encourages residents to work with neighbors to reduce home ignition potential and increase home survivability leading to the prevention of wildfire disasters. DOFAW						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
		staff also participates in: • Wildfire outreach and education events; • CWPP development; and • WUI Grant Program administration • The maintenance of 25 Remote Automated Weather Stations (RAWS) for fire weather reporting						
	Notable Changes:	None identified.						
	Challenges:	• Limited funds and staff capacity - although Chapter 185, HRS, mandates DLNR-DOFAW to prevent, control, and extinguish wildfires, DOFAW personnel are primarily natural resource managers, foresters, biologists, and technicians and do not focus solely on fire management activities, including mitigation. There is no permanent Wildfire Mitigation Specialist dedicated solely to wildfire risk reduction at the state level to coordinate multi-sector, interagency mitigation actions. • Six water storage structures are needed for County of Maui. • There may be a need to analyze prescribed fire liability laws in other states to determine if it would be appropriate to amend HRS. • Some agencies lack prescribed fire training. • Rainfall and mild temperatures that occur throughout the year contribute to a year-round growing season, thus requiring continual maintenance. • Native ecosystems in Hawaiʻi evolved with little or no fire. Wildfire is a threat to native forests, including watersheds and threatened and endangered species. Hawaiʻi has the highest number of species listed as threatened and endangered in the U.S. Over 25% of the state is covered by invasive, fire prone grasses and shrubs. Each time fire burns into native forest, this percentage increases. Wildfires in the WUI have been carried rapidly by invasive grasses into forested watersheds, which recharge water supplies, control erosion and run off, and supply culturally important plants. • There has also been an increase in the amount of fallow agricultural land. Abandoned agricultural land is susceptible to invasive, fire prone grasses and shrubs, thereby increasing fire risk to nearby communities and conservation land. • Preventing ignitions through effective public education (nearly all fires in the State of Hawaiʻi are human caused).						
	Opportunities:	• Establish DLNR-DOFAW fire crews at each district to focus solely on fire management activities, including mitigation. • Establish a Wildfire Mitigation Specialist dedicated solely to wildfire risk reduction at the state level to coordinate multi-sector, interagency mitigation actions. • Federal funding for fuel mitigation is available. • Maintain and improve fire and fuel breaks and access roads on state land (i.e., Action 2023-2018-029) • Reduce and/or convert hazardous fuels along roadsides (i.e., Action 2023-2018-055)						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Food, Water, Shelter; Safety and Security						
	Hazards:	Drought, Wildfire						
	State HMP Goals:	1, 2, 3, 5	◆		◆	◆		◆

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Wildfire Related Public Education and Outreach Events	**Capability Category and Description:**	Education, Outreach, and Capacity Building A number of wildfire-related public outreach events are conducted on a regular basis including: • An all-agency, unified wildfire and drought awareness campaign was launched in 2016. • An annual unified multi-agency Wildfire LOOKOUT! campaign was launched the following year to raise awareness about the threat of wildfire to Hawaii's natural resources and to private and public property. Over two dozen state, county, and federal agencies have committed to this effort to educate and inform residents about the threat of wildfires in Hawaiʻi. • Elected officials, government agencies, NGOs, and the public participate in the National Fire Protection Association's (NFPA) national initiative to better prepare communities for wildfires by holding multiple Wildfire Community Preparedness Day events throughout the State, including a photo contest. • Wildfire risk reduction workshops, trainings, and field tours are offered locally through the National Fire Academy, NFPA, HWMO, PFX, Hawaiʻi Conservation Conference, and Pacific Risk Management ʻOhana Conference for government agencies, large landowners, and the public. • DLNR-DOFAW features wildfire prevention information at Fire Prevention Week events alongside county and federal agencies. • DLNR-DOFAW sponsors Smoky Bear visits and HWMO sponsored Kaleo the Pueo visits at schools.						
	Notable Changes:	None identified.						
	Challenges:	Limited funds and staff capacity. • Some DLNR-DOFAW District Offices lack permanent Outreach and Education Specialists for the entire Division. • Over 98% of wildfires in Hawaiʻi are human caused, which means many are preventable. Preventable wildfires cause losses which exceed the cost of prevention education. There is no permanent Wildfire Prevention Specialist at the state level to focus on prevention education. • While under-publicized, the percentage of land area burned per year in Hawaiʻi exceeds the national average, and some years surpasses the western states.						
	Opportunities:	The US Forest Service can provide technical assistance in creating a statewide wildfire prevention plan. [d]						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	Education on the wildfire hazard						
	Community Lifelines:	Safety and Security; Communications						
	Hazards:	Drought, Wildfire						
	State HMP Goals:	2, 3, 5	◆		◆			
Community Wildfire Protection Plans (CWPPs)	**Capability Category and Description:**	Planning and Regulatory CWPPs help communities address wildfire response, hazard mitigation, and community preparedness as well as identify hazard reduction priorities. Newly established CWPPs have made additional lands eligible for funds available through the Wildland Urban						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
		Interface (WUI) Grant Program. There are 13 CWPPs established throughout the State of Hawai‘i, which cover over half of the State. Each county has at least one CWPP.						
	Notable Changes:	One new plan, the North Shore O‘ahu Community Wildfire Protection Plan was completed in 2021.						
	Challenges:	There is no permanent funding to develop CWPPs. HWMO has updated plans and created new plans with WUI grant funding.						
	Opportunities:	By establishing CWPPs to cover additional lands, those lands will be eligible for funds available through the WUI Grant Program (i.e., Action 2023-2018-030).						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	Help communities address wildfire response, hazard mitigation, and community preparedness as well as identify hazard reduction priorities						
	Community Lifelines:	Safety and Security						
	Hazards:	Drought, Wildfire						
	State HMP Goals:	1, 2, 5	◆		◆			
Firewise USA™	**Capability Category and Description:**	Education, Outreach, and Capacity Building Firewise USA™ is a recognition program that encourages residents to work with neighbors to reduce home ignition potential and increase home survivability leading to the prevention of wildfire disasters.						
	Notable Changes:	There are 14 Firewise USA recognized sites in the City and County of Honolulu, County of Maui, and County of Hawai‘i.						
	Challenges:	There is no permanent funding to promote this program and establish new Firewise USA recognized sites. HWMO has increased the number of Firewise USA recognized communities with WUI grant funding. There is no permanent Wildfire Mitigation Specialist dedicated solely to wildfire risk reduction at the state level to coordinate multi-sector, interagency mitigation actions.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	Education on home ignition potential						
	Community Lifelines:	Safety and Security						
	Hazards:	Wildfire						
	State HMP Goals:	2, 3, 5	◆		◆			
Wildland Urban Interface (WUI) Grant Program [d]	**Capability Category and Description:**	Financial U.S. Forest Service funds to mitigate risk from wildland fire within the WUI are available and awarded annually through a competitive process with emphasis on (1) hazardous fuel reduction in the WUI; (2) information and education; and (3) planning. In Hawai‘i, funding is delivered through DOFAW to communities, organizations, and agencies to implement WUI risk reduction projects.						
	Notable Changes:	None identified.						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction[a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Challenges:	• Applications must be covered by a CWPP. • There is no permanent Wildfire Mitigation Specialist dedicated solely to wildfire risk reduction at the state level to promote, write, review, and manages these grants. • State funds must be available to match these grants. • Hawai'i competes against the western states for these funds.						
	Opportunities:	Multi-sectors are eligible for this grant program.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	Education on wildfire						
	Community Lifelines:	None identified.						
	Hazards:	Wildfire						
	State HMP Goals:	2, 3, 5	◆		◆	◆		◆ (F)
Remote Automated Weather Stations (RAWS)	**Capability Category and Description:**	Administrative and Technical Remote automated weather stations (RAWS) ensure that microclimate data is captured to help rate fire danger and monitor fuels. They also provide DOFAW with up to date data that can be used to close areas in event of hazardous weather conditions. RAWS are maintained on an ongoing basis. There are 66 RAWS statewide maintained by federal and state agencies, including 25 operated by DOFAW, 16 operated by the Department of Defense, 16 operated by the National Park Service, 6 operated by US Fish and Wildlife Service, 1 operated by Bureau of Land Management, and 2 operated by unidentified agencies.						
	Notable Changes:	None identified.						
	Challenges:	Some RAWS are located in remote area, which may make maintenance challenging.						
	Opportunities:	Six RAWS are needed for County of Maui; further data analysis (i.e., Action 2023-2018-032)						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						
	Hazards:	Drought, Hurricane, Wildfire						
	State HMP Goals:	3, 4	◆		◆			
INVASIVE SPECIES								
Hawai'i Invasive Species Council	**Capability Category and Description:**	Administrative and Technical; Planning and Regulatory; Education, Outreach, and Capacity Building The Hawai'i Invasive Species Council (HISC) is an inter-departmental collaboration comprised of the Departments of Land & Natural Resources (DLNR), Agriculture (DOA), Health (DOH), Transportation (HDOT), Business, Economic Development & Tourism (DBEDT), and the University of Hawaii (UH). The HISC was established in 2003 for the special purpose of providing policy level direction, coordination, and planning among state departments, federal agencies, and international and local initiatives for the control and eradication of harmful invasive species infestations throughout the State and for preventing the introduction of other invasive species that may be potentially harmful.						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction [a]: Support	Effect on Loss Reduction [a]: Facilitate	Effect on Loss Reduction [a]: Conflict	Provides Funding for Mitigation
		The HISC has developed the *Hawai'i Interagency Biosecurity Plan 2017-2027* and the supporting document, *HISC and CGAPS 2025 Joint Strategy*						
	Notable Changes:	This is a new capability identified in the 2023 SHMP.						
	Challenges:	The State Legislature declared invasive species a major threat to the State's economy, natural environment, and health (State of Hawai'i 2015). Invasive species contribute to and exacerbate many statewide hazards.						
	Opportunities:	Hawai'i Interagency Biosecurity Plan identifies critical gaps in the State's biosecurity system and suggests policies, processes, and resources to address those gaps in regards to invasive species mitigation.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Food, Water, Shelter; Safety and Security; Transportation; Health and Medical; Energy; Transportation						
	Hazards:	Climate Change, Drought, Flood, Health Risks, Hurricane, Wildfire, Windstorm						
	State HMP Goals:	1, 2, 3, 5	◆		◆			
NATIVE ECOSYSTEMS PROTECTION AND MANAGEMENT								
Legacy Lands Conservation Program	**Capability Category and Description:**	Financial The State of Hawai'i dedicates a portion of its annual revenue from real estate conveyance taxes to the Land Conservation Fund. Each year the State Legislature provides the Legacy Land Conservation Program with some of the money held in the Fund. The Legacy Land Conservation Program distributes this money through a competitive grants process–for purchasing land and conservation easements and for paying the debt service on state financial instruments (such as bonds)–for the protection of land that shelters exceptional, unique, threatened, and endangered resources.						
	Notable Changes:	None identified.						
	Challenges:	Natural resources can be damaged by hazards, such as wildfires. Native ecosystems in Hawai'i evolved with little or no fire. Wildfire is a threat to native forests, including watersheds and threatened and endangered species. Hawai'i has the highest number of species listed as threatened and endangered in the U.S. Over 25% of the state is covered by invasive, fire prone grasses and shrubs. Each time fire burns into native forest, this percentage increases. Wildfires in the WUI have been carried rapidly by invasive grasses into forested watersheds, which recharge water supplies, control erosion and run off, and supply culturally important plants.						
	Opportunities:	This program can prevent development in hazard-prone areas.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Food, Water, Shelter						
	Hazards:	Climate Change, Drought, Flood, Hurricane, Wildfire						
	State HMP Goals:	1, 2	◆		◆			◆

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Watershed Partnership Program	**Capability Category and Description:**	Financial The Watershed Partnerships Program provides technical and financial support for the implementation of watershed management plans. The Watershed Partnerships Program is funded by the Natural Area Reserve Special Fund, established by HRS §195-9. These funds come from a portion of the conveyance tax, which is levied each time real estate property is bought or sold. The mission of the program is to “increase the effective management and protection of mauka watershed areas by raising the capacity of watershed partnerships, facilitating sharing of watershed management expertise, building public support for protecting watershed values, and developing sustainable funding sources.” Watershed protection measures relevant to mitigation goals include recharging water supplies, controlling erosion and runoff, mitigating flooding, and mitigating the impacts of climate change (DOFAW no date).						
	Notable Changes:	None identified.						
	Challenges:	Natural resources can be damaged by hazards, such as wildfires. Native ecosystems in the State of Hawaiʻi evolved with little or no fire. Wildfire is a threat to native forests, including watersheds and threatened and endangered species. The State of Hawaiʻi has the highest number of species listed as threatened and endangered in the U.S. Over 25% of the state is covered by invasive, fire prone grasses and shrubs. Each time fire burns into native forest, this percentage increases. Wildfires in the WUI have been carried rapidly by invasive grasses into forested watersheds, which recharge water supplies, control erosion and run off, and supply culturally important plants.						
	Opportunities:	By protecting forests, additional moisture is captured, preventing drought. Forest also absorb carbon, reducing climate change. Forests hold the soil, reducing erosion and flooding. The Governor’s Hawaiʻi Sustainable Initiative aims to protect 30% of priority watersheds by 2030 (i.e., Action 2023-2018-019)						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Food, Water, Shelter						
	Hazards:	Climate Change, Drought, Flood, Hurricanes, Wildfires						
	State HMP Goals:	1, 2	◆		◆			◆

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Natural Area Partnership Program	**Capability Category and Description:**	Financial The Natural Area Partnership Program (NAPP) was established in 1991 by the state Legislature and the Governor authorizing the Department of Land & Natural Resources (DLNR) to "provide state funds for the management of private lands that are dedicated to conservation." Lands and waters that might qualify include areas with intact native Hawaiian ecosystems, essential habitat for endangered species, and areas within the protective (P) subzone of the Conservation District.						
	Notable Changes:	None identified.						
	Challenges:	Natural resources can be damaged by hazards, such as wildfires. Native ecosystems in the State of Hawaiʻi evolved with little or no fire. Wildfire is a threat to native forests, including watersheds and threatened and endangered species. The State of Hawaiʻi has the highest number of species listed as threatened and endangered in the U.S. Over 25% of the state is covered by invasive, fire prone grasses and shrubs. Each time fire burns into native forest, this percentage increases. Wildfires in the WUI have been carried rapidly by invasive grasses into forested watersheds, which recharge water supplies, control erosion and run off, and supply culturally important plants.						
	Opportunities:	By protecting forests, additional moisture is captured, preventing drought. Forest also absorb carbon, reducing climate change. Forests hold the soil, reducing erosion and flooding. This is a program that helps private landowners mitigate hazards. Fuel reduction in WUI areas will reduce the threat of wildfires (i.e., Action 2023-2018-025)						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Food, Water, Shelter; Safety and Security						
	Hazards:	Climate Change, Drought, Flood, Hurricane, Wildfire						
	State HMP Goals:	1, 2, 3	◆		◆	◆		◆
Natural Area Reserves System (NARS)	**Capability Category and Description:**	Planning and Regulatory The statewide NARS was established to preserve in perpetuity specific land and water areas which support communities, as relatively unmodified as possible, of the natural flora and fauna, as well as geological sites, of Hawaiʻi. The system presently consists of 21 reserves on five islands, encompassing 123,810 acres of the State's most unique ecosystems. The Strategic Plan for Hawaii's Natural Area Reserves System (2008) includes objectives and sub-objectives that support mitigation goals, such as "employ appropriate fire management strategies" (DOFAW 2008).						
	Notable Changes:	None identified.						
	Challenges:	Natural resources can be damaged by hazards, such as wildfires. Native ecosystems in the State of Hawaiʻi evolved with little or no fire. Wildfire is a threat to native forests, including watersheds and threatened and endangered species. The State of Hawaiʻi has the highest number of species listed as threatened and endangered in the U.S. Over 25% of the state is covered by invasive, fire prone grasses and shrubs. Each time fire burns into native forest, this percentage increases. Wildfires in the WUI have been carried rapidly by invasive grasses into forested watersheds, which recharge water supplies, control erosion and run off, and supply culturally important plants.						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction[a]: Support	Effect on Loss Reduction[a]: Facilitate	Effect on Loss Reduction[a]: Conflict	Provides Funding for Mitigation
	Opportunities:	By protecting forests, additional moisture is captured, preventing drought. Forest also absorb carbon, reducing climate change. Forests hold the soil, reducing erosion and flooding. Fuel reduction in WUI areas will reduce the threat of wildfires (i.e., Action 2023-2018-025)						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Food, Water, Shelter; Safety and Security						
	Hazards:	Climate Change, Drought, Flood, Hurricane, Wildfire						
	State HMP Goals:	1, 2	◆		◆			◆

a. Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.
b. (F) = Federal grant funding supports in full or in part
c. HWMO provides Ready Set Go!, preparedness, or hazard reduction workshops (6-12 workshops per island per year each on Oʻahu and Kauaʻi, 12-15 in County of Maui, and 20+ across the Island of Hawaiʻi. Total: 44-59 workshops a year on average the last couple of years).
d. Identified by the department/agency as one of the most effective capabilities for achieving mitigation goals.

Table C-18. Engineering Division Capabilities

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation
DAM SAFETY PROGRAM **Description:** *The objectives of the dam safety program include encouraging high safety standards and regulations in the practices and procedures for dam site investigation, design, construction, operation and maintenance and emergency preparedness; maintaining updated and accurate inventory of dams, physical conditions, and potential hazard classifications; promoting a continuous, dynamic process where guidelines, practices, and procedures are examined periodically and updated; cooperating with all public and private agencies involved in dam safety activities including owner training and dissemination of information to the public, and emergency preparedness, in order to protect the health, safety, and welfare of the citizens of the State by reducing the risk of failure of dams or reservoirs.*								
Emergency Action Plans (EAP)	**Capability Category and Description:**	Planning and Regulatory HRS 179D-30 requires the owners of State-regulated high and significant hazard potential dams and reservoirs to establish an EAP to assist the local community in effectively responding to a dam safety emergency. Owners are required to have established protocols for flood warning. The Dam Safety program works with owners to develop or update their EAPs. The program's online database includes information and tools for dam owners, including an EZ-EAP instructional video, EAP development guidelines, EAP checklist, and EAP						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
		creation and maintenance application (DLNR Engineering 2017). EAPs are provided to local emergency management agencies.						
	Notable Changes:	None identified.						
	Challenges:	There are federal, state, county, and privately-owned dams in the State of Hawaiʻi.						
	Opportunities:	EAPs can be used to inform development of warning systems and outreach programs (i.e., Action 2023-2020-002)						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						
	Hazards:	Infrastructure Failure; Communications						
	State HMP Goals:	1, 2	◆		◆	◆		
Dam Safety Permits	**Capability Category and Description:**	Administrative and Technical The DLNR Engineering Division administers the State Dam and Reservoir Program as authorized under HRS Chapter 179D and HAR Title 13, Sub-Title 7, Chapter 190.1. A permit must be obtained from the Board of Land and Natural Resources for the construction, enlargement, repair, alteration or removal of dams (DLNR Engineering 2016).						
	Notable Changes:	None identified.						
	Challenges:	approximately 70% privately owned dams, and limited funding						
	Opportunities:	Dams and Reservoirs owners are able to apply for Special Purpose Revenue Bonds						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						
	Hazards:	Infrastructure Failure						
	State HMP Goals:	1, 2	◆		◆	◆		
Certificate of Approval to Impound (CAI)	**Capability Category and Description:**	Planning and Regulatory Requirements for obtaining a CAI for the impoundment of water at a dam or reservoir in the State of Hawaiʻi are outlined in HAR, Title 13, Sub-Title 7, Chapter 190.1. Completed applications are submitted to the Dam Safety Program.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future	None identified.						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Conditions:							
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						
	Hazards:	Infrastructure Failure						
	State HMP Goals:	1, 2	◆		◆	◆		
Training Events and Materials	**Capability Category and Description:**	Education, Outreach, and Capacity Building The Dam Safety program offers training events and materials including overview workshops and technical seminars on dam evaluation and rehabilitation, and operation and maintenance training.						
	Notable Changes:	Training topics are decided internally and are generally provided on a rotating basis on a 1-3 year frequency. Recent training activity includes: 2023 Dam Safety Basics; 2020 Dam Safety Failure Modes; 2019 presentation at the Hawai'i Floodplain Managers Conference; 2019 Dam Safety Emergency Interventions; 2017 Dam Safety technical seminar on dam evaluation and rehabilitation; 2015 Dam Safety EAP training; 2012 Dam Safety operation and maintenance training . A dam safety grant and special funds are used to hire contractors to do training for selected topics. Maui and Kaua'i have most dams and dam owners						
	Challenges:	None identified.						
	Opportunities:	Incorporate information from the hazard mitigation planning risk assessment into future trainings.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	Provides individuals with education opportunity on the dam hazard						
	Community Lifelines:	Safety and Security						
	Hazards:	Infrastructure Failure						
	State HMP Goals:	1, 2, 5	◆		◆			
Dam Inundation and Evacuation Maps	**Capability Category and Description:**	Administrative and Technical DLNR in partnership with the US Army Corps, Pacific Disaster Center and County Emergency Management Agencies engaged in the development of dam failure inundation and evacuation maps and individual assessment reports for regulated dams within the State of Hawai'i. These inundation maps and reports were then released for the development of dam evacuation plans by the counties and incorporated into the Dam Safety Online Database and is available for public download. Flood and Dam Evacuation areas are searchable via the State DLNR Flood Hazard Assessment Tool.						
	Notable Changes:	As of 2023, all regulated dams have evacuation maps available online, except one low hazard dam.						
	Challenges:	None identified.						
	Opportunities:	Additional outreach and public awareness (i.e., Action 2023-003)						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	Provides individuals with education opportunity on the dam hazard						
	Community Lifelines:	Safety and Security; Communications						
	Hazards:	Infrastructure Failure						
	State HMP Goals:	1, 2, 3, 5	◆		◆	◆		
NATIONAL FLOOD INSURANCE PROGRAM (NFIP) **Description:** *DLNR has been designated as the State Coordinating Agency responsible for assisting the coordination of the NFIP between the Federal and County agencies in the State of Hawai'i*								
Flood Hazard Assessment Tool (FHAT)	**Capability Category and Description:**	Education, Outreach, and Capacity Building The FHAT is an online map viewer where residents can view effective digital flood insurance rate map (DFIRM) information, historic FIRM and DFIRM information, obtain information on letter of map changes, and auto generate from fields for a FEMA elevation certificate. In addition, a report can be printed that provides parcel-specific flood hazard information as well as tsunami and dam evacuation zone information.						
	Notable Changes:	The FHAT expanded to include information on tsunami and dam failure evacuation hazard maps.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	Provides individuals with education opportunity on flood related hazards						
	Community Lifelines:	Food, Water, Shelter; Safety and Security						
	Hazards:	Infrastructure Failure, Flood, Tsunami						
	State HMP Goals:	1, 2, 4, 5	◆		◆			
Wai Halana Blog	**Capability Category and Description:**	Education, Outreach, and Capacity Building Wai Halana Blog is a Floodplain Management blog maintained by the DLNR Engineering division. It is available at waihalana.hawaii.gov. The blog contains information on flood and flood related hazards including topics such as flood insurance, climate change, emergency warning information, dam safety and tips on hurricane season.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	Wai Halana could be used as a component in a state-wide Community Rating System program for public information. Public outreach						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation
		could be conducted to expand the number of recipients.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	Provides individuals with education opportunity on flood related hazards						
	Community Lifelines:	Food, Water, Shelter; Safety and Security; Communications						
	Hazards:	Flood, Climate Change, Dam Failure, Hurricane						
	State HMP Goals:	1, 2, 4, 5	◆		◆			
Maintenance of channels, streambeds, streambanks, and drainageways	**Capability Category and Description:**	Capital Projects and Maintenance HRS § 46-11.5 stipulates that it is "the responsibility of the county to maintain all channels, streambeds, streambanks, and drainageways unless such channels, streambeds, streambanks, and drainageways are privately owned or owned by the State, in which event such channels, streambeds, streambanks, and drainageways shall be maintained by their respective owners." County responsibility accounts for the vast majority of this maintenance and counties also bear responsibility for enforcement. If maintenance is needed on State owned land, the appropriate department is identified and the maintenance is conducted.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						
	Hazards:	Flood						
	State HMP Goals:	1, 2	◆	◆	◆	◆		
Flood control and flood water conservation statutes	**Capability Category and Description:**	Planning and Regulatory HRS § 179 sets forth flood control and flood water conservation statutes, the purpose of which is to "provide for the coordination by the State of all federal and state flood control projects undertaken in Hawaiʻi and for such technical or financial assistance to its political subdivisions as may be desirable or necessary to assure maximum benefits to the people of the State from the expenditure of state funds for flood control purposes." These statutes designate the BLNR as the implementation authority for flood control and water conservation.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Opportunities:	None identified.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security; Food, Water, Shelter						
	Hazards:	Drought, Flood						
	State HMP Goals:	1, 2, 3	◆			◆		
Community Assistance Program –State Support Services Element (CAP-SSSE) [c]	**Capability Category and Description:**	Financial This program provides funding to states to provide technical assistance to communities in the National Flood Insurance Program (NFIP) and to evaluate community performance in implementing NFIP floodplain management activities. DLNR participates in this program for coordination of DLNR floodplain management, however, it does not receive FEMA CAP grant support. DLNR conducts the following activities which duplicates CAP activities: • Conduct Community Compliance Audits (a.k.a. CAVs) • Conduct Training Workshops and Public Outreach • Attend National and Regional NFIP related conferences • Maintain newsletter blog (Wai Halana) • Provide Technical Assistance to community officials and the public • Conduct V zone properties audits • Maintain an Internet Website dedicated to NFIP awareness						
	Notable Changes:	None identified.						
	Challenges:	Extensive reporting and required by the CAP program exceed the DLNR resources and distract from our mission of reducing flood hazards and damages.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	NFIP activities may change due to climate change impacts						
	Equitable Outcomes:	Receive education on NFIP activities						
	Community Lifelines:	Safety and Security; Food, Water, Shelter						
	Hazards:	Flood, Dam Failure, Hurricane, Tsunami						
	State HMP Goals:	1, 2, 3, 4, 5	◆		◆	◆		◆ (F)

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
State General Flood Control Plan (SGFCP)	**Capability Category and Description:**	Planning and Regulatory The SGFCP was developed in 1983 to coordinate floodplain management initiatives. The goal of the State General Flood Control Plan (SGFCP) is to assist the State in decision-making regarding flood hazards and prioritize areas to best focus limited resources. The last Statewide inventory of flood history and flood studies was performed in 1994. HRS 179 outlines the purpose, mandates and mission of the SGFCP.						
	Notable Changes:	The State General Flood Control Plan is currently being updated and will utilize digital database and website technologies to provide educational information and public awareness tools on flood risks, flood histories, hydrologic data, mitigation initiatives, a library for flood studies and post-flood reports, and other related information. In addition, through the update DLNR is interested in identifying building footprints within floodplains throughout the entire State.						
	Challenges:	None identified. There is limited funding to support this effort.						
	Opportunities:	The SGFCP update will also implement geospatial and internet technologies that will allow partner agencies to share, communicate, and utilize collected information.						
	Effect on Future Conditions:	Floodplains may need to be adjusted in upcoming years due to sea level rise impacts from climate change						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security; Food, Water, Shelter						
	Hazards:	Flood						
	State HMP Goals:	1, 2, 4	◆		◆	◆		
RISK MAP								
Risk Mapping, Assessment, and Planning Program (Risk MAP)	**Capability Category and Description:**	Administrative and Technical FEMA is working with federal, state, tribal and local partners across the nation to identify flood risk and promote informed planning and development practices to help reduce that risk through the Risk MAP program. Risk MAP provides high quality flood maps and information, tools to better assess the risk from flooding and planning and outreach support to communities to help them take action to reduce (or mitigate) flood risk. Each Risk MAP flood risk project is tailored to the needs of each community and may involve different products and services.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	Floodmaps may need to be adjusted in upcoming years due to sea level rise impacts from climate change						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Equitable Outcomes:	Risk MAP flood risk projects are tailored to the needs of each community and may involve different products and services						
	Community Lifelines:	Safety and Security						
	Hazards:	Flood, Hurricane, Tsunami						
	State HMP Goals:	1, 2, 3, 4	◆		◆	◆		◆ (F)
SILVER JACKETS **Description:** *Silver Jackets teams in states across the country bring together multiple state, federal, and sometimes tribal and local agencies to learn from one another and apply their knowledge to reduce the risk of flooding and other natural disasters in the United States and enhance response and recovery efforts when such events do occur. Silver Jackets are supported by the USACE Flood Risk Management Program.*								
Silver Jackets Interagency Projects	**Capability Category and Description:**	Financial A competitive process through the Silver Jackets program where multiple Federal agencies are involved in contributing towards a shared outcome. No specific cost-share or funding limit, although there is an expectation that the non-Federal sponsor will contribute either cash or work in-kind. Submittal deadlines are typically in the spring, around February-March.						
	Notable Changes:	This is a new capability. State of Hawaiʻi Silver Jackets Program Coordination Meetings began in November 2017. The Hawaiʻi State Office of Planning will be leading meeting efforts.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	None identified.						
	Hazards:	Flood, Climate Change, Infrastructure Failure, Hurricane, Tsunami						
	State HMP Goals:	2, 3	◆	◆	◆	◆		◆ (F)

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*
b. *(F) = Federal grant funding supports in full or in part*
c. *Identified by a stakeholder group as presenting an opportunity to improve effectiveness at meeting hazard mitigation goals.*

Table C-19. Historic Preservation Division Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Description: *The Historic Preservation Division works to preserve and sustain reminders of earlier times which link the past to the present. SHPD's three branches, History and Culture, Archaeology, and Architecture, strive to accomplish this goal through many different activities.*								
Historic Preservation	**Capability Category and Description:**	Education, Outreach, and Capacity Building The division's work includes maintaining the State of Hawai'i Register of Historic Places and coordinating nomination procedures for the National Register of Historic Places. The division's statewide Inventory of Historic Properties contains information on more than 38,000 historic sites in the State of Hawai`i. The National Register contains more than 350 places in the State of Hawai'i.						
	Notable Changes:	None identified.						
	Challenges:	Historic preservation objectives can conflict with mitigation goals as a historic designation may exempt structures from certain building requirements, such as local flood damage prevention ordinance requirements. In recent years there have been efforts to preserve the historic integrity of structures, while also incorporating mitigation strategies such as elevating or floodproofing structures in floodplains and conducting seismic retrofits.						
	Opportunities:	Federal tax incentives are available for mitigation of historic places in some instances. Support mitigation action 2023-2018-057 to coordinate access to SHPD-maintained cultural resource information.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Food, Water, Shelter						
	Hazards:	N/A						
	State HMP Goals:	1	◆				◆	

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*
b. *(F) = Federal grant funding supports in full or in part*

Table C-20. Land Division Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Description: *The Land Division is responsible for the management of State-owned lands in ways that will promote the well-being of Hawaii's people and insure that these lands are used in accordance with the goals, policies and plans of the State. Lands that are not set aside for use by other government agencies come within the direct purview of the division.*								
Shoreline Certification	**Capability Category and Description:**	Planning and Regulatory Applications for shoreline certification are submitted to the land division. Shoreline is defined as "the upper reaches of the wash of the waves, other than storm or seismic waves, at high tide during the season of the year in which the highest wash of the waves occurs, usually evidenced by the edge of vegetation growth, or the upper limit of debris left by the wash of the waves" in HAR §13-10. The certified shoreline establishes jurisdictional authority between the state and the county governments and establishes the line from which shoreline setbacks are established.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	Dynamic shoreline certification may provide a mechanism through which to address some of the impacts of sea level rise.						
	Effect on Future Conditions:	Dynamic shoreline certification may provide a mechanism through which to address some of the impacts of sea level rise.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						
	Hazards:	Flood, Climate Change						
	State HMP Goals:	1	◆	◆	◆			

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*
b. *(F) = Federal grant funding supports in full or in part*

Table C-21. Office of Conservation and Coastal Lands Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
COASTAL LANDS PROGRAM **Description:** *OCCL is responsible for management of coastal resources including beaches, dunes, and rocky shorelines seaward of county jurisdictions and/or within the State Conservation District. The Program supports the complementary long-term goals of conserving coastal resources and mitigating risks from natural and human-induced hazards for coastal communities. The Program develops and implements innovative shoreline management techniques, including alternatives for coastal erosion management through a long-standing cooperative relationship with the University of Hawaiʻi (UH) Sea Grant College Program.*								
Coastal Erosion Management Program	**Capability Category and Description:**	Education, Outreach, and Capacity Building The Coastal Lands Program supports sustainable alternatives for coastal erosion management including programs for beach and dune restoration and guidelines for other “soft” approaches to shoreline protection through the DLNR Coastal Erosion Management Plan (COEMAP), which identifies 7 broad goals, 20 recommendations and 21 implementing actions for improving the erosion management system in the State of Hawaiʻi. The Program works closely with coastal communities, resource management and regulatory agencies, and university researchers to improve management of coastal areas through science-based decision making. The Program also conducts public education, and outreach and distributes information and guidelines on best management practices, erosion control and construction practices for the State of Hawaii’s coastal areas in partnership with UH Sea Grant and other organizations.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	Beach and dune restoration may assist with the sea level rise, caused by climate change						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						
	Hazards:	Flood						
	State HMP Goals:	1, 2, 3, 5	◆			◆		
Small Scale Beach Nourishment (SSBN) Program	**Capability Category and Description:**	Administrative and Technical The SSBN program is intended to provide a viable alternative to shoreline hardening through development and enhancement of beach restoration programs – encouraging landowners to consider beach restoration over hard shoreline armoring. The SSBN program provides a streamlined application process for beach restoration projects within the DLNR under a programmatic Conservation District Use Permit and Environmental Assessment. SSBN authorizations allow placement of compatible beach sand within the State Conservation District and may						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
		be submitted under one of two Categories: SSBN Category I – (up to 500 cubic yards of sand), or SSBN Category II – (up to 10,000 cubic yards).						
	Notable Changes:	None identified. The programmatic Environmental Assessment and Finding of No Significant Impact (FONSI) for an updated small scale beach restoration (SSBR) program was published. On July 1, 2021, the Governor of the State of Hawai`i approved Act 162, which amended Hawaiʻi Revised Statutes Chapter 342D as follows: *The Department [of Health] shall not require a water quality certification pursuant to Section 401 of the Federal Clean Water Act under this chapter for any applicant of the small-scale beach restoration program that has received notice of authorization to proceed from the Department of Land and Natural Resource's' Office of Conservation and Coastal Lands.*						
	Challenges:	None identified.						
	Opportunities:	OCCL completed an updated PEA and FONSI for the updated SSBR program and is exploring the possibility of an agreement with the U.S. Army Corps of Engineers, and Coastal Zone Management Program to re-establish a streamlined inter-agency programmatic permitting process for small scale beach restoration projects. The proposed SSBR program is anticipated to be approved in the next couple years.						
	Effect on Future Conditions:	Beach restoration may assist with the sea level rise, caused by climate change						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security; Food, Water, Shelter						
	Hazards:	Flood, Hurricane						
	State HMP Goals:	1, 3	◆	◆	◆	◆		
CLIMATE 21C **Description:** *The Hawaiʻi Climate Adaptation Initiative Act of 2014 (Act 83; House Bill 1714) is designed to address the effects of climate change through 2050 to protect the State's economy, health, environment, and way of life. The initial focus of the Initiative will be on the effects of sea level rise on the islands.*								
Hawaiʻi Climate Change Portal	**Capability Category and Description:**	Education, Outreach, and Capacity Building A website that includes a vast wealth of information on climate change and how it is impacting the State of Hawaiʻi and other coastal states and locations around the world as well as all things related to the Hawaiʻi Climate Change Mitigation & Adaptation Commission. The website includes links to the Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report, Hawaiʻi Sea Level Rise Viewer, and announcements and archives of meetings for the State Interagency Climate Mitigation and Adaption Commission.						
	Notable Changes:	The website is updated to reflect new or updated reports and resources. https://climate.hawaii.gov/hi-adaptation/state-sea-level-rise-resources/						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	Provides method of education on climate change and its potential impacts						
	Equitable Outcomes:	Provides method of education on climate change and its potential impacts						
	Community Lifelines:	Communications						
	Hazards:	Climate Change						
	State HMP Goals:	2, 4, 5	◆		◆			
Hawaiʻi Climate Change Mitigation & Adaptation Commission (Climate Commission)	**Capability Category and Description:**	Planning and Regulatory The Climate Commission provides direction, facilitation, coordination, and planning among state and county agencies, federal agencies, and other partners about climate change mitigation (reduction of greenhouse gases) and climate change resiliency strategies, including but not limited to, sea level rise adaptation, water and agricultural security, and natural resource conservation.						
	Notable Changes:	The Climate Commission released a new statement on guidance for investment in resilient infrastructure, including nature-based solutions, green infrastructure, and carbon-smart practices. The Climate Commission is piloting an effort along with University of Hawaiʻi at Mānoa, stakeholders, and community members to develop a Climate Change Social Vulnerability Framework. Climate Change Portal | Social and Climate Vulnerability Framework Project (hawaii.gov)						
	Challenges:	None identified.						
	Opportunities:	Provide support for mitigation action 2023-2018-048 (Infrastructure managed retreat and/or nature-based solutions engineering pilot project to protect threatened Hawaiʻi infrastructure)						
	Effect on Future Conditions:	Guidance issued incorporates mitigation to climate change						
	Equitable Outcomes:	Factors such as demographics, socioeconomic status, and limited access to resources can make it much harder to prepare for and recover from climate change. Because of these conditions, events such as extreme weather, sea level rise, heatwaves, flooding, and erosion might prove a hazard for some, but a disaster for others. The creation of a comprehensive, user-friendly data portal on social vulnerability and climate change will support decision-makers, non-profits, and community leaders in addressing social vulnerability throughout their work.						
	Community Lifelines:	Safety and Security; Food, Water, Shelter						
	Hazards:	Climate Change						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation
	State HMP Goals:	2, 3	◆		◆			
Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report	**Capability Category and Description:**	Administrative and Technical The Sea Level Rise Vulnerability and Adaptation Report (SLR Report) provides the first state-wide assessment of the State of Hawaii's vulnerability to sea level rise and recommendations to reduce exposure and sensitivity to sea level rise and increase the capacity to adapt.						
	Notable Changes:	An update to the SLR Report was completed in 2022 assessing the State and Counties' progress in addressing sea level rise risks and preparedness https://climate.hawaii.gov/hi-adaptation/state-sea-level-rise-resources/						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	Provide description of vulnerability to sea level rise						
	Equitable Outcomes:	Provide description of vulnerability to sea level rise						
	Community Lifelines:	Safety and Security						
	Hazards:	Flood, Climate Change						
	State HMP Goals:	2	◆		◆	◆		
Hawaiʻi Sea Level Rise Viewer	**Capability Category and Description:**	Education, Outreach, and Capacity Building The Hawaiʻi Sea Level Rise Viewer was developed by through a partnership between UH Sea Grant, UH SOEST, PacIOOS, and DLNR. The Hawaiʻi Sea Level Rise Viewer is intended to provide an online atlas to support the Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report. The Viewer provides map data depicting projections for future hazard exposure and assessing economic and other vulnerabilities due to rising sea levels.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	Provide visualization of vulnerability to sea level rise						
	Equitable Outcomes:	Provide visualization of vulnerability to sea level rise						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Community Lifelines:	Safety and Security; Communications						
	Hazards:	Flood, Climate Change, Infrastructure Failure						
	State HMP Goals:	3, 4, 5	◆		◆			

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b. (F) = Federal grant funding supports in full or in part

Table C-22. State Board of Land and Natural Resources Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Shoreline Determination Rules and Enforcement Rules	**Capability Category and Description:**	Planning and Regulatory The BLNR is authorized by HRS §205A to adopt rules for determining the shoreline and appeals of shoreline determination and to enforce the established rules.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	Shoreline certification rules and procedures may present an opportunity to address some aspects of sea level rise.						
	Effect on Future Conditions:	Reduce likelihood of development in area susceptible to sea level rise						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						
	Hazards:	Flood, Climate Change						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	State HMP Goals:	1, 2	◆	◆		◆		
Conservation District	**Capability Category and Description:**	Planning and Regulatory The Board of Land and Natural Resources has adopted and administered land use regulations for the Conservation District pursuant to the State Land Use Law (Act 187) of 1961. The Conservation District has five subzones: Protective, Limited, Resource, General and Special. The first four subzones are arranged in a hierarchy of environmental sensitivity, ranging from the most environmentally sensitive (Protective) to least sensitive (General). The Special subzones defines a unique land use on a specific site. The use of Conservation District lands is regulated by Title 13 Chapter 5 of the HARs and Chapter 183C of the HRS.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	Reduce likelihood of development in hazardous and/or sensitive areas						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	None identified.						
	Hazards:	Flood, Drought						
	State HMP Goals:	1, 2	◆		◆			

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*
b. *(F) = Federal grant funding supports in full or in part*

C.1.9 DEPARTMENT OF TRANSPORTATION

Table C-23 includes information on hazard mitigation related capabilities for the Department of Transportation (HDOT). Table C-24 includes information on hazard mitigation related capabilities for the Oʻahu Metropolitan Planning Organization (OahuMPO).

Table C-23. Department of Transportation Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Description: *The Hawaiʻi Department of Transportation (HDOT) is responsible to plan, design, construct, operate, and maintain State facilities in all modes of transportation, including air, water, and land. Coordination with other State, County, and Federal programs is maintained to achieve these objectives.*								
Roadside Fuel Reduction Program	**Capability Category and Description:**	Administrative and Technical HDOT has a program to reduce or convert fuel load along roadsides and community open areas.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Transportation; Hazardous Material; Safety and Security						
	Hazards:	Wildfire						
	State HMP Goals:	4	◆		◆	◆		
Hazardous Materials Risk Management Program	**Capability Category and Description:**	Administrative and Technical Information on unintentional releases of hazardous materials and the consequences are collected and analyzed.						
	Notable Changes:	None identified.						
	Challenges:	Identifying low probability, high consequence events (which may not be apparent from incident data) and providing appropriate levels of protection are among the more demanding aspects of this risk management program. A further challenge is to strike a proper balance between levels of safety and costs that result from regulations, special permits, and approvals.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	Disadvantaged persons are more likely to live near facilities that produce hazardous waste.						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction [a]: Support	Effect on Loss Reduction [a]: Facilitate	Effect on Loss Reduction [a]: Conflict	Provides Funding for Mitigation
	Community Lifelines:	Hazardous Material; Safety and Security						
	Hazards:	Hazardous Materials						
	State HMP Goals:	4, 5	◆		◆			
Bridge Inspection Program	**Capability Category and Description:**	Administrative and Technical The bridge inspection program creates reports on the conditions of all HDOT bridges every two years.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	Implement mitigation action 2023-2013-028, for seismic retrofit performance evaluations.						
	Effect on Future Conditions:	Creates safer means of passage as sea levels rise and salinity increases.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						
	Hazards:	Infrastructure Failure, Earthquake, Flood, Landslide and Rockfall, Tsunami						
	State HMP Goals:	4	◆		◆			
Statewide Highway Shoreline Protection Study	**Capability Category and Description:**	Administrative and Technical Together with the Hawaiʻi Department of Transportation (HDOT), the University of Hawaiʻi Civil & Environmental Engineering (UH CEE) Department conducted a statewide field investigation for each island in the State of Hawaiʻi that identified shoreline locations requiring "immediate" mitigation measures, that is, imminent road failure affected by shoreline activity only, in order to reduce possible road closures during the next storm and hurricane season.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	Implement mitigation measures outlined in the Statewide Highway Shoreline Protection Study (i.e., Action 2023-2018-058)						
	Effect on Future Conditions:	Mitigate road flooding and road closures.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Transportation; Safety and Security						
	Hazards:	Flood, Climate Change and Sea Level Rise, Hurricane						
	State HMP Goals:	2	◆		◆	◆		

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*

Table C-24. O‘ahu Metropolitan Planning Organization Capabilities

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction [a]: Support	Effect on Loss Reduction [a]: Facilitate	Effect on Loss Reduction [a]: Conflict	Provides Funding for Mitigation
Description: *OahuMPO is responsible for coordinating transportation planning on O‘ahu. Although OahuMPO serves as the metropolitan planning organization for the two urbanized areas on O‘ahu (Honolulu and Kailua-Kaneohe), OahuMPO coordinates transportation planning for the entire island.*								
Transportation Asset Climate Change Risk Assessment Project	**Capability Category and Description:**	Administrative and Technical OahuMPO was selected by the Federal Highway Administration (FHWA) as one of five pilots nationwide to perform and evaluate a risk assessment of climate change on important transportation assets. Inventory assets were integrated with climate information and vulnerability was determined in two dimensions: the impact to the asset itself and, importantly, the socioeconomic consequences of that impact (SSFM 2011). While the report focuses on only several essential components of the Island of O‘ahu’s transportation infrastructure, the workshops, field work, and assessment looked at a far broader range of both transportation assets as well as climate change factors. Those assets selected for the report were deemed by those senior engineers, senior planners, and climate change experts, involved in the study to be the most at risk in 2011.						
	Notable Changes:	Climate change science has advanced since the assessment. Near-term risks to assets should now be assumed to be understated by the project. The study focused primarily on shoreline transportation assets and later advancements make it clear that the effects of climate change in the Hawaiian Islands are not limited to the shoreline.						
	Challenges:	Climate change science has advanced since the assessment and near-term risks to assets may now be understated by the project.						
	Opportunities:	Updated sea level rise information is available to reevaluate and plan for near and long-term risks not only to those assets identified in the study, but a broader range of effects that will result from temperature and rainfall (rockfall hazards), the need to address not only harbor infrastructure (Honolulu Harbor gantries) but also wastewater systems, oil refinery, and visitor industry assets, all of which are currently at shoreline.						
	Effect on Future Conditions:	Risk assessment of climate change on important transportation assets.						
	Equitable Outcomes:	Risk assessment takes socioeconomic consequences of the climate change impact.						
	Community Lifelines:	Transportation; Safety and Security						
	Hazards:	Climate Change						
	State HMP Goals:	2, 4	◆		◆			

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*

C.1.10 HAWAI‘I EMERGENCY MANAGEMENT AGENCY

Table C-25 includes information on hazard mitigation related capabilities for the Hawai‘i Emergency Management Agency (HI-EMA).

Table C-25. Hawai‘i Emergency Management Agency Capabilities

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation
Description: *The Hawai‘i Emergency Management Agency (HI-EMA) is the emergency management agency for the State of Hawai‘i. HI-EMA serves as the coordinating agency between the four county emergency management agencies (County of Hawai‘i Civil Defense, County of Maui Emergency Management Agency, City and County of Honolulu Department of Emergency Management, and Kaua‘i Emergency Management Agency) and as State Warning Point. The five core capabilities that guide HI-EMA are Prevention, Protection, Mitigation, Response, and Recovery. The branches in the HI-EMA organization address these capabilities: Preparedness, Operations, Telecommunications, Logistics, and Finance/Administration.*								
Hawai‘i Earthquake & Tsunami Advisory Committee (HETAC)[b]	**Capability Category and Description:**	Administrative and Technical HETAC is a volunteer peer group of scientists who has served as an advisory body to HI-EMA for over 25 years (est. September 1990). HETAC meets quarterly to promote activities such as research, project development and management, and mitigation (HI-EMA 2014). HETAC also supports the Pacific Tsunami Museum in their public outreach efforts.						
	Notable Changes:	No significant changes over reporting period						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						
	Hazards:	Earthquake, Tsunami						
	State HMP Goals:	3	◆		◆			◆ (F)
Western States Seismic Policy Council (WSSPC)	**Capability Category and Description:**	Planning and Regulatory Hawai‘i is a member of the WSSPC, which develops seismic policies and shares information to promote programs intended to reduce earthquake related losses. WSSPC also hosts a Tsunami Center.						
	Notable Changes:	WSSPC continues to support several mitigation initiatives in Hawai‘i including HHARP, printing 3,000 copies of the Natural Hazards Preparedness Wheel, and general outreach initiatives.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future	None identified.						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Conditions:							
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						
	Hazards:	Earthquake, Tsunami						
	State HMP Goals:	2, 3	◆		◆	◆		◆
Hawaiʻi Advisory Council on Emergency Management (HACEM)	**Capability Category and Description:**	Administrative and Technical Hawaiʻi Revised Statutes §127A-4 authorizes HACEM. Originally established in 1951, the Advisory Council was known as the Civil Defense Advisory Council until July 1, 2014 when HRS 127A became effective. The council consists of seven members nominated by the Governor and serves as a resource to the Governor and the Director of the Emergency Management Agency.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						
	Hazards:	Flood, Climate Change, Infrastructure Failure, Drought, Earthquake, Hazardous Materials, Health Risks, Windstorm, Hurricane, Landslide and Rockfall, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	3	◆	◆	◆	◆		
Get Ready Website	**Capability Category and Description:**	Education, Outreach, and Capacity Building This website is a key outreach tool that provides links and information to county specific Get Ready Hawaiʻi websites; information on preparing for hurricane, tsunami, flash flood, earthquake, and wildfire; and tips for preparing your family, home, and business.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	Expand website to provide information on all hazards addressed by the hazard mitigation plan.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	Provides disadvantaged communities with education on hazards.						
	Community Lifelines:	Safety and Security; Communications						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Hazards:	Earthquake, Flood, Hurricane, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	4, 5	◆			◆		
Hawaiʻi Hazards Awareness and Resilience Program (HHARP)[b]	**Capability Category and Description:**	Education, Outreach, and Capacity Building The aim of HHARP is to help communities prepare to be self-reliant during and after natural hazard events, improve their ability to take care of their own needs, and reduce the negative impacts of disasters. HHARP can enhance community resilience through education and outreach sessions that build awareness and understanding of hazard mitigation, preparedness, response and recovery.						
	Notable Changes:	This was established in 2014. As of December 2017, six communities have reached recognition level in the program and another six communities are on the verge of program recognition. This program won the *2016 National Award in Excellence for Educational Outreach to the General Public* from WSSPC.						
	Challenges:	None identified.						
	Opportunities:	Engage more communities to participate in and complete the program.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	Provides disadvantaged communities with education on hazards and how to become more resilient.						
	Community Lifelines:	Safety and Security; Communications						
	Hazards:	Flood, Climate Change, Infrastructure Failure, Drought, Earthquake, Hazardous Materials, Health Risks, Windstorm, Hurricane, Landslide and Rockfall, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	2, 5	◆			◆		
State of Hawaiʻi Emergency Operations Plan (HI-EOP)	**Capability Category and Description:**	Planning and Regulatory The HI-EOP establishes the shared framework for the state's response to, and initial recovery from emergencies and disasters. It outlines the state's hazard vulnerabilities and planning assumptions, and establishes the authorities, responsibilities, operational priorities and general strategies for state emergency operations that apply regardless of the specific type of emergency or disaster.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	The hazard mitigation plan is considered the hazard assessment section of the HI-EOP. The information on the State of Hawaii's hazard profile can be updated once the 2023 SHMP Update is completed.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security; Communications						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Hazards:	Flood, Climate Change, Dam Failure, Drought, Earthquake, Hazardous Materials, Health Risks, Windstorm, Hurricane, Landslide and Rockfall, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	2, 4	◆		◆			
Hawai'i Catastrophic Hurricane Plan	**Capability Category and Description:**	Planning and Regulatory The 2015 Hawai'i Catastrophic Hurricane Plan/FEMA Region IX Hawai'i outlines scalable and coordinated strategies to execute a joint state and federal response to catastrophic damage before, during, and following a catastrophic hurricane event (HI-EMA and FEMA Region IX 2015).						
	Notable Changes:	This is a new capability. The plan was developed in 2015.						
	Challenges:	None identified.						
	Opportunities:	The Cat Plan provides the basis for the development of other operational plans (e.g. Critical Systems Vulnerability Assessment) that highlight mitigation opportunities.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security; Communications						
	Hazards:	Hurricane						
	State HMP Goals:	2, 3, 4	◆		◆			
Training & Exercise Plan (TEP)	**Capability Category and Description:**	Planning and Regulatory The TEP is updated annually. It is the product of the Training and Exercise Planning Workshop (TEPW), which is hosted by HI-EMA and attended by stakeholders from all levels of government, the non-profit and private sectors. The TEP is informed by the input provided by this diverse group of agencies and is the roadmap for the State of Hawai'i to accomplish the training, exercise and planning priorities described within this document.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	The annual hurricane (Makani Pahili) exercise hot-wash provide an opportunity to discuss mitigation opportunities of identified vulnerabilities						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security; Communications						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Hazards:	Flood, Climate Change, Infrastructure Failure, Drought, Earthquake, Hazardous Materials, Health Risks, Windstorm, Hurricane, Landslide and Rockfall, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	2, 3, 4	◆		◆			
Department Emergency Operations Plan Template	**Capability Category and Description:**	Planning and Regulatory Each state department is required to have a Department Emergency Operations Plan that is consistent with the state plan. A template is provided by HI-EMA.						
	Notable Changes:	None identified.						
	Challenges:	Significant out-reach required for Departments that do not regularly participate in emergency exercises and events.						
	Opportunities:	Out-reach provides opportunity to discuss mitigation actions						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security; Communications						
	Hazards:	Flood, Climate Change, Infrastructure Failure, Drought, Earthquake, Hazardous Materials, Health Risks, Windstorm, Hurricane, Landslide and Rockfall, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	2, 3	◆		◆			
Department Operations Center (DOC) Planning Guidance and Resources	**Capability Category and Description:**	Planning and Regulatory Every state department should have a DOC, which is the location where their key personnel will gather in an emergency to coordinate support requested by the State Emergency Operations Center, and to address impacts to critical agency functions. This document provides guidance on supplies and back-up communications assets a DOC should be equipped with and contains templates that can be used to organize operations when the DOC is activated.						
	Notable Changes:	This is an operations/response plan.						
	Challenges:	None identified.						
	Opportunities:	Post-event Hot-wash provides an opportunity to discuss mitigation opportunities of identified vulnerabilities.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security; Communications						
	Hazards:	Flood, Climate Change, Dam Failure, Drought, Earthquake, Hazardous Materials, Health Risks, Windstorm, Hurricane, Landslide and Rockfall, Tsunami, Volcanic Hazards, Wildfire						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation
	State HMP Goals:	2, 3	◆	◆	◆	◆		
State Mitigation Forum (Forum)	**Capability Category and Description:**	Administrative and Technical The Hawaiʻi State Hazard Mitigation Forum was formerly established in 1998. The forum serves in an advisory capacity relative to the incorporation of hazard mitigation in policy in the State of Hawaiʻi. Forum members (17 in total) come from a broad spectrum of State and County agencies, and the private sector. The Forum also includes ex officio representatives from all four County Emergency Management Agencies, and FEMA. Two of the most important Forum duties are to assist in the development of the State Hazard Mitigation Plan, and to make mitigation project recommendations to the Emergency Management Agency Director. Two committees of the forum have been established: education and emergency shelter criteria. The Form bylaws can be found in Appendix B (State Hazard Mitigation Forum Bylaws).						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	Support mitigation action 2023-2018-056 to evaluate and update the SHMP on an annual basis.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security; Communications						
	Hazards:	Flood, Climate Change and Sea Level Rise, Infrastructure Failure, Drought, Earthquake, Hazardous Materials, Health Risks, Windstorm, Hurricane, Landslide and Rockfall, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	2, 3, 4	◆	◆	◆	◆		
Critical Systems Vulnerability Assessment	**Capability Category and Description:**	Administrative and Technical The Critical Systems Vulnerability Assessment is a holistic systems evaluation (rather than component by component) of the implications of a large natural disaster on key systems (e.g., ports, food & water, power). The gap analysis leads to a 9-step resiliency strategy, that lead to response, recovery and mitigation actions strengthen those systems and reduce response/recovery times						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	Identifies weaknesses on key systems which need improvement.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Hazards:	Earthquake, Hurricane, Tsunami						
	State HMP Goals:	1, 2, 3, 6	◆		◆	◆		
Natural Disaster Economic Recovery Strategy	**Capability Category and Description:**	Planning and Regulatory This Hawaiʻi Natural Disaster Economic Recovery Strategy (NDERS) addresses pre-disaster business continuity planning and post-disaster recovery actions for both public and private sectors. This strategy especially focuses on small business and economic recovery since small businesses are the major driver of the State of Hawaii's economy. The process to develop a strategy sought input from multiple stakeholders and resulted in 49 recommended implementation strategies grouped in four types (1) State or Federal legislative action is needed to change statutes and ordinances, or provide funding; (2) State government agency action could change administrative rules, policies, or programs; (3) public-private partnerships; and (4) private sector initiatives and actions (OP 2014a).						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	Coordinated planning efforts for economic recovery (i.e., Actions 2023-004 and 2023-2018-006)						
	Effect on Future Conditions:	Provide business owners with knowledge on business continuity and recovery.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						
	Hazards:	Flood, Climate Change, Dam Failure, Drought, Earthquake, Hazardous Materials, Health Risks, Windstorm, Hurricane, Landslide and Rockfall, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	1, 2, 3, 5, 6	◆	◆	◆			
Threat Hazard Identification and Risk Assessment (THIRA)	**Capability Category and Description:**	Administrative and Technical The THIRA process helps communities identify capability targets and resource requirements necessary to address anticipated and unanticipated risks.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	The 2023 SHMP Update will be integrated into future THIRA updates.						
	Effect on Future Conditions:	Identifies hazards and risks within a selected area.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						
	Hazards:	Earthquake, Flood, Health Risks, Hurricane, Tsunami, Volcanic Hazards						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation
	State HMP Goals:	1, 3, 6	◆		◆	◆		
Stakholder Preparedness Review (SPR)	**Capability Category and Description:**	Administrative and Technical The SPR assesses the State's ability to meet the capability targets established in the THIRA.						
	Notable Changes:	New FEMA guidance has been issued for report development.						
	Challenges:	None identified.						
	Opportunities:	HI-EMA will be conducting a comprehensive update to the SPR in 2023. The 2023 SHMP Update will be integrated into the 2023 SPR.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						
	Hazards:	Flood, Climate Change, Infrastructure Failure, Drought, Earthquake, Hazardous Materials, Health Risks, Windstorm, Hurricane, Landslide and Rockfall, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	4, 6	◆		◆	◆		
HI-EMA Strategic Plan	**Capability Category and Description:**	Planning and Regulatory Strategic Plan for HI-EMA.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						
	Hazards:	Flood, Climate Change, Dam Failure, Drought, Earthquake, Hazardous Materials, Health Risks, Windstorm, Hurricane, Landslide and Rockfall, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	6	◆		◆			
Makani Pahili 2017 Emergency Power Prioritization Workshop Series	**Capability Category and Description:**	Education, Outreach, and Capacity Building The Hawaiʻi Emergency Management Agency (HI-EMA) conducted a series of workshops in preparation for Makani Pahili 2017 to identify power generation requirements in accordance with the 2015 Hawaiʻi Catastrophic Hurricane Plan.						
	Notable Changes:	None identified.						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Challenges:	None identified.						
	Opportunities:	Information from this workshop series was integrated into the 2023 SHMP Update, as appropriate, and formed the basis for the critical facility data base used for the risk assessment.						
	Effect on Future Conditions:	Identify power generation needs for hurricane preparedness.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security; Communications; Energy						
	Hazards:	Infrastructure Failure, Earthquake, Flood, Windstorm, Hurricane, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	1, 3, 4	◆	◆	◆	◆		
HAWAIʻI WING CIVIL AIR PATROL **Description:** *Hawaiʻi Wing Civil Air Patrol (CAP) has three primary missions: emergency services, cadet programs, and aerospace education. Hawaiʻi Wing Units are located on Oʻahu, Hawaiʻi, Kauaʻi, and Maui.*								
Aircraft Alert System	**Capability Category and Description:**	Disaster Response/Recovery CAP aircraft are capable of night flights with instrument-rated pilots equipped with speakers and sirens on the islands of Kauaʻi, Oʻahu, Maui, and Hawaiʻi are deployed to alert areas where any land-based sirens have malfunctioned. CAP has eleven aircrafts.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	May notify disadvantaged populations of an impending hazard.						
	Community Lifelines:	Safety and Security; Communications						
	Hazards:	Tsunami						
	State HMP Goals:	1, 3, 5	◆			◆		

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*
b. *Identified by the department/agency as one of the most effective capabilities for achieving mitigation goals.*
c. *(F) = Federal grant funding supports in full or in part; HETAC tsunami work is funded by NOAA*

C.1.11 HAWAIʻI STATE LEGISLATURE

Table C-26 includes information on hazard mitigation related capabilities for the Hawaiʻi State Legislature

Table C-26. Hawaiʻi State Legislature Capabilities

Capability		Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
		Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	

Hawaiʻi State Legislature Grant-in-Aid (GIA) Program	**Capability Category and Description:**	Financial Pursuant to Chapter 42F, Hawaiʻi Revised Statutes (HRS), the Legislature may award state funds on an annual basis as a grant by an appropriation to a specified recipient, to support the activities of the recipient and permit the community to benefit from those activities. These activities may include hazard mitigation. An appropriation for a grant shall be disbursed by a contract between the state agency designated the expending agency for the appropriation by the legislature, and the recipient of the grant. During the Regular Legislative Session of 2016, the Hawaiʻi State Legislature appropriated $158,000 as a grant to Hawaiʻi Wildfire Management Organization (HWMO) to support wildfire prevention and hazardous fuel reduction measures, including: • Create all-agency unified wildfire prevention messaging, related materials, and a public awareness campaign to maximize public protection and preparedness; and • Develop cross-boundary fuel reduction priorities, maps, and projects for all four counties in the State of Hawaiʻi. • DLNR-DOFAW was the designated expending agency for the grant to HWMO.
	Notable Changes:	Funds were appropriated to HWMO as a grant pursuant to Chapter 42F, HRS, during the Regular Legislative Session of 2016. A contract was executed and funds were encumbered in 2017. The contract is currently open and the Statewide initiative is ongoing. This grant was used to distribute wildfire outreach materials endorsed by all fire agencies to schools on all islands and help to coordinate the annual unified multi-agency Wildfire LOOKOUT! campaign to raise awareness about the threat of wildfire to Hawaii's natural resources and to private and public property. This grant will also fund HWMO to develop cross-boundary fuel reduction priorities, maps, and projects for all four counties in the State of Hawaiʻi. HWMO has started holding workshops on County of Maui and County of Hawaiʻi to develop these fuel reduction priorities, maps, and projects. There may be other grants pursuant to Chapter 42F, HRS, that are funding other hazard mitigation projects with other state agencies designated as expending agencies.
	Challenges:	The Hawaiʻi State Legislature decides on which recipients and the type of activities to fund as long as the grants support the activities of the recipient and permit the community to benefit from those activities.
	Opportunities:	This is a funding source for mitigation activities performed by the non-governmental sector
	Effect on Future Conditions:	May fund projects to assist with climate change adaptations.
	Equitable Outcomes:	Funded projects may benefit disadvantaged communities.
	Community Lifelines:	Safety and Security

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction [a]: Support	Effect on Loss Reduction [a]: Facilitate	Effect on Loss Reduction [a]: Conflict	Provides Funding for Mitigation
	Hazards:	Flood, Climate Change, Infrastructure Failure, Drought, Earthquake, Hazardous Materials, Health Risks, Windstorm, Hurricane, Landslide and Rockfall, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	1, 2, 3, 5	◆	◆	◆			◆
Hawai'i State Legislature Senate Resolution 35	**Capability Category and Description:**	Financial Designating Hawaii's Coral Reefs as Critical Natural Infrastructure and Strongly Supporting Nature-based Solutions Such as Coral Reef Restoration for Risk Reduction. Healthy coral reef ecosystems can help to mitigate the effects of climate change and natural disasters by absorbing up to ninety-seven percent of wave energy brought about by storms and extreme weather events. One study has estimated that Hawaii's coral reefs protect and save coastal infrastructure from $836,000,000 in costs and damages annually due to destructive flooding and similar events.						
	Notable Changes:	Resolution adopted on April 5, 2023						
	Challenges:	The Hawai'i State Legislature decides on which recipients and the type of activities to fund.						
	Opportunities:	This is a new funding source which will allow for unique coral reef restoration projects (i.e., Action 2023-009)						
	Effect on Future Conditions:	May fund projects to assist with climate change adaptations.						
	Equitable Outcomes:	Funded projects may benefit disadvantaged coastal communities.						
	Community Lifelines:	Food, Water, Shelter; Safety and Security; Communication; Transportation; Energy; Health and Medical; Hazardous Material						
	Hazards:	Climate Change and Sea Level Rise, Flood, Hurricane, Tsunami						
	State HMP Goals:	1, 2, 3	◆	◆	◆			◆

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*
b. *(F) = Federal grant funding supports in full or in part*

C.1.12 UNIVERSITY OF HAWAIʻI

Table C-27 includes information on hazard mitigation related capabilities for the University of Hawaiʻi (UH). The Pacific Disaster Center (PDC) is managed under a Cooperative Agreement with the Office of the Undersecretary of Defense and its capabilities are included in Table C-28. Table C-29 includes information on the Pacific Regional Integrated Sciences and Assessments (Pacific RISA) program. Table C-30 includes information on the Pacific Risk Management ʻOhana (PRiMO).

Table C-27. University of Hawaiʻi Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
SCHOOL OF OCEAN AND EARTH SCIENCE TECHNOLOGY **Description:** *The School of Ocean and Earth Science and Technology (SOEST) at the University of Hawaiʻi at Mānoa is a world-class research and academic institution focused on informing solutions to some of the world's most vexing problems. Through an integrated, comprehensive, and sustained system of Earth and planetary observations, research, and education, SOEST staff work to transform the way people live on Earth by enabling a healthy public, economy, and planet.*								
SOEST Public Resources	**Capability Category and Description:**	Education, Outreach, and Capacity Building SOEST's website includes a number of publicly available resources including a video archive, publications, K-12 resources, and a data access portal. Among the programs generating hazard related information are: • Mauna Kea Weather Center provides realtime data, model output, and forecasts for Mauna Kea including blizzard conditions and high winds at the summits. The model output covers the state at a 900 meter resolution and provides 2-day forecast output of clouds, winds, and storm conditions, including hurricanes and kona lows, etc. • VMAP, a weather modeling program provides 2-day web-based ongoing forecasts of atmospheric concentrations of sulfur dioxide and sulfate aerosols using initial conditions from the Flyspec Array developed by Keith Horton of SOEST and maintained by the USGS. • The Hawaiʻi Beach Safety website was developed by Dr. Fletcher. Using current weather, surf, public safety alerts and beach conditions we calculate hazard levels at thirty-three Oʻahu beaches. Hazard ratings may vary between nearshore and offshore. • Pacific Islands Ocean Observing System (PacIOOS) empowers ocean users and stakeholders in the Pacific Islands by providing web-based and on-demand accurate and reliable coastal and ocean information, tools, and services that are easy to access and use, including products wave hazard, currents, shoreline impacts, water characteristics, and weather (see details below). • The Department of Meteorology maintains the Weather Server (Department of Meteorology 2017), which provides real time weather observations and forecasts for the State of Hawaiʻi, the central Pacific region and the US Mainland.						
	Notable Changes:	None identified.						
	Challenges:	Supported internally and through grant funds; subject to availability of agency funding						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Opportunities:	None identified.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	Provides educational opportunities on hazards and their risks.						
	Community Lifelines:	Safety and Security; Communications						
	Hazards:	Flood, Climate Change, Windstorm, Hurricane, Volcanic Hazards						
	State HMP Goals:	1, 2, 3, 4, 5	◆		◆	◆		
SOEST Research	**Capability Category and Description:**	Administrative and Technical SOEST faculty and staff are recognized as international leaders in research, innovation, and education on topics as varied as renewable energy, oceanography, coral reef ecology, volcanology, remote sensing, cosmochemistry, tropical meteorology and climate modeling, and projection of future climate change for the State of Hawaiʻi. SOEST faculty work with community groups and agencies at local, state, and federal levels, to perform the fundamental research that underlies policy development in water quality, renewable energy, natural hazard management, natural hazards and climate variability (e.g., El Niño, Pacific Decadal Oscillation), climate change impacts, and sustainable ecosystems. SOEST includes several research centers, labs, programs and groups. Particularly relevant for hazard mitigation goals include: • The Sea Level Center • The Coastal Geology Group • The State Climatologist • The Department of Ocean and Resources Engineering maintains tsunami modeling capabilities for determination of tsunami inundation and run-up projections as well as for modeling ocean and harbor currents and water levels over the course of tsunami events. • The Department of Geology and Geophysics maintains research programs on public risk perception, volcano hazards management and training programs for crisis response.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	Support mitigation action 2023-2013-121 with data to develop harbor maps for tsunami evacuation.						
	Effect on Future Conditions:	Knowledge from faculty and staff may assist in planning for climate change impacts.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						
	Hazards:	Flood, Climate Change and Sea Level Rise, Drought, Windstorm, Hurricane, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	3, 4	◆		◆	◆		

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Sea Grant	**Capability Category and Description:**	Financial Hawaiʻi Sea Grant supports an innovative program of research, extension, education, and communication services directed to the improved understanding and stewardship of coastal and marine resources. Realizing the necessity of collaboration to address coastal resource issues, Hawaiʻi Sea Grant also provides links between academia, federal, state, and local government agencies, industries, and local community members. Hawaiʻi Sea Grant has five focus areas: (1) sustainable coastal development, (2) hazard resilience in coastal communities (3) sustainable coastal tourism (4) indigenous cultural heritage (5) water resource sustainability; and six centers of excellence: (1) smart building and community design (2) sustainable coastal tourism (3) marine science education (4) coastal and climate science and resilience (5) integrated science, knowledge, and culture; and (6) water resource sustainability. With capacity and concentration working in these focal areas for more than 10 years, the Center for Coastal and Climate Science and Resilience (CCCSR) was formally established in 2016 to increase support for collaborative and transdisciplinary coastal and climate research, outreach, and education in the service of communities and decision-makers to understand and address impacts of coastal hazards, climate change, and sea-level rise in Hawaiʻi and the Pacific region. University of Hawaiʻi researchers and Hawaiʻi Sea Grant extension faculty working through the CCCSR significantly amplify project impacts and outcomes through increased collaboration and involvement of multidisciplinary center faculty. The CCCSR engages a broad range of regional stakeholders involved in coastal community resilience and coastal ecosystem management to inform the CCCSR's research agenda, advise decision-makers on potential impacts of climate change and the implementation of adaptation measures, and improve sustainable management of public coastal resources and shoreline land use.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	Partnerships leveraged between counties, state departments (e.g. DLNR) and the University to support staff in county planning agencies that participate directly in hazard mitigation activities and planning.						
	Effect on Future Conditions:	Hazard mitigation activities are correlated to climate change.						
	Equitable Outcomes:	Hazard mitigation activities could improve community resilience.						
	Community Lifelines:	Safety and Security; Communications						
	Hazards:	Flood, Climate Change, Earthquake, Hurricane, Tsunami						
	State HMP Goals:	1, 2, 3, 4, 5	◆	◆	◆	◆		
Pacific Islands Ocean Observing System (PacIOOS)	**Capability Category and Description:**	Administrative and Technical The Pacific Islands Ocean Observing System (PacIOOS) provides coastal and ocean data and information to promote a safe, healthy, and productive ocean and resilient coastal zone. PacIOOS collects real-time data on ocean conditions, forecasts future events, and develops user-friendly tools to access this information. Based within the School of Ocean and Earth Science and Technology (SOEST) at the University of Hawaiʻi at Mānoa, PacIOOS is part of the U.S. Integrated Ocean Observing System (IOOS).						
	Notable Changes:	• Installed a number of wave buoys around the islands; 10 wave buoy locations now maintained by PacIOOS around the Islands of						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
		Kaua'i, O'ahu, Maui, Lāna'i, and Hawai'i. • Provides six-day High Sea Level forecasts for six harbors in the islands. • Provides two 6-day wave run-up forecasts provided: for Waikiki and North Shore, O'ahu. • Provides the Haleiwa Harbor Surge Forecast. • Provides high resolution wave and wind forecasts for the islands. • Developed and hosts the Hawai'i Sea Level Rise Viewer as the online atlas to support the Hawai'i Sea Level Rise Vulnerability and Adaptation report. • Developed and now hosts a map viewer for Honolulu Sea Level Rise Inundation Risk, which illustrates risk of inundation from a Hurricane and/or Tsunami with 1-meter of sea level rise. • Developed the Hawai'i Shoreline Change tool, which displays scenarios of sea level rise, historical shorelines, and erosion rates by parcel.						
	Challenges:	PacIOOS is mostly federally funded, and while funding has been fairly level for the past decade, it is insufficient to address all the needs expressed by stakeholders.						
	Opportunities:	Advancements in the wave run-up forecast are currently being made with funding from multiple agencies and organizations.						
	Effect on Future Conditions:	Could notify scientists and the public of changing coastal and oceanic conditions which may be correlated to climate change.						
	Equitable Outcomes:	Provides disadvantaged communities with the opportunity to access real-time information on coastal and ocean data.						
	Community Lifelines:	Safety and Security; Communications						
	Hazards:	Flood, Climate Change and Sea Level Rise, Earthquake, Windstorm, Hurricane, Tsunami						
	State HMP Goals:	1, 2, 3, 4, 5	◆		◆			
THE CENTER FOR THE STUDY OF ACTIVE VOLCANOES Description: *The Center for the Study of Active Volcanoes (CSAV) operates out of the University of Hawai'i at Hilo. The Center is a training and outreach program founded by Robert W. Decker. CSAV's mission is to provide information on volcanic and natural hazards that occur in Hawai'i and worldwide. CSAV has been operating since 1989, and is a cooperative program of the University of Hawai'i at Hilo, the Hawaiian Volcano Observatory (HVO), and the Hawai'i Institute of Geophysics and Planetology at the University of Hawai'i at Mānoa (UHM).*								
CSAV Public Education and Outreach Program on Natural Hazards	**Capability Category and Description:**	Education, Outreach, and Capacity Building Includes website with information on natural hazards, YouTube and Vimeo channels, Facebook page, Visiting Schools Program, Public Seminar, Community Association Visits, and Teacher Training Workshops						
	Notable Changes:	None identified.						
	Challenges:	Outreach program is funded on an annual basis and will vary according to agency funding available in a given year.						
	Opportunities:	There is a significant need for comprehensive, web-based on-demand hazard mitigation guidance that could be met with University capabilities if resources were available for their development.						
	Effect on Future Conditions:	None identified.						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Equitable Outcomes:	Provides educational opportunities for disadvantaged communities.						
	Community Lifelines:	Safety and Security; Communications						
	Hazards:	Earthquake, Flood, Hurricane, Tsunami, Volcanic Hazards						
	State HMP Goals:	1, 2, 4, 5	◆		◆			
CSAV Cooperative Research Program	**Capability Category and Description:**	Administrative and Technical Includes monitoring and assessment of volcanoes, internship program, deformation studies, seismic analysis, volcanic hazards and society, geotechnical monitoring, geology and mapping, and public outreach						
	Notable Changes:	None identified.						
	Challenges:	Funded annually and subject to resource availability from funding agency.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	May provide educational opportunities for disadvantaged communities through public outreach.						
	Community Lifelines:	Safety and Security; Communications						
	Hazards:	Volcanic Hazards						
	State HMP Goals:	1, 2, 4, 5	◆		◆	◆		
GEOGRAPHY DEPARTMENT								
Hawaiʻi Climate Data Websites	**Capability Category and Description:**	Administrative and Technical Hosts a family of websites that provides data on the climate of Hawaiʻi including Rainfall Atlas, Evapotranspiration, Solar Radiation and Climate (Geography Department 2014).						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	May provide insight to climatic changes.						
	Equitable Outcomes:	Provides educational opportunities for disadvantaged communities.						
	Community Lifelines:	Safety and Security; Communications						
	Hazards:	Flood						
	State HMP Goals:	2, 4, 5	◆		◆			
HAWAIʻI INSTITUTE OF GEOPHYSICS AND PLANETOLOGY **Description:** *The Hawaiʻi Institute of Geophysics and Planetology is a research institute within the School of Ocean and Earth Sciences and Technology specializing in basic and applied research in earth and space sciences*								

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
HIGP Research	**Capability Category and Description:**	Administrative and Technical Research faculty conduct research in a variety of technologies related to natural and technological hazards including: • Satellite remote sensing and quantification of volcanic and trace gases and aerosols • Multispectral remote sensing of lava flows • Geodetic modeling and tsunami detection • Remote sensing and spectroscopy of contaminants in the atmosphere and oceanic environment • Infrasound (acoustic) monitoring of volcanic events and nuclear testing for nuclear test ban treaty verification • Engineering and development of satellite instrumentation for remote sensing of earth and atmospheric processes.						
	Notable Changes:	None identified.						
	Challenges:	Supported extramurally through grant funds; subject to availability of agency funding						
	Opportunities:	None identified.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						
	Hazards:	Tsunami, Volcanic Hazards, Technological (nuclear and chemical) hazards						
	State HMP Goals:	4	◆		◆			
State Climatologist	**Capability Category and Description:**	Administrative and Technical Research focus on the impact of climate variability and climate change on natural hazards such as hurricane, flood, drought, vog, and wild fire in Hawaiʻi. Use a high-resolution regional climate model and advanced statistical methods for studying future changes in natural hazards. • Hurricane risk assessment • Hurricane intensity forecasts • Seasonal hurricane frequency forecasts • El Niño, La Niña, and rainfall changes in the State of Hawaiʻi • A high resolution numerical model for assessing current and future weather hazards in the State of Hawaiʻi • Projection of future flooding and drought events for the State of Hawaiʻi using dynamical and statistical downscaling approaches • Estimating return levels of extreme precipitation using an extreme value theory • Long-term changes in trade winds over the Hawaiian islands and their impact on society • Vog dispersion under various weather systems using numerical models						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation
		• Seasonal and monthly prediction of temperature and precipitation using the Bayesian inference • Seasonal prediction of wildland fire activity for the State of Hawai'i • Sea level forecasting						
	Notable Changes:	None identified.						
	Challenges:	Funded internally but need extramural funds to carry out the tasks outlined in Description; subject to availability of agency funding						
	Opportunities:	None identified.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						
	Hazards:	Flood, Climate Change, Infrastructure Failure, Drought, Health Risks, Windstorm, Hurricane, Volcanic Hazards						
	State HMP Goals:	4	◆		◆			
NATIONAL DISASTER PREPAREDNESS TRAINING CENTER (NDPTC) **Description:** *The NDPTC is a member of the National Domestic Preparedness Consortium (NDPC), which was expanded in 2007 to address all-hazards capabilities by the addition of the University of Hawai`i. The NDPTC is authorized to develop and deliver training and educational programs related to homeland security and disaster management, with a specific focus on natural hazards, coastal communities, and the special needs and opportunities of islands and territories. The NDPTC actively engages internally with FEMA and the University of Hawai`i, as well as with external partners across the region to integrate the delivery of its trainings, products, and services.*								
NDPTC Training Programs	**Capability Category and Description:**	Administrative and Technical The Center has trained more than 35,000 first responders across the nation. In addition to emergency managers and first responders, the Center works closely with urban planners and transportation agencies. The Center has built a nationwide network of subject matter experts, instructors, and training support personnel to facilitate training and adoption of new technologies.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						
	Hazards:	Flood, Climate Change, Infrastructure Failure, Drought, Earthquake, Hazardous Materials, Health Risks, Windstorm, Hurricane, Landslide and Rockfall, Tsunami, Volcanic Hazards, Wildfire						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	State HMP Goals:	4	◆	◆	◆	◆		

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*

Table C-28. Pacific Disaster Center Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Description: *PDC provides the most powerful, global decision support technology, as well as risk and vulnerability assessments, preparedness expertise, training and exercise support, and response capabilities. Our early warning and decision support technology, DisasterAWARE, is being used by decision makers and disaster management practitioners in the State of Hawaiʻi and worldwide for disaster risk reduction, planning and preparedness, operational response, and recovery.* PDC provides a number of technical capabilities described below.								
DisasterAWARE™ [b]	**Capability Category and Description:**	Administrative and Technical Through DisasterAWARE, practitioners have access to PDC's vast data holdings and tools, in a single platform, including: ▪ Customizable early warning notifications and real-time hazard updates ▪ Mapping and visualizations for at-a-glance decision making ▪ Impact, damage, and needs assessment ▪ Risk and vulnerability analysis ▪ Civilian/Military/Interagency sharing and collaboration capabilities ▪ Hundreds of State of Hawaiʻi-specific data layers and thousands globally (e.g. hazard risk areas, critical infrastructure, vulnerable populations, observations and forecasts, etc.) ▪ Historical hazard impact information Custom version for disaster management and humanitarian assistance practitioners: https://emops.pdc.org/emops/ Version accessible to the public: https://disasteralert.pdc.org/disasteralert/						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	Can provide analysis on predictions for climate change impacts						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security; Communications						
	Hazards:	Flood, Climate Change, Infrastructure Failure, Drought, Earthquake, Hazardous Materials, Health Risks, Windstorm, Hurricane, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	4	◆	◆	◆			
Risk and Vulnerability Assessment [b]	**Capability Category and Description:**	Administrative and Technical PDC's RVA enhances the ability of decision makers to anticipate and characterize potential risk and shocks by making visible the socioeconomic, political, cultural, and environmental factors that contribute to risk and resilience. Our RVA methodology is hazard independent and can be run for any hazard type.						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	Provides risk assessments for hazards						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						
	Hazards:	Flood, Climate Change, Infrastructure Failure, Drought, Earthquake, Hazardous Materials, Health Risks, Windstorm, Hurricane, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	4	◆		◆			
Training and Exercise Support [b]	**Capability Category and Description:**	Administrative and Technical PDC provides DisasterAWARE™ training and exercise support to help disaster managers coordinate and test complex networks of response activities—simulating real-world events to ensure stakeholders respond effectively under high-pressure circumstances. We support scenario-based training, tabletop exercises, functional exercises, and full-scale exercises. Exercise capabilities include: ▪ Scenario development, design, and simulation ▪ Event scripting and data integration ▪ Communications and information sharing through DisasterAWARE™ ▪ Subject matter expertise (e.g. best practices, hazard risk, etc.)						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security; Communications						
	Hazards:	Flood, Infrastructure Failure, Drought, Earthquake, Hazardous Materials, Health Risks, Windstorm, Hurricane, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	1, 4	◆		◆			
Response Support [b]	**Capability Category**	Administrative and Technical						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction[a]: Support	Effect on Loss Reduction[a]: Facilitate	Effect on Loss Reduction[a]: Conflict	Provides Funding for Mitigation
	and Description:	With a global mission, PDC supports disaster managers in the State of Hawai'i and worldwide with timely and accurate hazard information. Through custom products, PDC can assess potential impact and needs allowing communities to quickly mobilize the right resources to protect lives and reduce losses. Response capabilities include: ▪ Early warning notification (Email & SMS) ▪ Decision support (DisasterAWARE™) ▪ Custom mapping and products ▪ Hazard modeling ▪ Pre-impact needs assessments ▪ Interagency and civilian/military information sharing ▪ Subject matter expertise (SME; e.g. Comprehensive Disaster Management (CDM), Risk and Vulnerability Assessment (RVA), and Global health hazard evaluation) Decision makers and disaster management practitioners may request PDC response support at response@pdc.org.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	Can provide insight into future needs to increase community resilience to climate change						
	Equitable Outcomes:	Can increase a community's resilience to hazards and climate change						
	Community Lifelines:	Safety and Security; Communications						
	Hazards:	Flood, Infrastructure Failure, Drought, Earthquake, Hazardous Materials, Health Risks, Windstorm, Hurricane, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	1, 4	◆	◆	◆			
Pre- and post-impact modeling[b]	**Capability Category and Description:**	Administrative and Technical Access modeled data through DisasterAWARE™ layers and analytical reports, including pre- and post-impact data, estimated losses and needs estimates for a variety of hazards including but not limited to tsunami travel times, earthquake shaking and intensity, tropical cyclone storm surge, rainfall, and wind impacts, and volcanic ash cloud impacts. PDC's Hazus modeling expertise includes earthquakes, hurricane, flood inundation, and tsunami events. Our capabilities include Hazus modeling for damage and loss estimates, impacts to infrastructure and population, and direct economic losses. We also leverage Hawai'i-specific data for Hazus earthquake modeling that incorporates information about the state's unique built environment.						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	Can provide insight into future needs to increase community resilience to climate change						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security; Communications						
	Hazards:	Earthquake, Flood, Hurricane, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	1, 4	◆	◆	◆			

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*
b. *Identified by the department/agency as one of the most effective capabilities for achieving mitigation goals.*

Table C-29. Pacific Regional Integrated Sciences and Assessments Capabilities

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction[a]: Support	Effect on Loss Reduction[a]: Facilitate	Effect on Loss Reduction[a]: Conflict	Provides Funding for Mitigation
Description: *The RISA program created in 1995 to pioneer innovative mechanisms for enhancing the value of climate information and products for understanding and responding to a variety of challenges associated with climate variability and change at the regional scale. The Pacific RISA program supports Pacific island and coastal communities in adapting to the impacts of climate variability and change. We strive to enhance Pacific communities' abilities to understand, plan for, and respond to changing climate conditions. Our work is conducted through interdisciplinary research and partnerships with local, national, and regional stakeholders.*								
Pacific RISA Projects	**Capability Category and Description:**	Administrative and Technical Pacific RISA is engaged in many projects to support mitigation goals including but not limited to work on regional climate projections, human dimensions of drought, and integrating climate and disaster risk assessments.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	Provides regional climate projections						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security						
	Hazards:	Climate Change, Drought						
	State HMP Goals:	2, 4	◆		◆			
Pacific RISA Education & Outreach	**Capability Category and Description:**	Education, Outreach, and Capacity Building The Pacific RISA website includes a number of education and outreach materials including case studies, "documoments," and a newsletter.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	None identified.						
	Equitable Outcomes:	Provides education opportunity for disadvantaged communities						
	Community Lifelines:	Safety and Security; Communications						
	Hazards:	Climate Change, Drought, Wildfire						
	State HMP Goals:	1, 5	◆		◆			

a. Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.

Table C-30. Pacific Risk Management 'Ohana Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Description: *PRiMO began in 2003 as an effort to explore opportunities to enhance communication and collaboration among the ''Ohana, or family, of local, national, and regional organizations involved in risk management. PRiMO has since transformed into a true collaborative effort governed by a coordinating council of navigators. These key representatives from the region provide leadership, resources, and policy guidance to PRiMO as well as seek institutional support for PRiMO from within their respective organizations.*								
Hui	**Capability Category and Description:**	Administrative and Technical Hui members are experts in their field and together the members bridge the information gaps between science and service providers, decisions makers and other stakeholders. These working groups represent the heart of the PRIMO effort, where the various organizations come together to develop and implement actions plans that improve the resilience of the Pacific region. Hui include: Communications, Health Security, Indigenous Knowledge and the Environment, Information Access and Geospatial technology, Risk Assessment and Planning, and Training and Education.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Effect on Future Conditions:	Implemented actions may improve resiliency to climate change						
	Equitable Outcomes:	None identified.						
	Community Lifelines:	Safety and Security; Health and Medical; Communications						
	Hazards:	Flood, Climate Change, Infrastructure Failure, Drought, Earthquake, Hazardous Materials, Health Risks, Windstorm, Hurricane, Landslide and Rockfall, Tsunami, Volcanic Hazards, Wildfire						
	State HMP Goals:	3	◆		◆	◆		

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*

C.2 State Funding Capabilities Detailed Tables

The following sections provide detailed information presented in Section 5 (Capability Assessment) of the 2023 SHMP Update.

C.2.1 PROJECTS SUBMITTED FOR FEMA FUNDING

Table C-31 shows projects submitted for funding during the performance period of the 2018 SHMP. Table C-32 shows the evaluation of federal funding resources that the state has access to or is eligible to use to fund mitigation efforts.

Table C-31. Projects Submitted for Funding during Performance Period of 2018 SHMP

Grant	DR# or Fiscal Year	Project Name	Subapplicant	Activity Type	Status	Total Project Cost
HMGP	4365	Maui Food Bank Emergency Generator	Maui Food Bank	Generator	Closed	$125,000.00
HMGP	4365	Lāhainā Wastewater Treatment Facility Emergency Generator Replacement	Maui County, Department of Environmental Management	Generator	Open	$845,000.00
HMGP	4365	Volcanic Emission Public Alert	County of Hawaiʻi, Department of Health-UH	Telemetry System	Open	$566,920.00
HMGP	4365	Hawaiʻi State Wiring Code Update	Structural Engineers Association of Hawaiʻi	Hardening	Open	$276,667.00
HMGP	4365	7% Shoreline & Special Management Area Regulations	City and County of Honolulu Office of Climate Change	Planning	Open	$298,409.00
HMGP	4365	Kauaʻi War Memorial Hardening, Phased	Kauaʻi County Department of Parks and Recreation	Envelop Hardening	Open	$35,000.00
HMGP	4365	Honolulu Fire Station Safety Fire Station 7 - Bay Doors Hardening	City and County of Honolulu Fire Department	Envelop Hardening	Open	$321,775.00
HMGP	4366	Planning & Technical Assistance Assessment of the Volcanic Hazard	Hawaiʻi County, Department of Research & Development	Advance Assistance	Closed	$300,000.00
HMGP	4366	7% Long Term Disaster Recovery & Post Disaster Mitigation	City and County of Honolulu Office of Climate Change	Planning	Open	$580,000.00
HMGP	4366	5% High Resolution Numerical Simulation	University of Hawaiʻi Office of Research	Technical Study	Open	$402,022.00
HMGP	4366	5% Near Real Time Wildfire Protection System	University of Hawaiʻi Office of Research	Technical Study	Open	$1,310,281.00
HMGP	4366	5% Shoreline and Riparian Setbacks for Hawaiʻi County Analysis	County of Hawaiʻi, Planning Department	Technical Study	Open	$260,968.00
HMGP	4366	7% Multi-Hazard Mitigation Plan Online Outreach	County of Maui, Emergency Management Agency	Planning	Open	$145,329.00

Grant	DR# or Fiscal Year	Project Name	Subapplicant	Activity Type	Status	Total Project Cost
HMGP	4366	7% Integration of Climate Change Adaption into the 2020 Hazard Mitigation Plan Update	County of Hawaiʻi Civil Defense Agency	Planning	Open	$100,000.00
HMGP	4395	Advance Assistance, Energy & Critical Infrastructure Vulnerability & Resiliency Assessment	State of Hawaiʻi Energy Office	Advance Assistance	Open	$800,000.00
HMGP	4395	7% Oʻahu Resilience Hub Action Plan	City and County of Honolulu	Planning	Open	$285,000.00
HMGP	4365	Oʻahu Tsunami Signage Installation and Educational Outreach - Revised	City and County of Honolulu	Signage and Public Outreach	Open	$822,900.00
HMGP	4365	Advance Assistance, Planning & Technical Assistance Assessment of the Volcanic Hazard	County of Hawaiʻi	Advance Assistance	Closed	$300,000.00
HMGP	4366	County of Hawaiʻi, Public Safety Building Floodproofing	County of Hawaiʻi, Police Department	Dry Floodproofing	Open	$216,254.00
HMGP	4604	Hardening of Parker No. 2, Waiaha and Lalamilo B Wells	County of Hawaiʻi, Department of Water Supply	Transfer switches	Open	$315,000.00
HMGP	4366	Pacific Tsunami Museum Advance Assistance Dry Flood Proofing	Pacific Tsunami Museum	Dry Floodproofing	Open	$45,500.00
HMGP	4366	Komohana Research and Extension Center Retrofits, Phased	University of Hawaiʻi	Envelop Hardening	Open	$606,343.88
HMGP	4366	Waianuenue Bridge Modernization, Phased	County of Hawaiʻi, Department of Public Works	Seismic Hardening	Open	$2,070,000.00
HMGP	4366	Wastewater Treatment Facility Generators	County of Hawaiʻi	Generator	Open	$1,834,757.00
HMGP	4395	County Honolulu Department of Water Supply Miliani Well Generator	City and County of Honolulu, Board of Water Supply	Generator	Open	$1,050,000.00
HMGP	4549	Hanalei Hill Emergency Access Road Phased	Kauaʻi Emergency Management Agency	Hardening	Under FEMA Review	$204,443.00
HMGP	4604	Wailuku Wastewater Pump Station Hardening	County of Maui	Hardening	Under FEMA Review	$964,645.00
BRIC	2020	Kaimuki Middle School Microgrid, with Kapiolani Community College Resilient Power System	Honolulu Office of Climate Change, Sustainability and Resiliency	Microgrid	Open	$375,000.00

Grant	DR# or Fiscal Year	Project Name	Subapplicant	Activity Type	Status	Total Project Cost
BRIC	2020	Board of Water Supply Emergency Power Master Plan	City and County of Honolulu, Board of Water Supply	Planning	Open	$75,000.00
BRIC	2020	Wastewater Options for Sea Level Rise	Honolulu Office of Climate Change, Sustainability and Resiliency	Technical Study	Open	$150,000.00
PDM	2019	Advance Assistance - City Facilities	Honolulu Office of Climate Change, Sustainability and Resiliency	Planning	Open	$166,667.00
PDM	2019	State Hazard Mitigation Plan Update	HI-EMA	HM Plan Update	Open	$267,000.00
BRIC	2021	C&C Multi-Hazard Mitigation Plan Update	Honolulu Office of Climate Change, Sustainability and Resiliency	HM Plan Update	Under FEMA Review	$262,500.00
BRIC	2021	Kapalama Canal Flood Control Project Scoping	Honolulu Office of Climate Change, Sustainability and Resiliency	Scoping	Under FEMA Review	$393,750.00
BRIC	2021	Hawaiʻi Department of Transportation Scoping Activity - Airport Microgrids and Transportation Resilience	Hawaiʻi Department of Transportation, Airports	Scoping	Under FEMA Review	$492,187.50
HMGP	5404	Community Defensible Space and Hazardous Fuels Reduction Phased	County of Hawaiʻi	Fire Mitigation	Under FEMA Review	$778,777.00
HMGP	4510	Molokaʻi High School Gym Retrofit	HI-EMA	Wind Retrofit	Under FEMA Review	$7,217,780.52
HMGP	4510	Waialua High School Shelter Retrofit	HI-EMA	Wind Retrofit	Under FEMA Review	$5,761,290.51
HMGP	4510	Laupāhoehoe School Wind Retrofit	HI-EMA	Wind Retrofit	Under FEMA Review	$2,102,149.81
HMGP	4510	Advance Assistance, Residential Retrofit Program	HI-EMA	Advance Assistance	Under FEMA Review	$899,815.50
HMGP	4510	Emergency Power Transfer Switching Capability for Critical Water Infrastructure	County of Hawaiʻi, Department of Water Supply	Transfer switches	Under FEMA Review	$702,000.00
HMGP	4510	7% Flood Forecast System	University of Hawaiʻi	Planning	Under FEMA Review	$985,300.00
HMGP	4510	Advance Assistance, Maui Dune Restoration	University of Hawaiʻi	Advance Assistance	Under FEMA Review	$235,760.00
HMGP	4510	5% Aloha Safe Homes Education and Outreach	University of Hawaiʻi	5% Initiative	Under FEMA Review	$210,785.00
HMGP	4510	5% Aloha Safe Homes Community Behavior	University of Hawaiʻi	5% Initiative	Under FEMA Review	$214,925.00
HMGP	4510	Pali Momi Hospital Generators	Pali Momi Medical Center	Generator	Under FEMA Review	$6,516,000.00

Grant	DR# or Fiscal Year	Project Name	Subapplicant	Activity Type	Status	Total Project Cost
HMGP	4510	Adventist Health Castle Hospital Generator	Adventist Health Castle	Generator	Under FEMA Review	$5,497,545.00
HMGP	4510	County of Hawaiʻi Fire Department Station Generators	County of Hawaiʻi Fire Department	Generator	Under FEMA Review	$2,557,045.21
HMGP	4510	7% Climate Change Community Resilience	County of Kauaʻi Planning Department	Planning	Under FEMA Review	$363,960.00
HMGP	4510	County of Kauaʻi Coco Palms Resort Acquisition	Kauaʻi Emergency Management Agency	Acquisition	Under FEMA Review	$9,000,000.00

Table C-32. Evaluation of Funding Resources for Mitigation Efforts

Funding Program	Funding Agency	Pre-Disaster	Post-Disaster
Hazard Mitigation Grant Program (HMGP)	FEMA		◆
	Description: *To provide funds to states, territories, Indian tribal governments, and communities to significantly reduce or permanently eliminate future risk to lives and property from natural hazards. HMGP funds projects in accordance with priorities identified in state or local hazard mitigation plans, and enables mitigation measures to be implemented during the recovery from a disaster.*		
Building Resilient Infrastructure and Communities (BRIC)	FEMA	◆	
	Description: *To provide funds to states, territories, tribal governments, and communities for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event. Funding these plans and projects reduces overall risks to the population and structures, while also reducing reliance on funding from actual disaster declarations.*		
Flood Mitigation Assistance Grant (FMA)	FEMA	◆	
	Description: *To implement cost-effective measures that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insured under the National Flood Insurance Program (NFIP).*		
Post-Disaster Economic Recovery Grants and Assistance	Economic Development Administration		◆
	Description: *Grant funding to assist with the long-term economic recovery of communities, industries, and firms adversely impacted by disasters.*		
U.S. Small Business Administration Loan Programs	Small Business Administration		◆
	Description: *Small Business Administration (SBA) provides low-interest disaster loans to homeowners, renters, business of all sizes, and most private nonprofit organizations. SBA disaster loans can be used to repair or replace the following items damaged or destroyed in a declared disaster: real estate, personal property, economic injury, machinery and equipment, and inventory and business assets. Funding: Homeowners may apply for up to $200,000 to replace or repair their primary residence. Renters and homeowners may borrow up to $40,000 to replace or repair personal property-such as clothing, furniture, cars, and appliances – damaged or destroyed in a disaster. Physical disaster loans of up to $2 million are available to qualified businesses or most private nonprofit organizations.*		

Funding Program	Funding Agency	Pre-Disaster	Post-Disaster
Public Assistance Grants	FEMA		◆
	Description: *Grants for the repair, replacement, or restoration of disaster-damaged, publicly owned facilities and the facilities of certain private nonprofit organizations. Mitigation funding is available for work related to damaged components of eligible buildings/structures.*		
Community Development Block Grants Program (Non-entitled Counties)	U.S. HUD	◆	
	Description: *In the State of* Hawaiʻi, *three counties qualify for this program -* Hawaiʻi, *Kauaʻi, and Maui. Funds are allocated using a formula based on population, poverty, and housing overcrowding, with the poverty factor carrying a double weight. CDBG funds may be used for activities which include, but are not limited to:* ▪ Acquisition of real property ▪ Relocation and demolition ▪ Rehabilitation of residential and non-residential structures ▪ Construction of public facilities and improvements, such as water and sewer facilities, streets, neighborhood centers, and the conversion of school buildings for eligible purposes ▪ Public services, within certain limits ▪ Activities relating to energy conservation and renewable energy resources ▪ Provision of assistance to nonprofit and profit-motivated businesses to carry out economic development and job creation/retention activities *Each activity must meet one of the following national objectives for the program: benefit low- and moderate-income persons, prevention or elimination of slums or blight, or address community development needs having a particular urgency because existing conditions pose a serious and immediate threat to the health or welfare of the community for which other funding is not available*		
Community Development Block Grants/ Entitlement Grants	U.S. HUD	◆	
	Description: *The City and County of Honolulu qualifies for this program. Grants to entitled cities and urban counties to develop viable communities (e.g., decent housing, suitable living environments, expanded economic opportunities), principally for low- and moderate-income persons. Activities as the same as for the non-entitled counties.*		
Community Development Block Grant Disaster Recovery Program	U.S. HUD		◆
	Description: *HUD provides flexible grants to help cities, counties, and States recover from Presidentially declared disasters, especially in low-income areas, subject to availability of supplemental appropriations. In response to Presidentially declared disasters, Congress may appropriate additional funding for the Community Development Block Grant (CDBG) Program as Disaster Recovery grants to rebuild the affected areas and provide crucial seed money to start the recovery process.*		
Public Housing Capital Fund Emergency/Natural Disaster Funding	U.S. HUD		◆
	Description: *Funding to public housing agencies that confront an emergency situation or a natural disaster.*		
Single Family Housing Repair Loans and Grants (Section 504 Rural Housing Loans and Grants)	U.S. Department of Agriculture	◆	◆
	Description: *Repair loans, grants, and technical assistance for very low-income homeowners living in rural areas to repair their homes and remove health and safety hazards.*		

Funding Program	Funding Agency	Pre-Disaster	Post-Disaster
Guaranteed Single Family Housing Loans (Section 502 Rural Housing Loans)	U.S. Department of Agriculture	◆	
	Description: *Also known as the Section 502 Direct Loan Program, this program assists low- and very-low-income applicants obtain decent, safe and sanitary housing in eligible rural areas by providing payment assistance to increase an applicant's repayment ability.*		
Farm Ownership Loans	U.S. Department of Agriculture	◆	
	Description: *Direct loans, guaranteed/insured loans, and technical assistance to farmers to develop, construct, improve, or repair farm homes, farms, and service buildings and to make other necessary improvements.*		
HOME Investment Partnerships Program	U.S. HUD	◆	
	Description: *Grants to states, local government, and consortia for permanent and transitional housing (including support for property acquisition, improvements, demolition, and relocation) for very low and low-income persons.*		
Rural Development Assistance—Housing	U.S. Department of Agriculture		◆
	Description: *Grants, loans, and technical assistance for addressing rehabilitation and health and safety needs in primarily low-income rural areas. Declaration of major disaster necessary.*		
Rural Development Assistance—Utilities	U.S. Department of Agriculture	◆	
	Description: *Direct and guaranteed rural economic loans and business enterprise grants to address utility issues and development needs.*		
Assistance—Community Facility Direct Loans/Grants	U.S. Department of Agriculture	◆	
	Description: *Grants, direct and guaranteed loans, and technical assistance to construct, enlarge, or improve community facilities for healthcare, public safety, and public services in primarily low-income rural areas.*		
Community Development Block Grant—Section 108 Loan Guarantees	U.S. HUD	◆	
	Description: *Loan guarantees to public entities for economic development, housing rehabilitation, public facilities, and large-scale physical development projects (including mitigation measures).*		
Homeland Security Grant Program	FEMA	◆	
	Description: *Grants to enhance the ability of states, territories, and urban areas to prepare for, prevent, and respond to terrorist attacks and other major disasters. Includes State Homeland Security Program, Urban Areas Security Initiative, Law Enforcement Terrorism Prevention Program, Metropolitan Medical Response System, and Citizen Corps Program grant programs.*		
Infrastructure Protection Program	FEMA	◆	
	Description: *Grants to strengthen the nation's ability to protect critical infrastructure facilities and systems. Includes Transit Security Grant Program, Port Security Grant Program, Intercity Bus Security Grant Program, Trucking Security Program, and Buffer Zone Protection Program grant programs.*		
Assistance to Firefighters Grant Program	FEMA	◆	
	Description: *Grants to local fire departments to protect citizens and firefighters against the effects of fire and fire-related incidents*		
Fire Prevention and Safety Grant	FEMA	◆	

Funding Program	Funding Agency	Pre-Disaster	Post-Disaster
Program	***Description:*** *Grants for projects that enhance the safety of the public and firefighters from fire and related hazards. The primary goal is to target high-risk populations and mitigate high incidences of death and injury.*		
Fire Management Assistance Grant Program	FEMA		◆
	Description: *Grants for the mitigation, management, and control of fires on publicly or privately owned forests or grasslands, which threaten such destruction as would constitute a major disaster.*		
Hazardous Materials Emergency Preparedness Program	U.S. Department of Transportation	◆	
	Description: *Project grants and technical assistance to enhance hazardous materials emergency planning and training*		
Nonstructural Alternatives to Structural Rehabilitation of Damaged Flood Control Works	U.S. Army Corps of Engineers		◆
	Description: *Direct planning and construction grants for nonstructural alternatives to the structural rehabilitation of flood control works damaged in floods or coastal storms.*		
Reimbursement for Firefighting on Federal Property	U.S. Fish and Wildlife Service		◆
	Description: *Provides reimbursement only for direct costs and losses over and above normal operating costs.*		
National Dam Safety Program	FEMA	◆	
	Description: *National Dam Safety Program (NDSP). The NDSP, which is led by FEMA, is a partnership of the states, federal agencies, and other stakeholders to encourage individual and community responsibility for dam safety. Grant assistance to the States: Provides vital support for the improvement of the State dam safety programs that regulate most of the dams in the United States.*		
Land and Water Conservation Fund	Land and Water Conservation Fund	◆	
	Description: *Funding to states for outdoor recreational development, renovation, land acquisition, and planning. Funding: The fund is authorized at $900 million annually, a level that has been met only twice during the program's 40-year history. The program is divided into two distinct funding pots: state grants and federal acquisition funds.*		
The Forest Legacy Program	U.S. Forest Service	◆	
	Description: *Federal program in partnership with states supports efforts to protect environmentally sensitive forest lands. Designed to encourage the protection of privately owned forest lands, Forest Legacy is an entirely voluntary program. To maximize the public benefits it achieves, the program focuses on the acquisition of partial interests in privately owned forest lands. Forest Legacy helps states develop and carry out their forest conservation plans. It encourages and supports acquisition of conservation easements, legally binding agreements transferring a negotiated set of property rights from one party to another, without removing the property from private ownership. Most Forest Legacy Program conservation easements restrict development, require sustainable forestry practices, and protect other values. Funding: To qualify, landowners are required to prepare a multiple resource management plan as part of the conservation easement acquisition. The federal government may fund up to 75% of project costs, with at least 25% coming from private, state, or local sources. In addition to gains associated with the sale or donation of property rights, many landowners also benefit from reduced taxes associated with limits placed on land use.*		
Transportation Trust	Federal Highway Administration	◆	

Funding Program	Funding Agency	Pre-Disaster	Post-Disaster
Fund	***Description:*** *Transportation Trust Fund funds grants through a competitive application-based process administered by the Local Aid District Offices. County Aid Program- Administer the County Aid Program for road and bridge infrastructure improvements under county jurisdiction. Each County receives an annual formula based allotment that takes into consideration county road lane mileage and population. The County Aid Program is funded through the Transportation Trust Fund and provides funding for eligible costs of projects included in the county's approved Annual Transportation Program.*		
Department of Homeland Security Grant Program (HSGP)	Department of Homeland Security	◆	
	Description: The Homeland Security Grant Program (HSGP) plays an important role in the implementation of the National Preparedness System by supporting the building, sustainment, and delivery of core capabilities essential to achieving the National Preparedness Goal of a secure and resilient nation. HSGP is composed of three interconnected grant programs including the State Homeland Security Program (SHSP), Urban Areas Security Initiative (UASI), and the Operation Stonegarden (OPSG). Together, these grant programs fund a range of preparedness activities, including planning, organization, equipment purchase, training, exercises, and management and administration.		
Emergency Management Performance Grant Program (EMPG)	Department of Homeland Security	◆	
	Description: Grants are available to State, local, territorial, and tribal governments in preparing for all hazards. The Federal Government, through the EMPG Program, provides necessary direction, coordination and guidance, and provides necessary assistance, as authorized so that a comprehensive emergency preparedness system exists at all levels for all hazards.		
Coastal Resilience Grants	NOAA	◆	
	Description: The NOAA Coastal Resilience Grants program supports projects that increase coastal resilience and restore habitat.		
Small Civil Works Projects; Continuing Authorities Program (CAP)	U.S. Army Corps of Engineers	◆	
	Description: The Secretary of the Army has been delegated the authority to plan, design, and construct certain types of water resource and environmental restoration projects without specific Congressional authorization. Each authority has its own requirements and strict limits on responsibilities and financial contributions of the federal partners: (Section 14—Emergency Streambank and Shoreline Erosion; (2) Section 103—Hurricane and Storm Damage Reduction; (3) Section 107—Small Navigation Improvements; (4) Section 111—Shore Damage Attributable to Federal Navigation Projects; (5) Section 204—Regional Sediment Management & Beneficial Uses of Dredges Materials; (6) Section 205—Small Flood Damage Reduction Projects; (7) Section 206—Aquatic Ecosystem Restoration; (8) Section 208—Snagging and Clearing for Flood Control; (9) Section 1135—Project Modification for Improvement of the Environment (USACE no date). Submittal deadlines are typically in May-June. Cost shares are typically 50% for feasibility and 65% for construction. Most projects are less than $15,000,000.		
Cooperative Forestry State Fire Assistance	US Forest Service	◆	
	Description: The Cooperative Forestry program manages a number of programs including The Forest Stewardship Program, The Forest Legacy Program, The Community Forest Program, The Urban and Community Forestry Program, Ecosystem Services and Markets, and Wood Innovations		
Tsunami Mitigation Program	NOAA	◆	

Funding Program	Funding Agency	Pre-Disaster	Post-Disaster
	Description: The National Tsunami Hazard Mitigation Program (NTHMP) is a Federal and State program designed to protect people and reduce property losses in the event of a tsunami. Led by the National Oceanic and Atmospheric Administration (NOAA), the NTHMP consists of other primary participants, including FEMA. This program is currently expanding to include 17 new coastal U.S. States, territories, and commonwealths at some level of risk to tsunamis along the Atlantic and the Gulf of Mexico, and elsewhere in the Pacific Ocean.		
Cooperating Technical Partners (CTP) Program	FEMA	◆	
	Description: *With over 20,000 communities in the National Flood Insurance Program (NFIP), there is a significant challenge keeping flood hazard maps current. The CTP Program is an innovative approach to creating partnerships between FEMA and participating NFIP communities, regional agencies, state agencies, tribes and universities that have the interest and capability to become more active participants in the FEMA flood hazard mapping program. Each fiscal year, FEMA issues a Notice of Funding Opportunity (NOFO) document to announce the availability of the CTP cooperative agreement funding opportunity. The NOFO describes the available funding, priorities, requirements and process for eligible applicants to request funding for program activities.*		
Earthquake Hazards Reduction State Assistance Program	FEMA, National Earthquake Hazards Reduction Program (NEHRP)	◆	
	Description: *The Earthquake Hazards Reduction State Assistance Program is one part of FEMA's activities under the NEHRP Reauthorization Act of 2004, which directs the agency to support state efforts to mitigate seismic risks and thereby reduce future losses from earthquakes. FEMA provides program funds annually to states and U.S. territories that face serious earthquake hazards and that develop ways to effectively reduce risks posed by these hazards.*		
Justice 40	Executive Order	◆	◆
	Description: *Executive Order 14008 established the Justice40 Initiative, making it a goal that 40-percent of the overall benefits of certain Federal investments flow to disadvantaged communities that are marginalized, underserved, and overburdened by pollution. The categories of investment are: climate change, clean energy and energy efficiency, clean transit, affordable and sustainable housing, training and workforce development, remediation and reduction of legacy pollution, and the development of critical clean water and wastewater infrastructure.*		
Infrastructure Investment and Jobs Act (IIJA)	Public Law	◆	◆
	Description: *The IIJA, most commonly known as the Bipartisan Infrastructure Bill and originally in the House as the INVEST in America Act (H.R. 3684) was signed into law by President Biden in November 2021. Various funds are expected to be made available through this Act to support hazard mitigation, including funding and programs related to carbon reduction.*		

C.3 State Pre- and Post-Disaster Capabilities and Core Mitigation Capabilities

The National Preparedness Goal (FEMA 2020) identifies seven core capabilities for the mitigation mission area:

- **Threats and Hazard Identification**—Identify the threats and hazards that occur in the geographic area; determine the frequency and magnitude; and incorporate this into analysis and planning processes so as to clearly understand the needs of a community or entity
- **Risk and Disaster Resilient Assessment**—Assess risk and disaster resilience so that decision makers, responders, and community members can take informed action to reduce their entity's risk and increase their resilience
- **Planning**—Conduct a systematic process engaging the whole community as appropriate in the development of executable strategic, operational, and/or tactical-level approaches to meet defined objectives
- **Community Resilience**—Enable the recognition, understanding, communication of, and planning for risk and empower individuals and communities to make informed risk management decisions necessary to adapt to, withstand, and quickly recover from future incidents
- **Public Information & Warning** —Deliver coordinated, prompt, reliable, and actionable information to the whole community through the use of clear, consistent, accessible, and culturally and linguistically appropriate methods to effectively relay information regarding any threat or hazard and, as appropriate, the actions being taken and the assistance being made available
- **Long-term Vulnerability Reduction**—Build and sustain resilient systems, communities, and critical infrastructure and key resources lifelines so as to reduce their vulnerability to natural, technological, and human-caused threats and hazards by lessening the likelihood, severity, and duration of the adverse consequences
- **Operational Coordination**—Establish and maintain a unified and coordinated operational structure and process that appropriately integrates all critical stakeholders and supports the execution of core capabilities.

Table C-33 shows the State of Hawai‘i mitigation capabilities and the mitigation mission area core capability that they support. This information is included to support the development and enhancement of the State of Hawai‘i THIRA and State Preparedness Report.

Table C-33. State of Hawaiʻi Mitigation Capabilities by Mitigation Core Capability

	Mitigation Core Capabilities						
Capability	Threats & Hazard Identification	Risk & Disaster Resilient Assessment	Planning	Community Resilience	Public Information & Warning	Long-term Vulnerability Reduction	Operational Coordination
Aircraft Alert System (HI-EMA)					◆		
Building Code Committee (SEAOH)						◆	
Building Code Council (DAGS)						◆	◆
Capital Improvements Budget (DBF)			◆			◆	
Clean Water Act Section 401 Water Quality Certifications (DOH EHA)					◆		
Climate 21C (OCCL)	◆	◆	◆	◆	◆	◆	
Coastal Lands Program (OCCL)		◆		◆		◆	
Coastal Zone Management Program (OP)	◆		◆	◆		◆	
Commission on Water Resources Management (CWRM)	◆	◆	◆			◆	◆
Community Development District Program (HCDA)			◆				
Critical Systems Vulnerability Assessment (HI-EMA)	◆	◆	◆			◆	
Dam Safety Program (Engineering)		◆	◆		◆	◆	
Damage Assessments (DAGS)		◆		◆			
Department Emergency Operations Plan Template (HI-EMA)			◆				
Department of Hawaiian Home Lands Land Trust (DHHL)	◆		◆	◆			
Department of Health All-Hazards Training and Exercise Program (DOH HRA)	◆	◆					◆
Department Operations Center (HI-EMA) Planning Guidance and Resources (HI-EMA)			◆				
Disaster Response Committee (SEAOH)		◆		◆			
Energy Assurance Program (HSEO)	◆	◆	◆			◆	
Epidemiological Surveillance (DOH HRA)	◆	◆					◆

Capability	Mitigation Core Capabilities						
	Threats & Hazard Identification	Risk & Disaster Resilient Assessment	Planning	Community Resilience	Public Information & Warning	Long-term Vulnerability Reduction	Operational Coordination
Fire Program (DOFAW)	◆	◆	◆	◆	◆	◆	
Forestry Program (DOFAW)	◆	◆	◆	◆		◆	
Geography Department (UH)	◆				◆		
Get Ready Website (HI-EMA)				◆	◆		
GoHawaiʻi Mobile App (HTA)					◆		
Hawai`i Environmental Policy Act (DOH OEQC)			◆			◆	
Hawai`i Emergency Planning and Community Right to Know Act (DOH EHA)				◆	◆		
Hawaiʻi Advisory Council on Emergency Management (HI-EMA)	◆	◆					◆
Hawaiʻi Catastrophic Hurricane Plan (HI-EMA)			◆				◆
Hawaiʻi Earthquake & Tsunami Advisory Committee (HI-EMA)		◆				◆	◆
Hawaiʻi Hazards Awareness and Resilience Program (HI-EMA)		◆	◆	◆	◆		
Hawaiʻi Institute of Geophysics and Planetology (UH)	◆	◆			◆		
Hawaiʻi State Legislature Grant-in-Aid Program (HSL)		◆	◆	◆		◆	
Hawaiʻi State Legislature Senate Resolution 35 (HSL)		◆	◆	◆		◆	
Hawaiʻi State Planning Act (OP)			◆	◆		◆	◆
Hawaiʻi Statewide Geographic Information System Program (OPSD)	◆	◆	◆				◆
Hazardous Materials Risk Management Program (HDOT)					◆		
Hazardous Waste Section Regulations (DOH EHA)	◆						◆
Hospital Preparedness Program (DOH HRA)		◆	◆				◆
Immunization Programs (DOH HRA)				◆	◆		
Laboratory Preparedness and Response Program		◆	◆				◆

Capability	Mitigation Core Capabilities						
	Threats & Hazard Identification	Risk & Disaster Resilient Assessment	Planning	Community Resilience	Public Information & Warning	Long-term Vulnerability Reduction	Operational Coordination
(DOH HRA)							
Land Acquisition Program (DAGS)						◆	
Mandatory Seller Disclosures in Real Estate Transactions (DCCA)	◆				◆		
Mass Feeding Operations (DOH EHA)							◆
Medical Countermeasure Points of Distribution (DOH HRA)			◆				◆
National Disaster Preparedness Training Center (UH)				◆			◆
National Flood Insurance Program (Engineering)	◆	◆	◆	◆		◆	◆
Native Ecosystems and Management (DOFAW)				◆		◆	
Natural Disaster Economic Recovery Strategy (HI-EMA)		◆	◆	◆			
NPDES Wastewater Discharge Permits (DOH EHA)						◆	
Pacific Disaster Center Technical Capabilities (PDC)	◆	◆	◆	◆			
Pacific Risk Management ‘Ohana (PRiMO)	◆	◆	◆	◆		◆	
Pacific RISA (Pacific RISA)	◆	◆			◆		
Polluted Runoff Control Program (DOH EHA)						◆	
Radiation Section- Radiation Assessment Team (DOH EHA)		◆					
Risk MAP (Engineering)	◆	◆	◆			◆	
Roadside Fuel Reduction Program (HDOT)				◆			
Safe Drinking Water Emergency FAQs (DOH EHA)					◆		
School of Ocean and Earth Science Technology (UH)	◆	◆	◆	◆	◆		
Shelter Upgrade Program (DAGS)				◆			
Shoreline Certification (Land Division)						◆	
Silver Jackets (Engineering)			◆				◆

Capability	Mitigation Core Capabilities						
	Threats & Hazard Identification	Risk & Disaster Resilient Assessment	Planning	Community Resilience	Public Information & Warning	Long-term Vulnerability Reduction	Operational Coordination
State Board of Land and Natural Resources (BLNR)						◆	
State Fire Council (SFC)	◆					◆	◆
State Land Use Law (OPSD)			◆			◆	
State Mitigation Forum (HI-EMA)		◆	◆			◆	◆
State of Hawaiʻi Emergency Operations Plan (HI-EMA)			◆				◆
State-owned Building Insurance (DAGS)				◆			
The Center for the Study of Active Volcanoes (UH)	◆				◆		
Threat Hazard Identification and Risk Assessment (HI-EMA)	◆		◆				
Training & Exercise Plan (HI-EMA)			◆		◆		◆
Transportation Asset Climate Change Risk Assessment Project (O’ahu MPO)			◆				
Underground Storage Tank Section Regulations (DOH EHA)	◆						
Vector Control Program (DOH EHA)		◆					
Weatherization Assistance Program (OCS)				◆	◆		
Western States Seismic Policy Council (HI-EMA)		◆				◆	

Acronym in parenthesis refers to the state department detail table under which the capability is discussed (see Section C.1 (State Capability Assessment Detailed Tables). Listing under a particular department or agency should not be construed to imply that the department is the sole administrator of the capability. Additionally, in some instances the capability is associated with the duties of the department but the department does not have administrative authority over the capability.

C.4 Criteria for Prioritizing Planning and Project Grants

- HI-EMA and the State Hazard Mitigation Forum (Forum) recognized the need to implement a new method of funding prioritization with this 2023 SHMP Update. The updated funding prioritization method clearly identifies potential scoring to make the prioritization process easier to understand for the subapplicants and the reviewers at HI-EMA and on the Forum.

C.4.1 SUBAPPLICATION/APPLICATION REVIEW

HI-EMA issues a Notice of Interest (NOI) soliciting proposals from potential State, local or non-profit entities interested in Hazard Mitigation Assistance (HMA) funding. These subapplications are part of the overall State application to FEMA. HI-EMA reviews the NOI proposals to ensure they are complete, technically feasible, and fall within the HMA program priorities. After HI-EMA completes its eligibility review, including clarifying follow-up questions, the Administrator invites all eligible subapplicants to proceed with the full application process. HI-EMA staff members provide technical assistance and guidance in completing a full, eligible subapplication within the allotted timeframe. The Forum reviews all complete, eligible submissions and performs a funding prioritization analysis. The resultant ranked subapplications are included in the State application and are submitted to the Administrator for concurrence before submission to FEMA.

C.4.2 SUBAPPLICATION/APPLICATION PRIORITIZATION

HI-EMA requests that the County emergency management agencies review the HMA plan/project subapplications from their County prior to submitting to the State for review. Since these agencies have ex officio representatives on the Forum, they can provide guidance on County priorities. The Forum then utilizes the following tables to conduct its prioritization analysis of plan/project subapplications before submitting the full State application to FEMA. The following tables are based upon the current FEMA evaluation criteria for each funding program, and also reflects the priorities of the State.

Table C-34. Summary of Total Potential Scores per Subapplication

	BRIC	HMGP	FMA	HHPD
Base Score	100	100	100	100
Additional Scoring	20	15	10	25
Total Potential Score	**120**	**115**	**110**	**125**

Table C-35. Funding Prioritization Base Table for FEMA BRIC, HMGP, FMA, and HHPD Subapplications

	Topic	Criteria	Score
1	**Capacity to Implement**	The subapplication describes that the subapplicant has the capacity needed to implement and manage the plan/project.	25
2	**Alignment with SHMP Objectives**	The subapplication describes which State HMP objectives the plan/project aligns with.	20
3	**Socially Vulnerable Population Impacted**	The plan/project advances mitigation for socially vulnerable populations, identified by using the social vulnerability index in the SHMP.	15
4	**Climate Change and Future Conditions**	The subapplication describes how the plan/project will enhance climate adaptation and resilience, details how the project is being responsive to the effects of climate change and other future conditions (population, demographic, land use, or location, intensity, and frequency of hazard events), and cites data sources, assumptions, and models. If a project, incorporates anticipated future changes into the project design.	10
5	**Community Engagement and Outreach**	The subapplication describes how outreach was conducted to the public and stakeholders discussing the plan/project prior to application.	10

	Topic	Criteria	Score
6	**Nature-based Solutions**	If the project is structural, the subapplication describes how it incorporates nature-based solutions.	10
7	**Advanced Assistance**	Was the plan/project awarded FEMA funding to support project scoping through advanced assistance?	10

Table C-36. Additional Scoring for Building Resilient Infrastructure and Communities (BRIC) Subapplications

	Topic	Criteria	Score
1	**Risk Reduction/Resilience Effectiveness**	The subapplication shows how the project will reduce risk and advance resiliency through innovative methods while addressing inequities and support to those with the greatest need.	10
2	**Community Engagement and Other Outreach Activities**	The subapplication describes the outreach strategy and supporting activities that advance mitigation, including engagement of diverse stakeholders and socially vulnerable communities.	5
3	**Leveraging Partners**	The project subapplication incorporates partnerships (e.g., state, native, private, local community, etc.) that will ensure the project meets community needs, including those of vulnerable populations, and show the outcome of those partnerships (e.g., leveraging resources such as financial, material, and educational resources, coordinating multijurisdictional projects, focus on equity related issues, etc.)	5

Table C-37. Additional Scoring for Hazard Mitigation Grant Program (HMGP) Subapplications

	Topic	Criteria	Score
1	**Project Area**	The plan/project will benefit the region impacted by the federal disaster declaration.	10
2	**Previous Submittal**	The plan/project subapplication was previously submitted under another FEMA grant program but not awarded; and still considered a priority.	5

Table C-38. Additional Scoring for Flood Mitigation Assistance (FMA) Subapplications

	Topic	Criteria	Score
1	**Repetitive Loss Properties**	The subapplication includes substantially damaged, repetitive, and severe repetitive loss properties	10

	Topic	Criteria	Score
		that will be mitigated by the project.	

Table C-39. Additional Scoring for High Hazard Potential Dam (HHPD) Subapplications

	Topic	Criteria	Score
1	**Project Benefitting Area—Residential Homes**	The project provides increased protection and safety to residential homes	10
2	**Project Benefitting Area—Community Lifelines**	The project provides increased protection and safety to community lifelines	10
3	**Project Benefitting Area—Economic Centers**	The project provides increased protection to economic centers	5

C.5 Local Capability Assessment Detailed Table

County policies, programs, funding, and other capabilities are used to support and accomplish hazard mitigation goals and objectives. A list of foundational capabilities for hazard mitigation was developed based on FEMA local mitigation planning guidance, professional judgement, and suggestions from the State Hazard Mitigation Forum. This list was not intended to be inclusive of every capability discussed in the local HMPs or every capability that may be used to support hazard mitigation at the local level.

Table C-40 includes a summary of foundational capabilities relevant for hazard mitigation in the State and if these capabilities were identified and discussed in the County local HMPs. The text included provides details on how the capability was discussed/addressed in the local plan and does not account for inaccuracies in this discussion. It is important to note that the absence of a capability does not mean that the capability does not exist in the county. It simply means that no discussion was found describing or identifying the capability in the local HMP. This suggests that the capability may not be used to its full potential to support mitigation within the County or it may suggest that the department or agency responsible for implementing the capability may not have been fully involved in the local HMP planning process. In addition, it is important to note that codes, regulations, and/or plans may have been updated since the time of their publication. Notes are provided below the table on some such updates. In addition, please note that some of the capabilities included are local level capabilities, while others are state programs and/or regulations.

Table C-40. Foundational Capabilities as Identified and Reflected in County Local Hazard Mitigation Plans

Foundational Capability	County of Kauaʻi	City and County of Honolulu	County of Maui	County of Hawaiʻi
Building Code [a]	**Yes** 2018 IBC/IRC	**Yes** Based on the 2006 IBC with amendment provisions relating to hurricane and flood preventative design measures	**Yes** 2006 IBC and IRC as amended	**Yes** County in process of adopting 2012 IBC as per HAR State Building Code
Capital Improvement Program	**Yes** Considering ways to leverage resources for improving facilities and to partner for improving communication systems in the county	**Yes** Discusses including hazard mitigation projects in CIP	**Yes** Maui County Code Title 3, Chapter 3.04.040 – Capital Program	**Yes** Discusses including hazard mitigation projects in CIP

Foundational Capability	County of Kauaʻi	City and County of Honolulu	County of Maui	County of Hawaiʻi
Climate Action/Resilience Plan	**Yes** County of Kauaʻi Climate Adaptation Plan – ongoing County of Kauaʻi Multi-Hazard Mitigation and Resilience Plan (2021); Hanalei Watershed Hui Community Disaster Resilience Plan	**Yes** Oʻahu's Resilience Strategy which will include the City's first-ever climate action and adaptation plan	**No**	**No**
Community Development Plans	**Yes** Climate change and coastal hazards assessment to be incorporated into three community development plans	**Yes** Natural hazard policies for Community Development Plans	**Yes** Risk assessment results presented at Community Plan level so that information can be integrated as appropriate	**Yes** The HMP is incorporated into Community Development Plans to make all natural hazards explicit factors for planning
Community Wildfire Protection Plan	**Yes** Community Wildfire Protection Plan for Kauaʻi County (2016);	**Yes** West Oʻahu Community Wildfire Protection Plan	**Yes** Currently CWPPs are in place for Molokaʻi, South Maui, Upcountry, and Western Maui	**Yes** Plans for Kaʻu, South Kona, North Kona, Northwest Hawaiʻi, Ocean View, and Hawaiʻi Volcanoes National Park
Continuity of Operations Plan	**Yes** Trainings offered to Kauaʻi Visitor and Business Industry, considering training for county agency being considered	**No**	**No**	**Yes**
County Owned Building Insurance	**No**	**No**	**No**	**No**

Foundational Capability	County of Kauaʻi	City and County of Honolulu	County of Maui	County of Hawaiʻi
Economic Development Plan	**Yes** Kauaʻi Comprehensive Economic Development Plan 2022-2026: Kauai's Comprehensive Economic Development Strategy (CEDS) Report (2021) Kauaʻi Agricultural Economic Development Plan 2023 (almost done) Kauaʻi Tourism Strategic Plan/ Destination Management Action Plan 2021-2023	**No**	**Yes** Maui General Plan 2030, Economic Development Elements; Hawaiʻi Comprehensive Economic Development Strategy, 2010	**Yes** County Comprehensive Economic Development Strategy
Emergency Operations Plan	**Yes** County of Kauaʻi has begun to update its Emergency Operations Plan-Basic Plan (2007); Kauaʻi County Hurricane Response Logistics Concept of Operations (CONOPS) 2013	**Yes** City & County Emergency Operations Plan (2007)	**Yes** County of Maui Emergency Operations Plan (2009)	**Yes** County of Hawaiʻi Emergency Operations Plan (2011)
Firewise	**No** State Firewise Coordinator mentioned	**No** Action included to assist communities to become Firewise Communities	**Yes** Participating sites include: Kahikinui, Kula; Launiupoko, Lahaina; Paniolo Hale, Maunaloa; and Waiohuli, Kula	**Yes** Participating sites include: Honokoa, Kanehoa, Kohala by the Sea, Kohala Waterfront, Puʻukapu, Waialea, Waikiʻi Ranch, Waikoloa Village
Flood Damage Prevention Ordinance	**Yes** Includes higher standards	**Yes** The FHAT tool is discussed as a decision support tool to enable better compliance with flood regulations	**Yes** Maui County's 2020 Multi-Hazard Mitigation Plan will continue to serve as a CRS-credited Floodplain Management Plan.	**Yes** Includes higher standards; Participates in CRS

Foundational Capability	County of Kauaʻi	City and County of Honolulu	County of Maui	County of Hawaiʻi
General Plan	**Yes** County of Kauaʻi General Plan 2015 technical information used to inform the local HMP and hazard mitigation was incorporated into the General Plan update	**Yes** Natural hazard policies for General Plan	**Yes** General Plan 2030: Countywide Policy Plan, Maui Island Plan, Community Plans discusses integration of hazard mitigation into General Plan	**Yes** Discusses integration of hazard mitigation into General Plan
Get Ready Website	**No**	**No**	**No**	**No**
Hawaiʻi Hazards Awareness and Resilience Program	**Yes** Hanapēpē/ʻEleʻele is a HHARP community	**No**	**Yes** West Maui is a HHARP community	**No**
Hawaiʻi State Legislature Grant-in-Aid (GIA) Program	**No**	**Yes** Discussed in ongoing wildfire mitigation activities	**Yes** Only the capital improvement project portion is discussed	**No**
Legacy Lands Conservation Program	**No**	**No**	**No**	**No**
Land Acquisition Plan / Willing Seller Program	**No**	**Yes** Discussed in relation to policy analysis	**Yes** Action identified to develop a flood acquisition/elevation plan	**Yes** Action included for the volcanic risk home buyout program
Post-Disaster Recovery	**Yes** County of Kauaʻi Disaster Debris Action Manual (2001) County of Kauaʻi partnered with Hawaiʻi Sea Grant to develop pre-disaster recovery authority and re-development scenarios (on-going)	**No** Action included to develop a master plan to implement sustainable design in post-disaster rebuilding	**Yes** Hawai'i Revised Statues Title 10. Public Safety and Internal Security, 127; Title 13. Planning and Economic Development, 209	**No**
Public Health Preparedness Plan [b]	**Yes** State of Hawaiʻi Health Risk and Vulnerability Assessment (2017) DOH Pandemic Plan (Pending)	**No**	**No**	**No**
Real Estate Disclosure [c]	**Yes**	**Yes**	**Yes**	**Yes**

Foundational Capability	County of Kaua'i	City and County of Honolulu	County of Maui	County of Hawai'i
Rehabilitation of High Hazard Potential Dams (HHPD)	**No** Relies on DLNR for HHPD policies, programs, and capabilities	**No** Relies on DLNR for HHPD policies, programs, and capabilities	**No** Relies on DLNR for HHPD policies, programs, and capabilities	**No** Relies on DLNR for HHPD policies, programs, and capabilities. One HHPD-specific mitigation action in included in the HMP.
Risk MAP Program	**No**	**Yes** Honolulu participating as a FEMA Risk MAP community	**No**	**No**
Sea Level Rise Study/Plan	**Yes** A technical study on sea level rise scenarios was commissioned to inform the General Plan and Community Development Plans; Kaua'i Climate Change and Coastal Hazard Assessment and West Kaua'i Community Vulnerability Assessment Island Wide Climate Change Vulnerability & Equity Assessment conducted for the on-going Climate Adaptation Plan	**No** Discussed generally	**Yes** Sea level rise exposure assessment conducted as part of planning process, Parks Department and Department of Environmental Management are planning studies.	**No** Discussed generally
Shoreline Setbacks	**Yes** Erosion-based shoreline setback ordinance has been adopted based on historical erosion rates and future sea level rise	**Yes** 60-foot setback for new subdivisions; otherwise, the standard setback is 40-feet	**Yes** Maui has shoreline setbacks to account for sea level rise	**Yes** Standard 40-foot setback is required; action included to update policies to include coastal erosion
Site Plan Review	**No**	**Yes** Site Development Division	**Yes** Maui County Code, Title 12 – Landscape Planting and Beautification; Title 16 – Buildings and Construction, Chapter 16.26B Building Code	**Yes** County of Hawai'i Building Code, County Ordinance Chapter 5

Foundational Capability	County of Kaua'i	City and County of Honolulu	County of Maui	County of Hawai'i
Special Management Area Permits [d]	**Yes** Erosion planning and management activities through administration of the SMA	**Yes** Erosion planning and management activities through administration of the SMA	**No** Discusses Coastal Zone Management Program generally	**Yes** Limited discussion
State Hazard Mitigation Forum	**Yes** Kaua'i currently has 3 voting and 2 ex officio Forum Members	**Yes**	**Yes**	**Yes**
StormReady®/TsunamiReady®	**Yes**	**Yes**	**Yes**	**Yes**
Stormwater Management / Low Impact Development	**No** Drainage systems discussed in limited fashion	**Yes** Drainage systems approaches discussed	**Yes** Maui Storm Water Management Program Plan; prepared in accordance with Hawai'i Administrative Rules, Chapter 11-55 Appendix K for Kahului, Maui Maui County Code, Title 18, Chapter 20.135 – Post-Construction Stormwater Quality Best Management Practices; Title 16, Chapter 26B.3900 – Postconstruction Stormwater Quality Best Management Practices	**Yes** Hilo Drainage and Flood Control Report; Drainage Master Plan for the County of Hawai'i (1971); Current drainage standards are based on a 10-year storm
Subdivision Requirements [e]	**Yes**	**Yes** Site Development Division; Uniform Land Sales Practices Act	**Yes** Maui County Code Title 18 – Subdivisions	**Yes** Notes Memorandum of Agreement between County of Hawai'i and Department of Hawaiian Home Lands
Threat & Hazard Identification & Risk Assessment (THIRA) [f]	**No**	**No**	**Yes** Maui County's THIRA is maintained by the State (HI-EMA)	**No**
Water Management Plan	**Yes** County of Kaua'i Drought Mitigation Strategies document (2004)	**Yes** Honolulu Board of Water Supply	**No** Action included to develop a water conservation ordinance	**Yes** Hawai'i Drought Plan (2017)

Foundational Capability	County of Kauaʻi	City and County of Honolulu	County of Maui	County of Hawaiʻi
Zoning Code or Land Use Ordinance [g]	**Yes** Two Zoning Districts	**Yes** Last update was 2004	**Yes** Maui County Code Title 19 – Zoning, Article 1. Interim Zoning Provisions; Article II. Comprehensive Zoning Provisions	**Yes** Existing mechanisms within the General Plan and Zoning Code allow the County to direct new development proposals away from known natural hazard locations

Note: Yes =Capability discussed in hazard mitigation plan, No = capability not discussed in hazard mitigation plan; Information presented in this table reflects information as it is presented in the County hazard mitigation plans unless otherwise noted. Codes, regulations, and/or plans may have been updated since the time of their publication.

a. *The State Building Code is included in HAR §3-180 State Building Code; Counties may make local amendments.*

b. *There are no county equivalent public health agencies within the state; however, plans have been developed for all counties either directly by the Department of Health (for Oʻahu) or via the District Health Offices of the Neighbor Islands (County of Kauaʻi, County of Maui, and County of Hawaiʻi). In addition, the State of Hawaiʻi Health Risk and Vulnerability Assessment pertains to the entire state.*

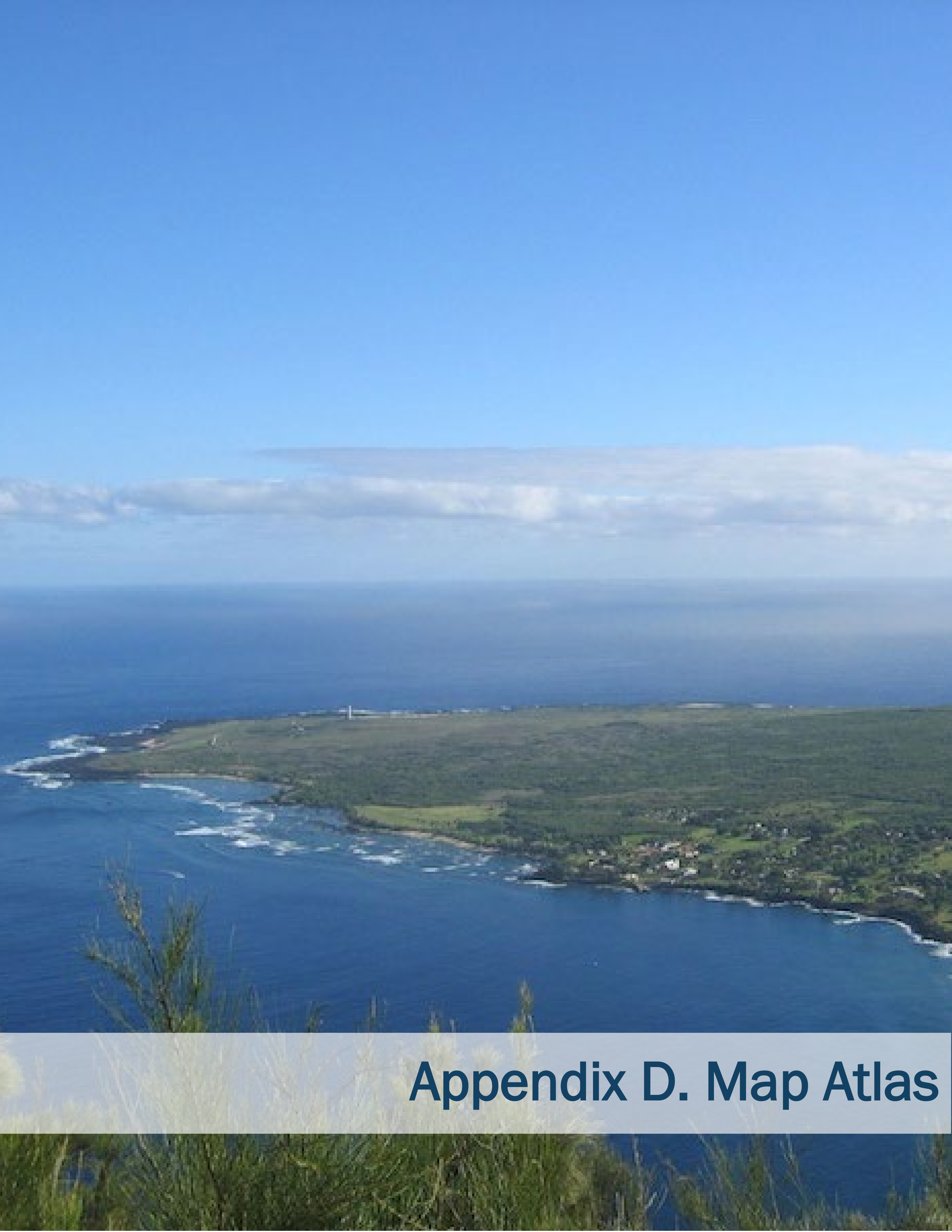
c. *Disclosure of hazard risk is required in some real estate transactions by State law (see HRS 508D, Mandatory Seller Disclosures in Real Estate Transactions).*

d. *Special Management Area Permits are part of the State Coastal Zone Management Program and are administered at the County level.*

e. *State law includes requirements as part of the Uniform Land Sales Practices Act (HRS Chapter 484).*

f. *County representatives have participated in the development of the State THIRA.*

g. *County government have regulatory authority over Urban District lands and shared authority over Agricultural and Rural District Lands. Conservation District lands are reserved for the State.*



Appendix D. Map Atlas

CONTENTS

FIGURES

[1] *Section Cover Photo: Pālāʻau State Park, Molokaʻi. Photo courtesy of DLNR*

APPENDIX D. MAP ATLAS

The 2023 HMP Update streamlined the information included in the State Profile (Section 3) and the Risk Assessment (Section 4). This appendix includes additional maps to support each section, as appropriate.

D.1 State Profile

Figure D-1. State Buildings in the County of Kaua'i

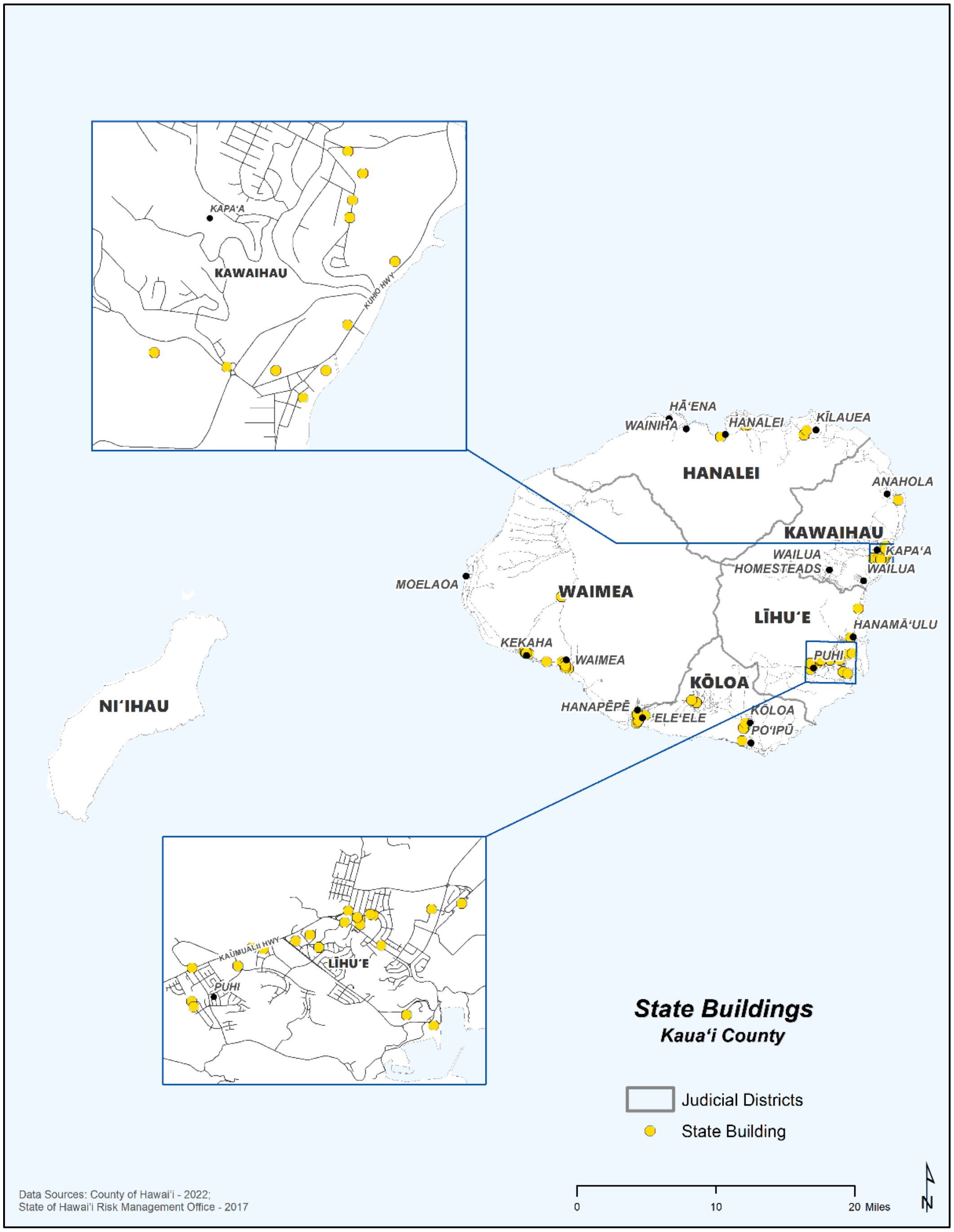


Figure D-2. State Buildings in the City and County of Honolulu

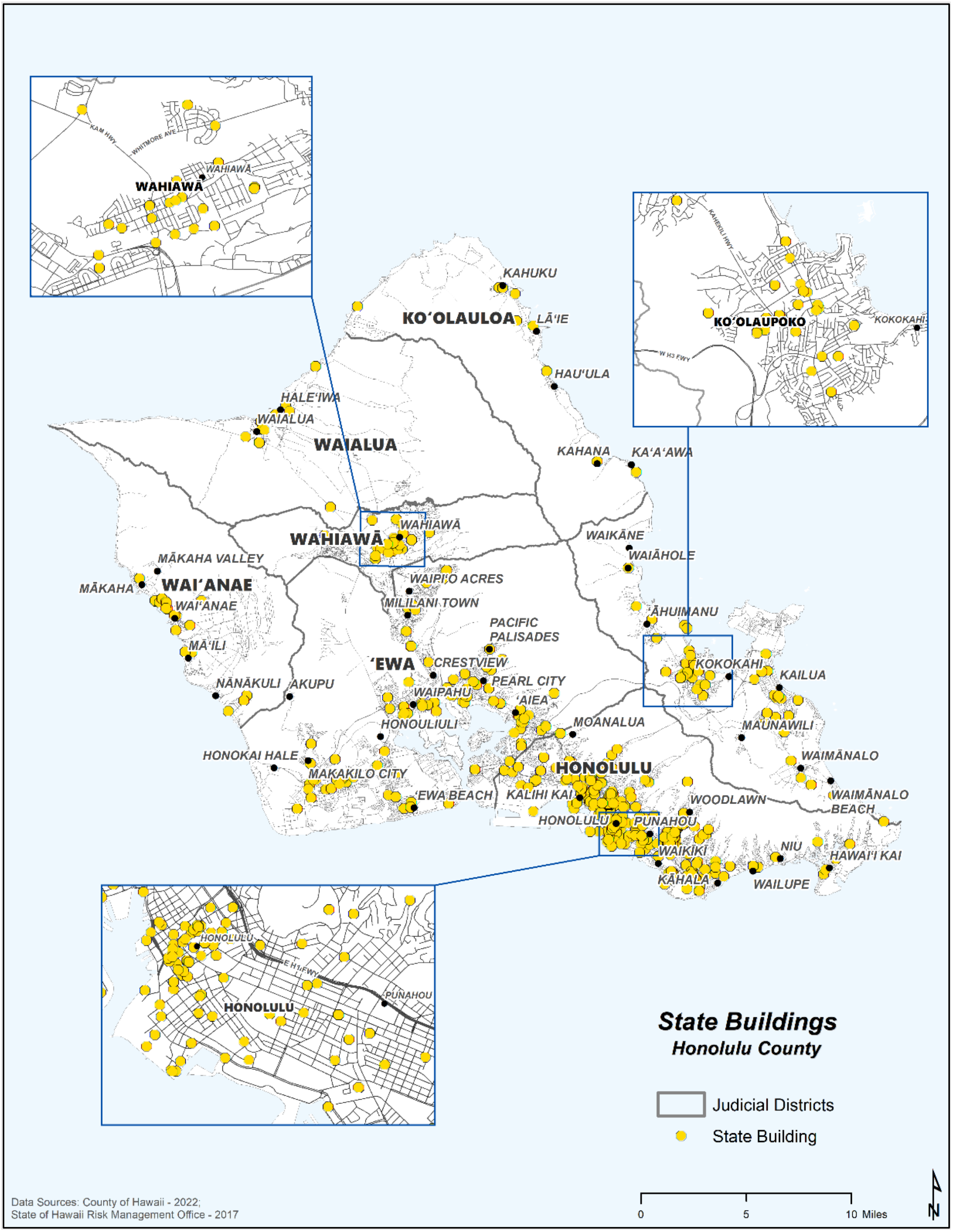


Figure D-3. State Buildings in the County of Maui

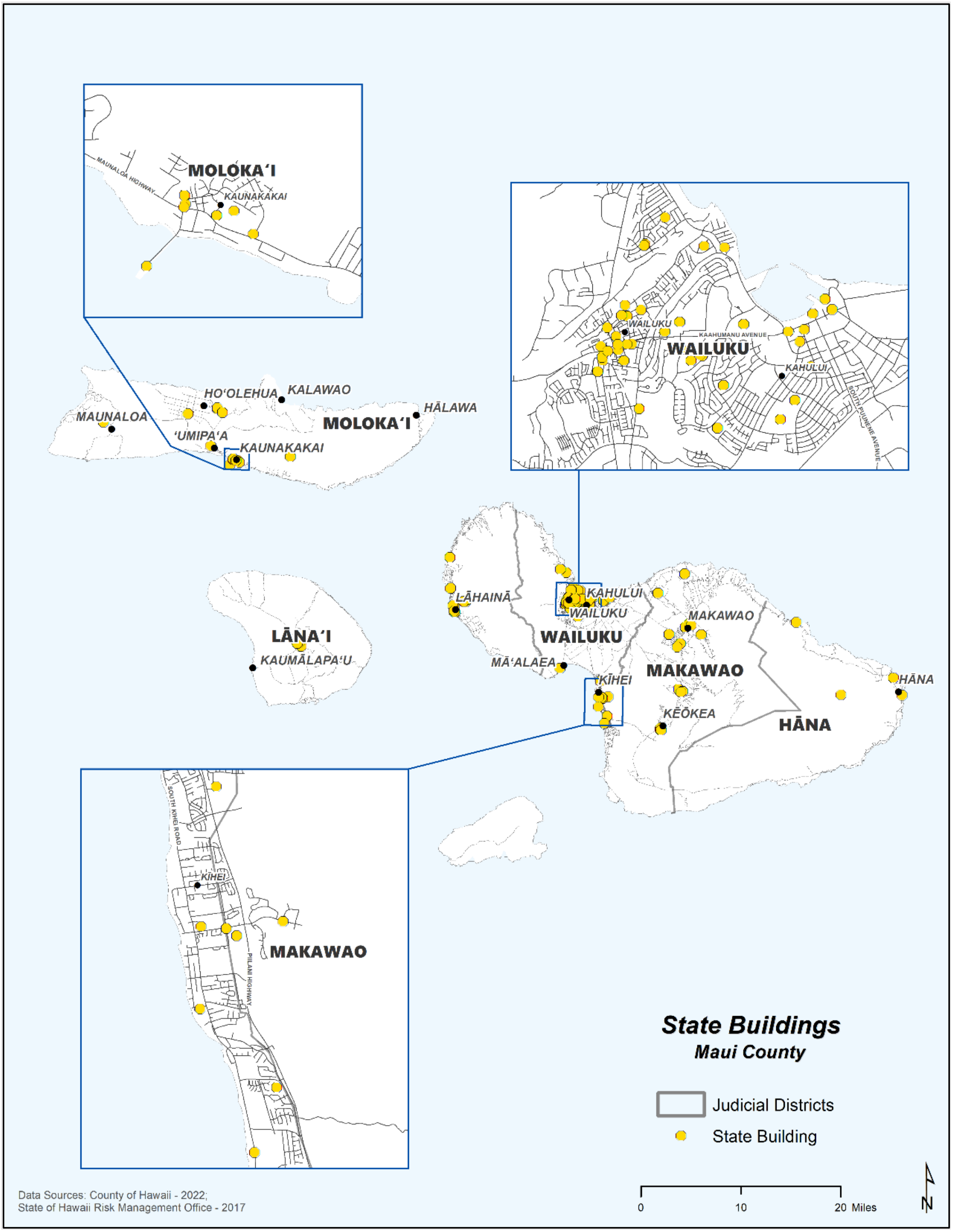


Figure D-4. State Buildings in the County of Hawaiʻi

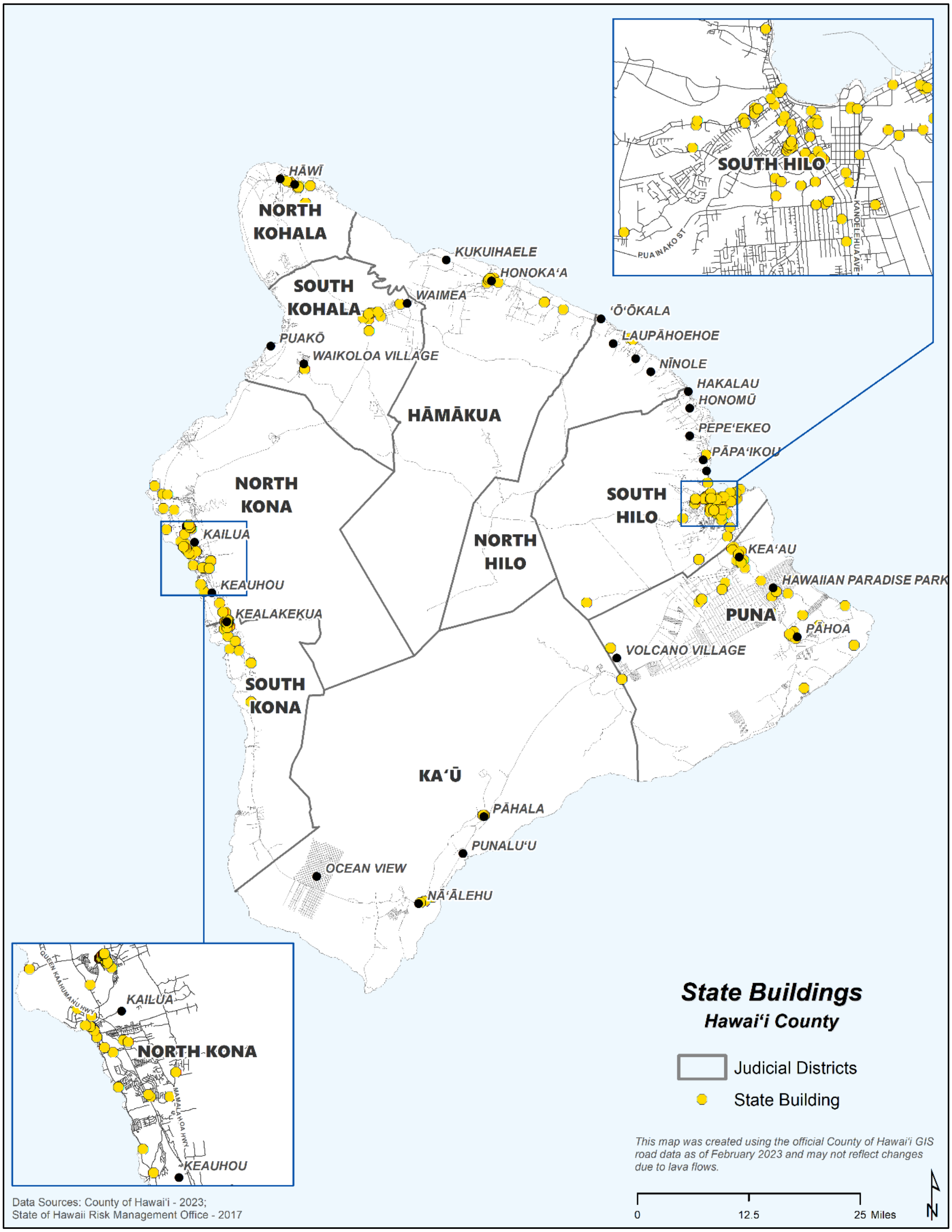
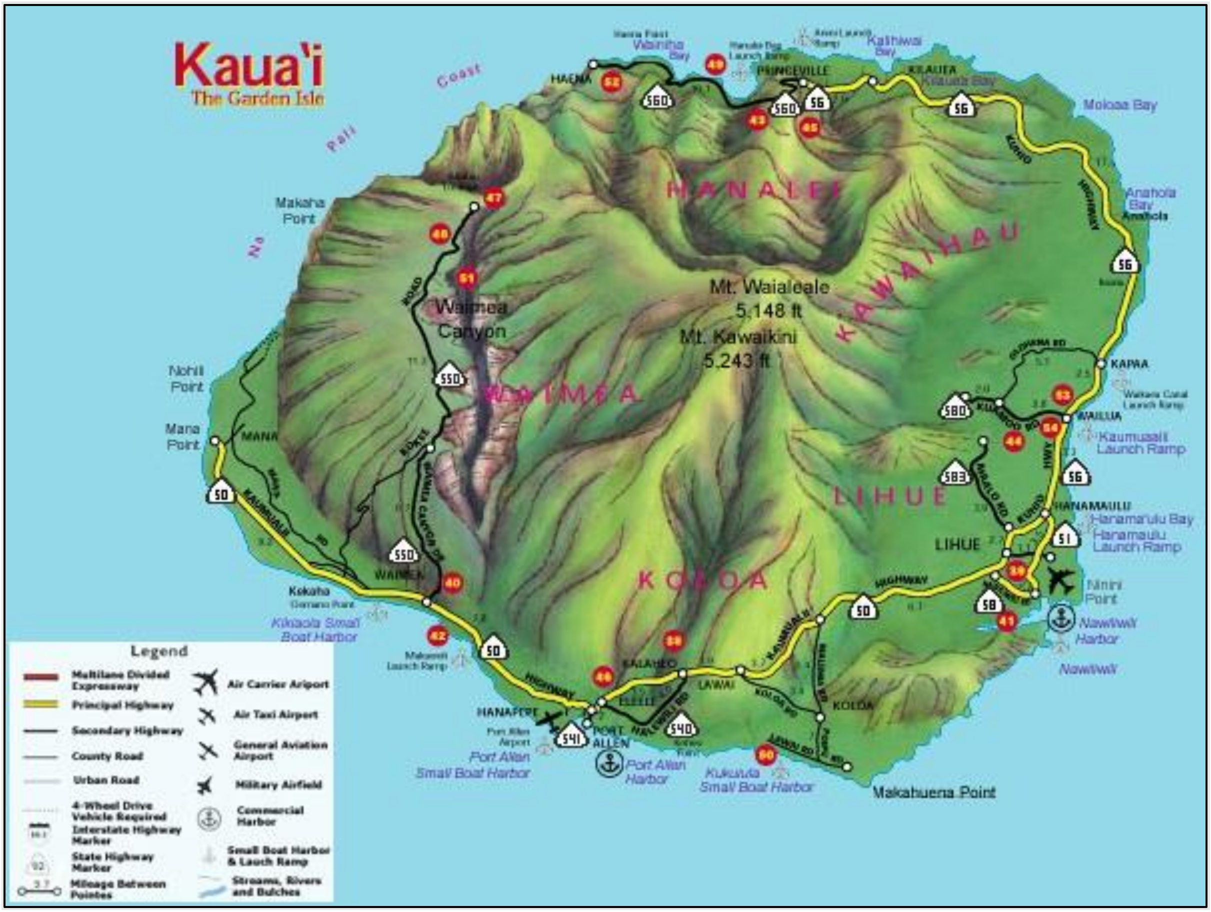
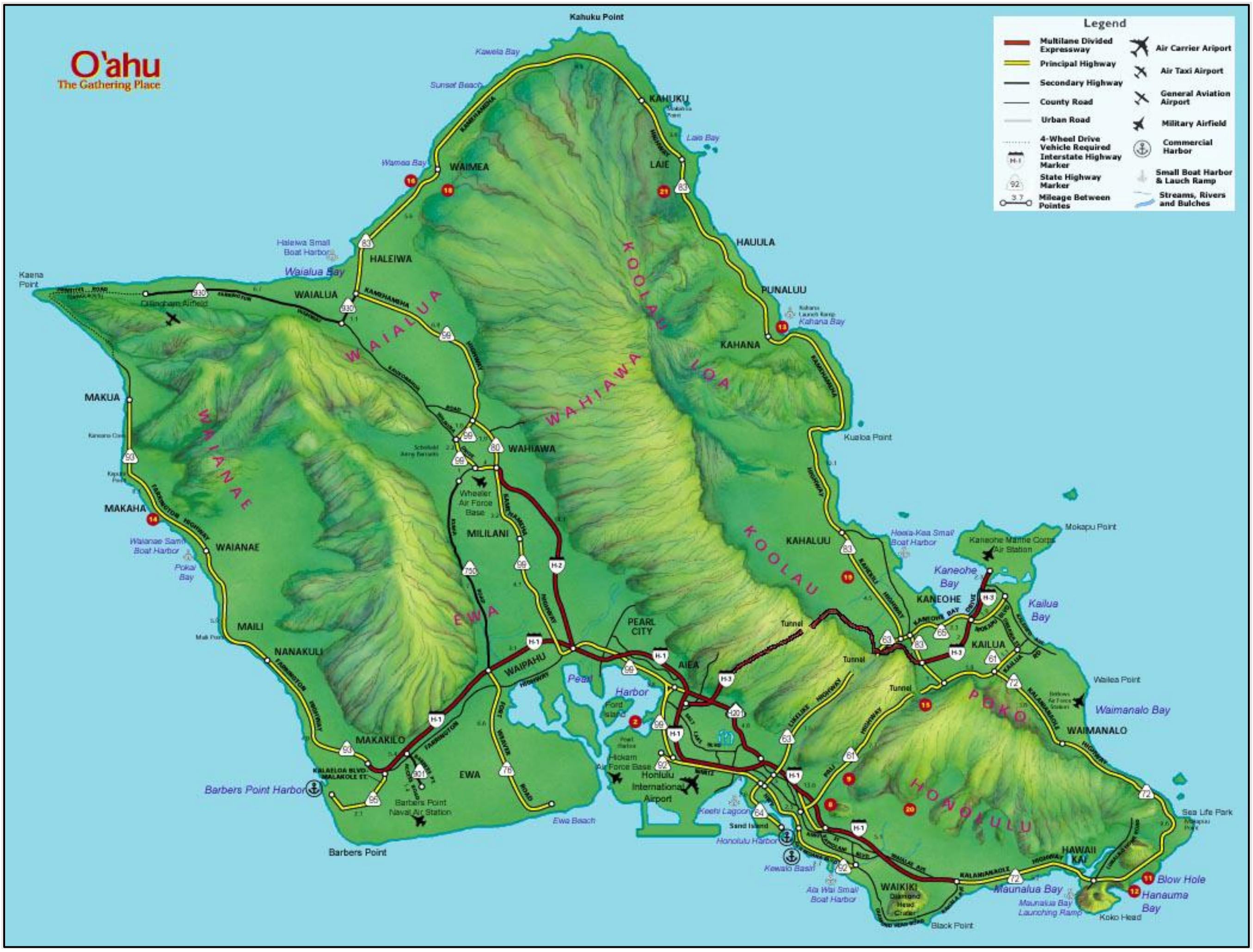


Figure D-5. Transportation Assets in the County of Kaua'i



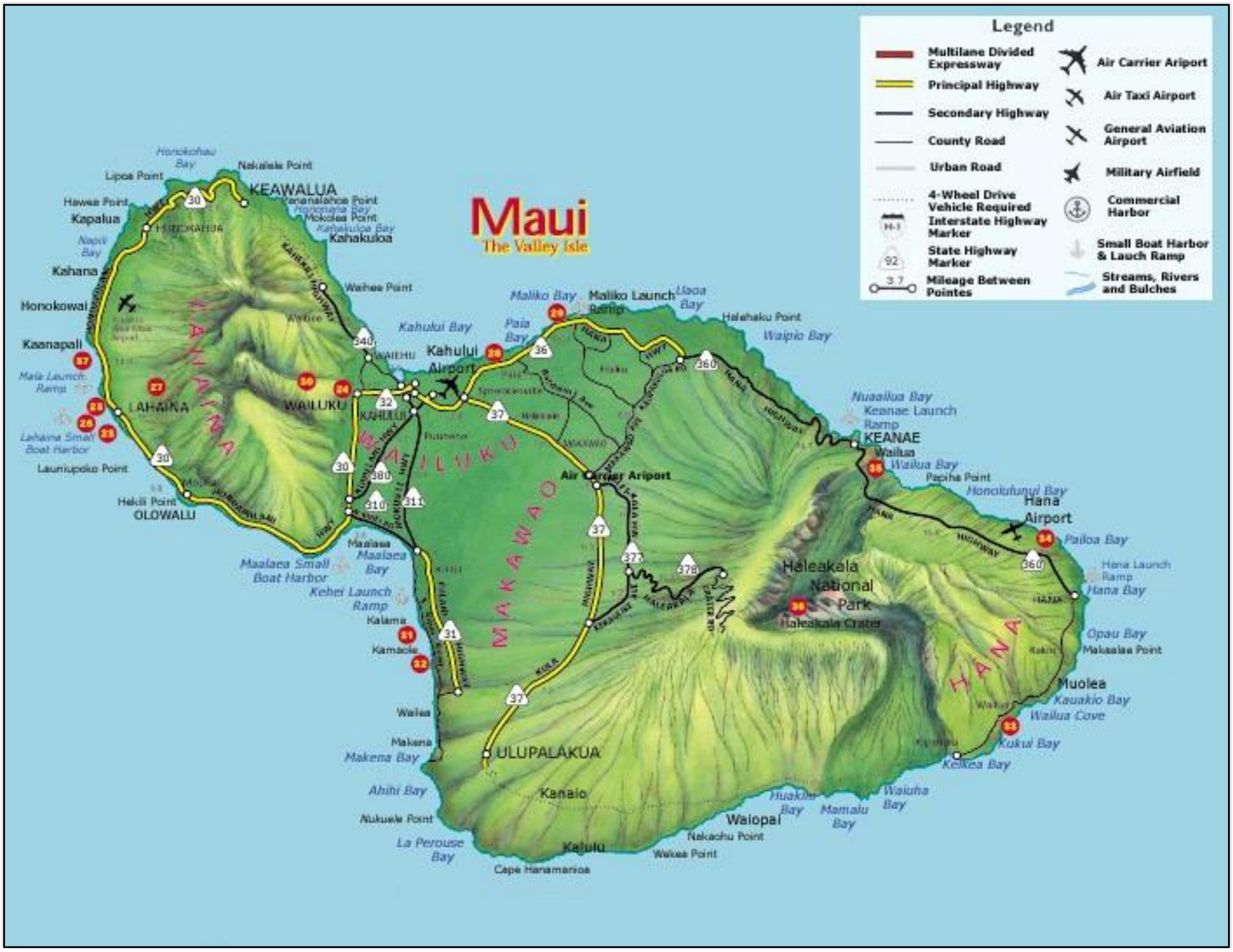
Source: State of Hawai'i Department of Transportation 2018

Figure D-6. Transportation Assets in the City and County of Honolulu



Source: State of Hawai'i Department of Transportation 2018

Figure D-7. Transportation Assets on the Island of Maui

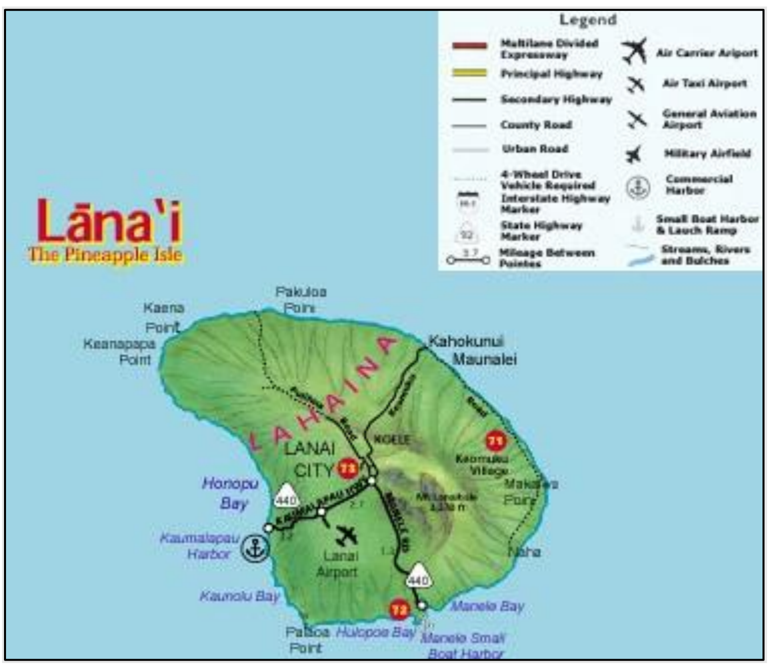


Source: State of Hawai'i Department of Transportation 2018

Figure D-8. Transportation Assets on the Island of Moloka'i

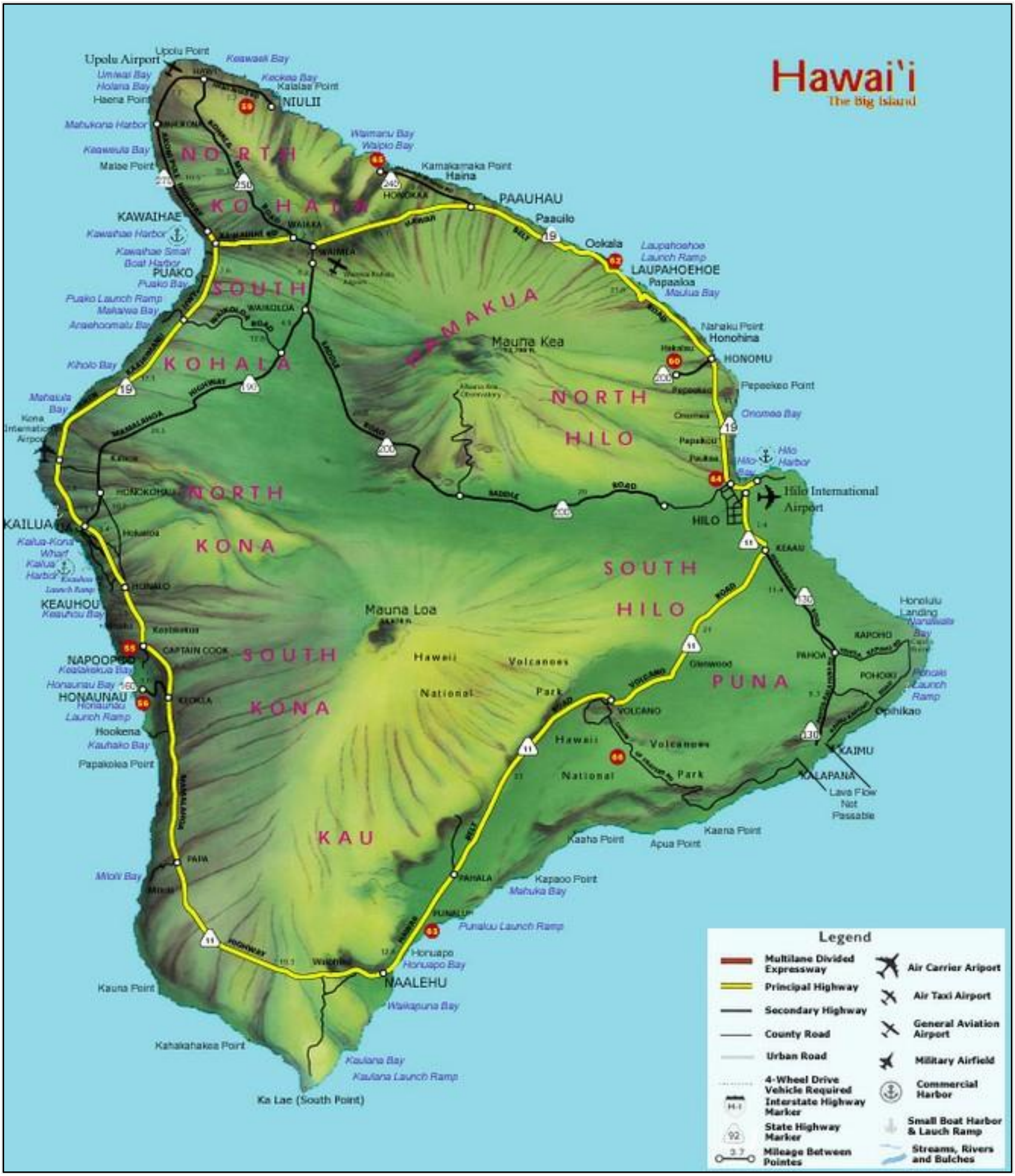
Source: State of Hawai'i Department of Transportation 2018

Figure D-9. Transportation Assets on the Island of Lāna'i



Source: State of Hawai'i Department of Transportation 2018

Figure D-10. Transportation Assets in the County of Hawai'i



Source: State of Hawai'i Department of Transportation 2018

Figure D-11. Critical Facilities in the County of Kaua'i

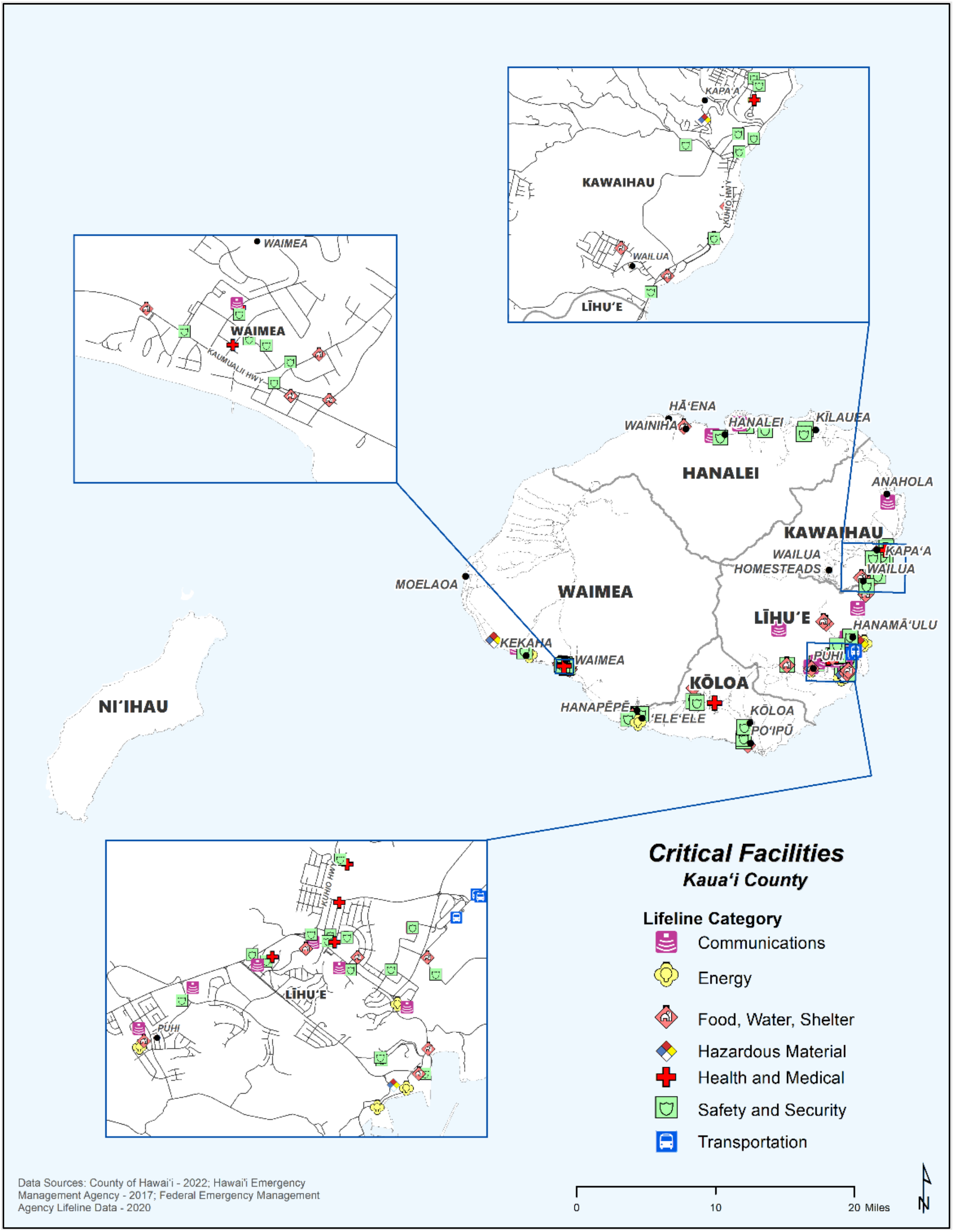


Figure D-12. Critical Facilities in the City and County of Honolulu

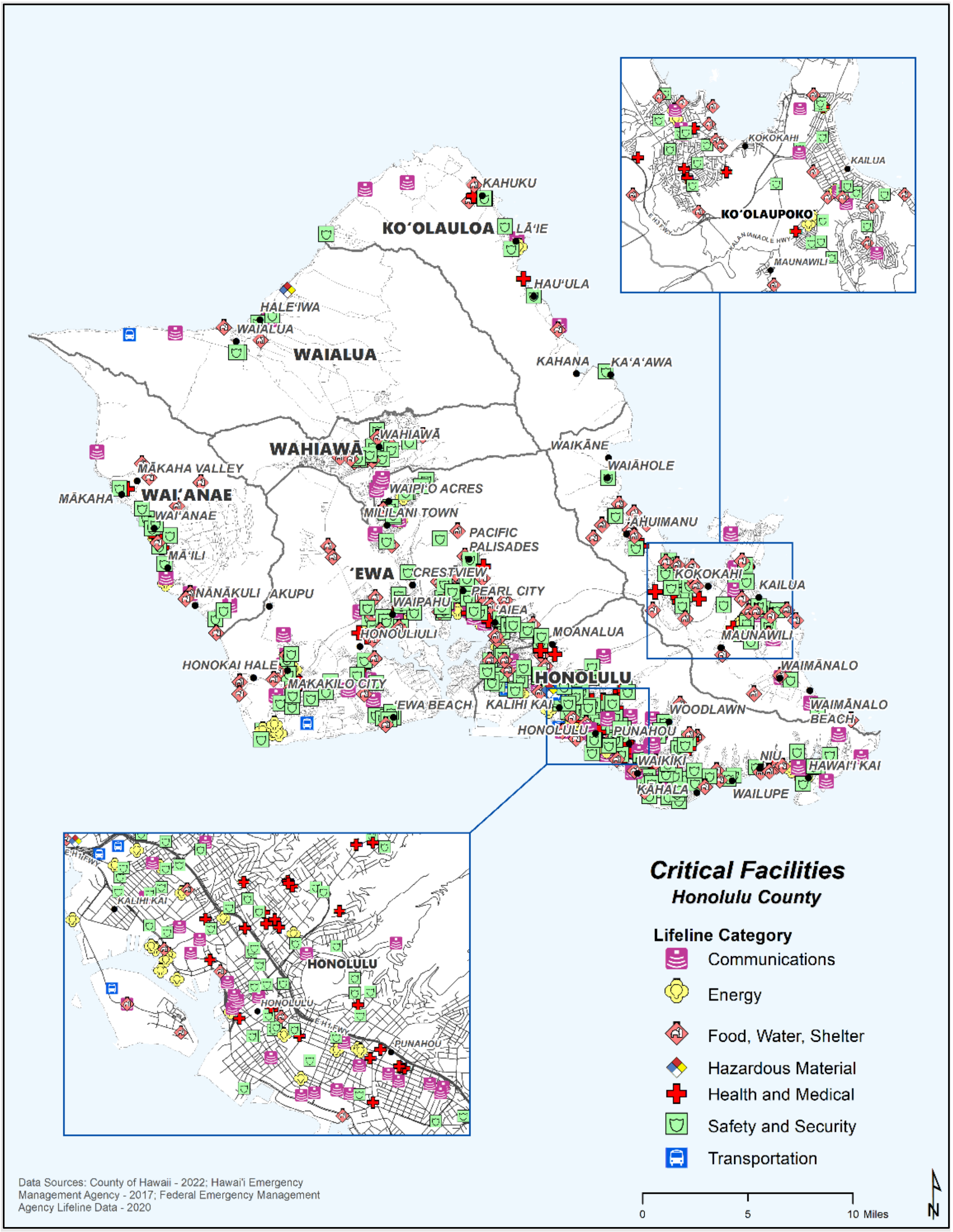


Figure D-13. Critical Facilities in the County of Maui

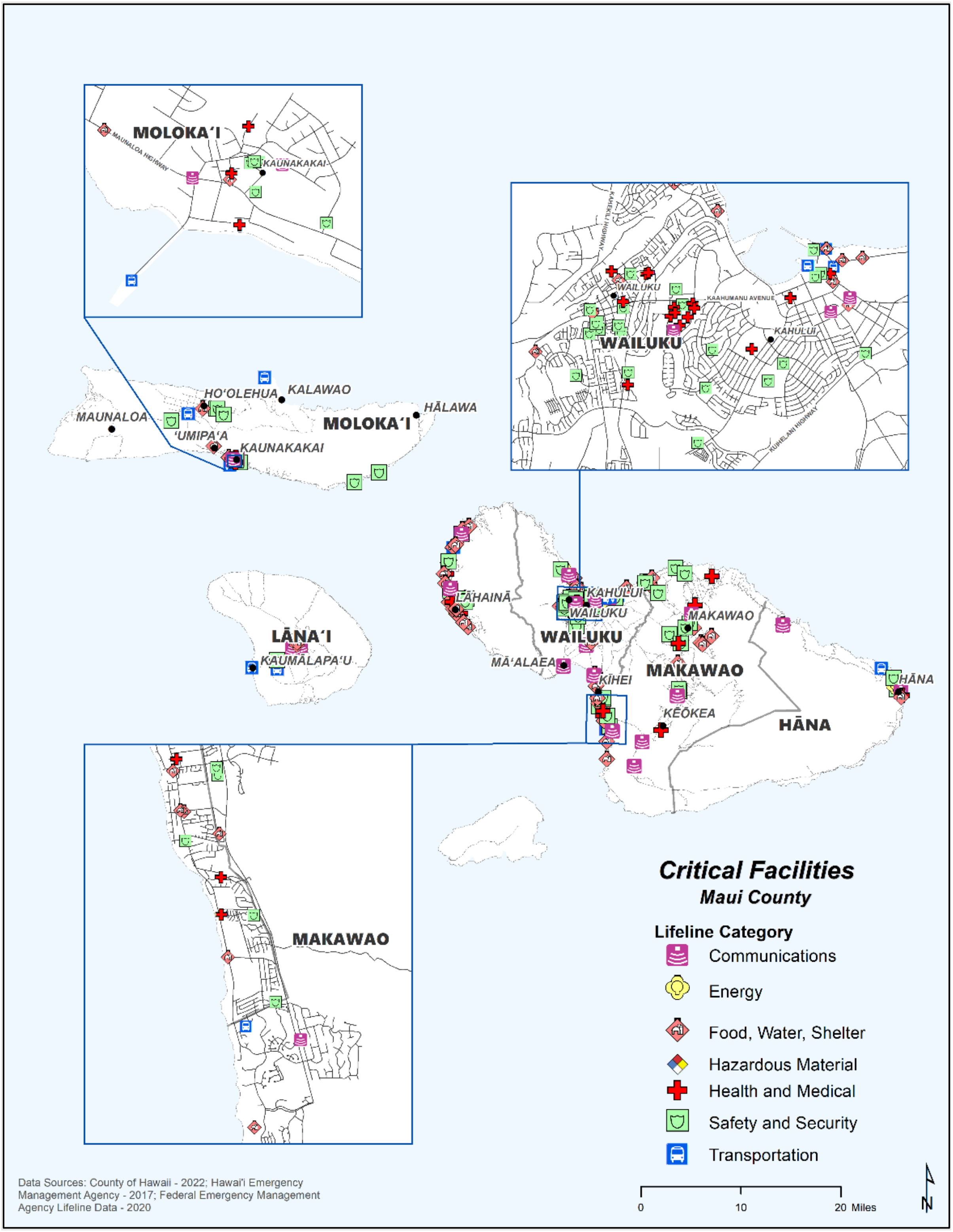


Figure D-14. Critical Facilities in the County of Hawai'i

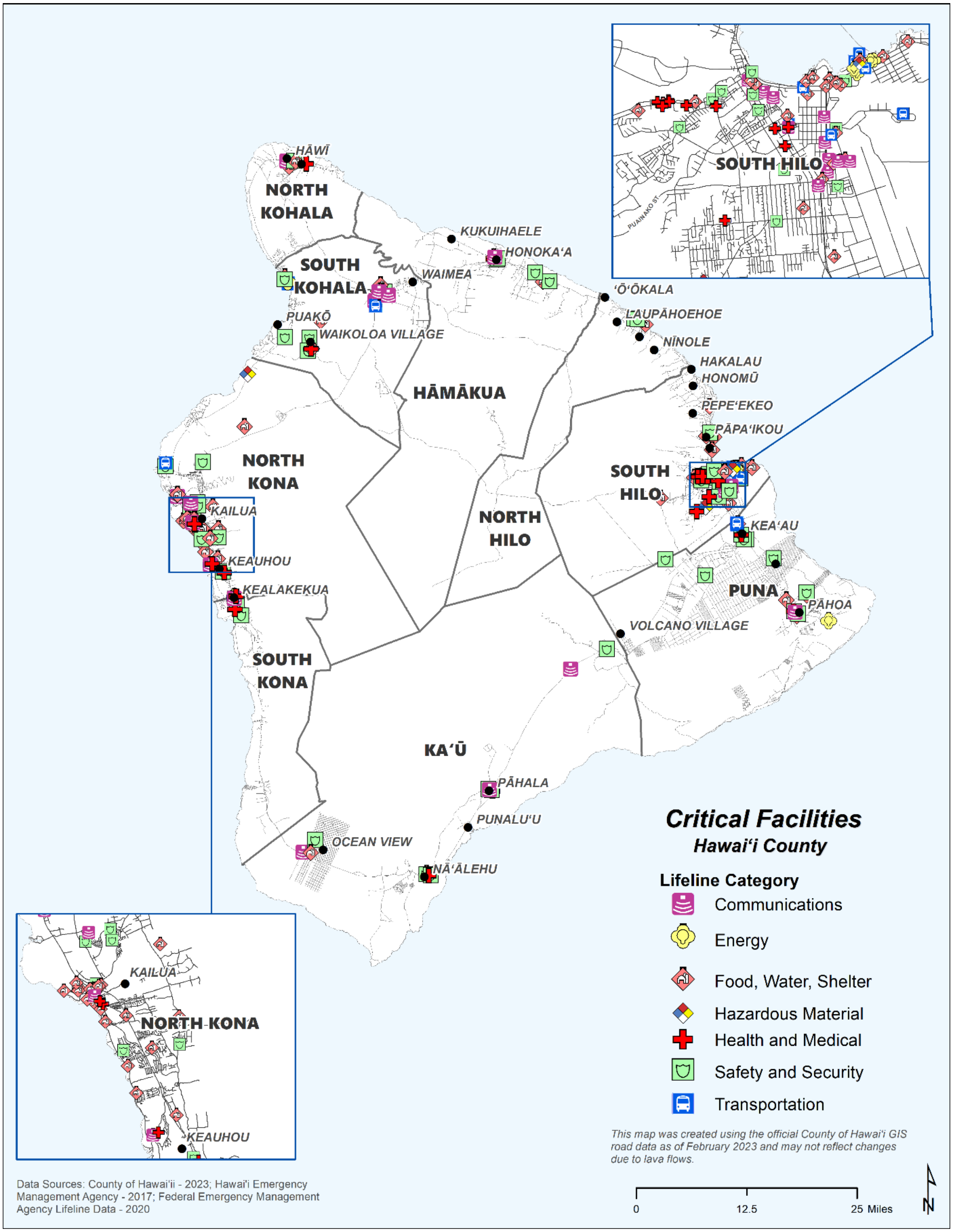


Figure D-15. Environmental Resource Areas in the County of Kauaʻi

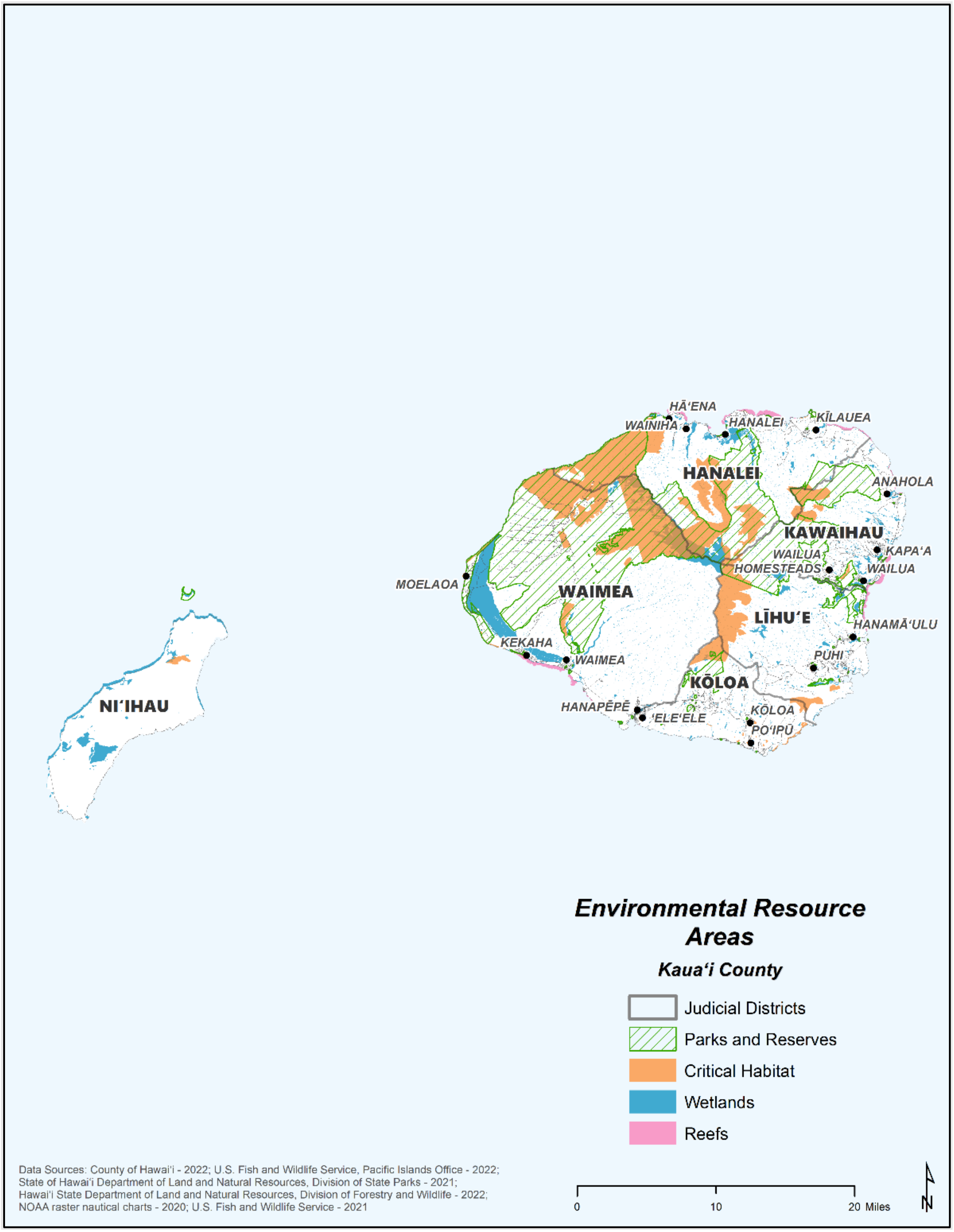


Figure D-16. Environmental Resource Areas in the City and County of Honolulu

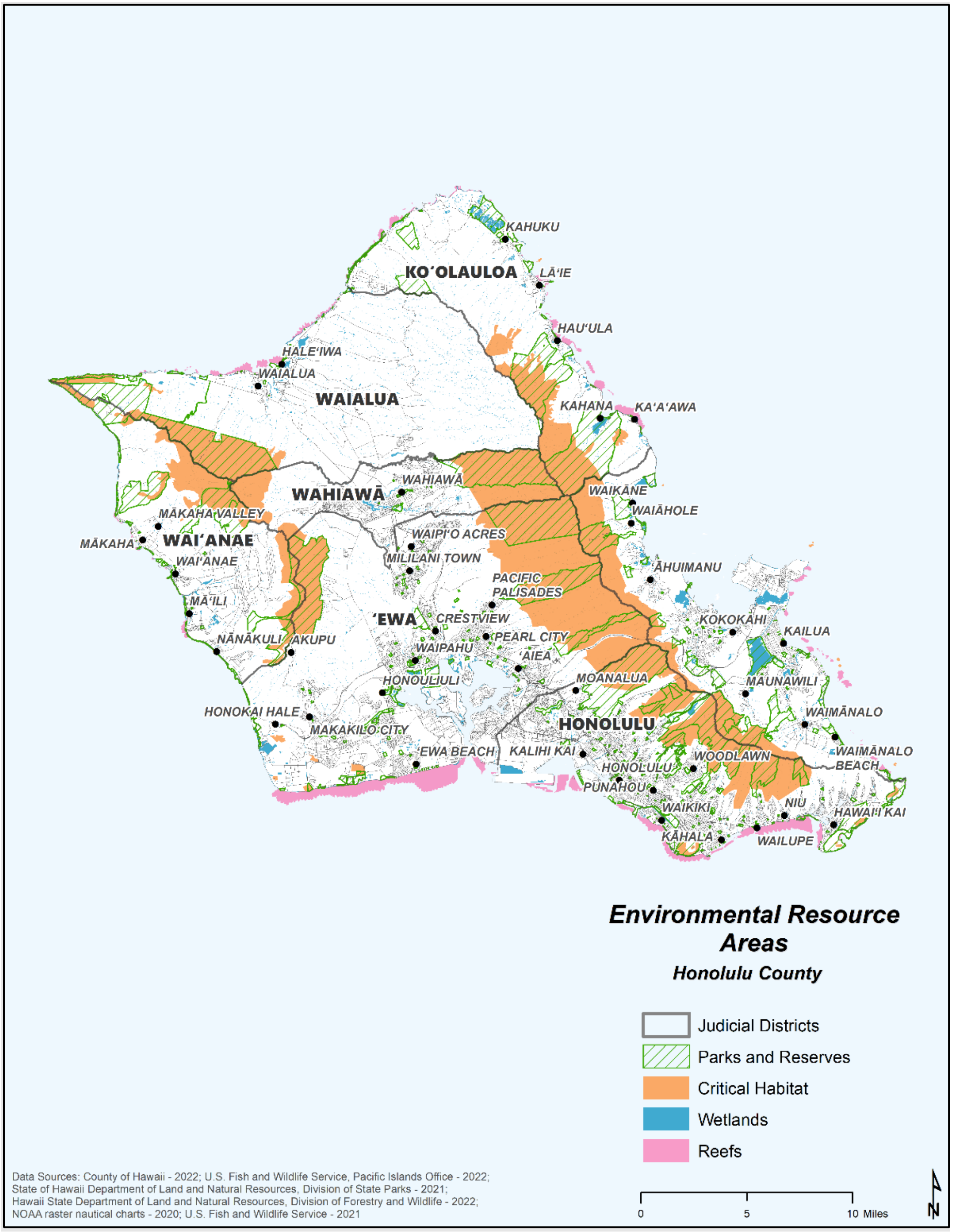


Figure D-17. Environmental Resource Areas in the County of Maui

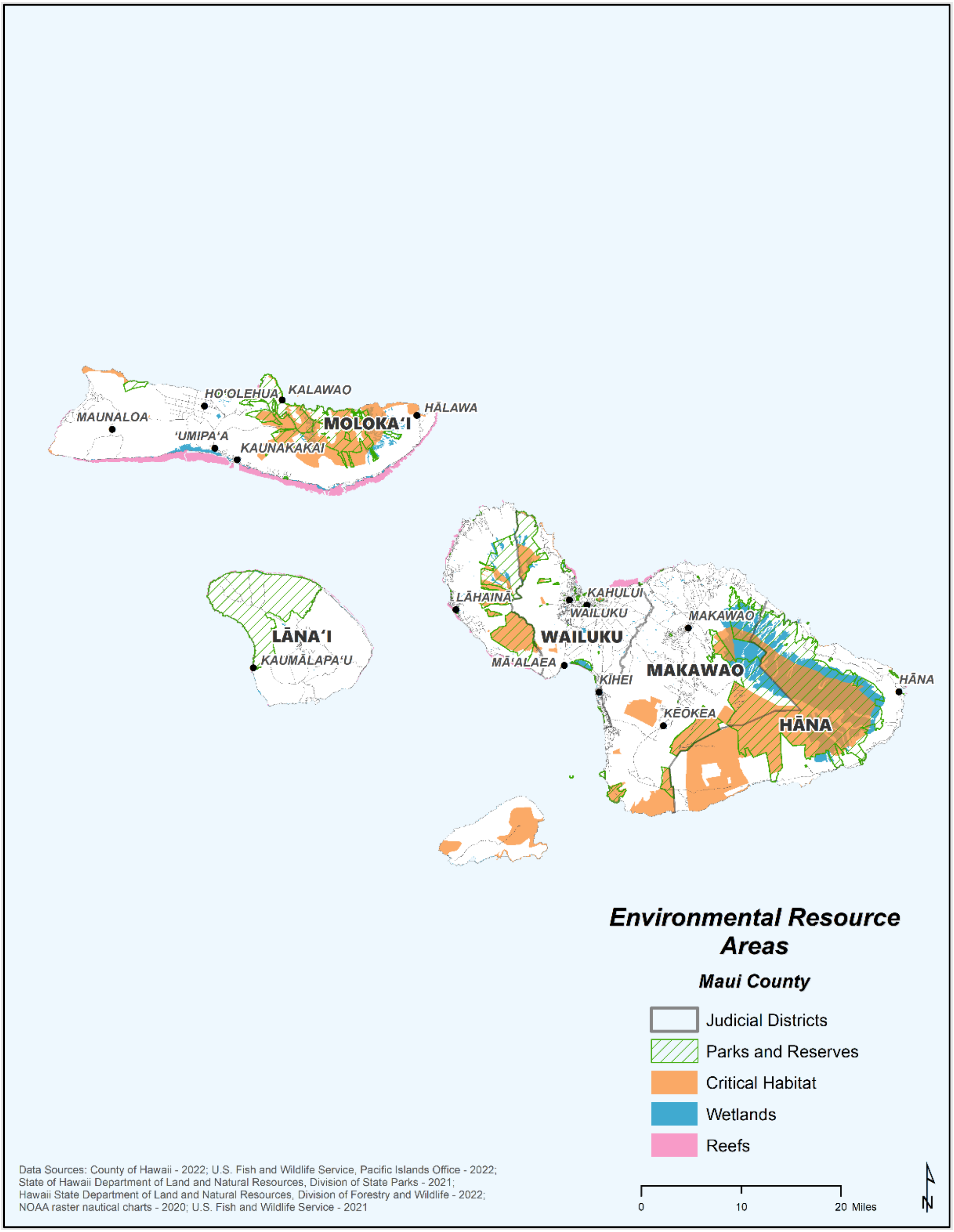


Figure D-18. Environmental Resource Areas in the County of Hawai'i

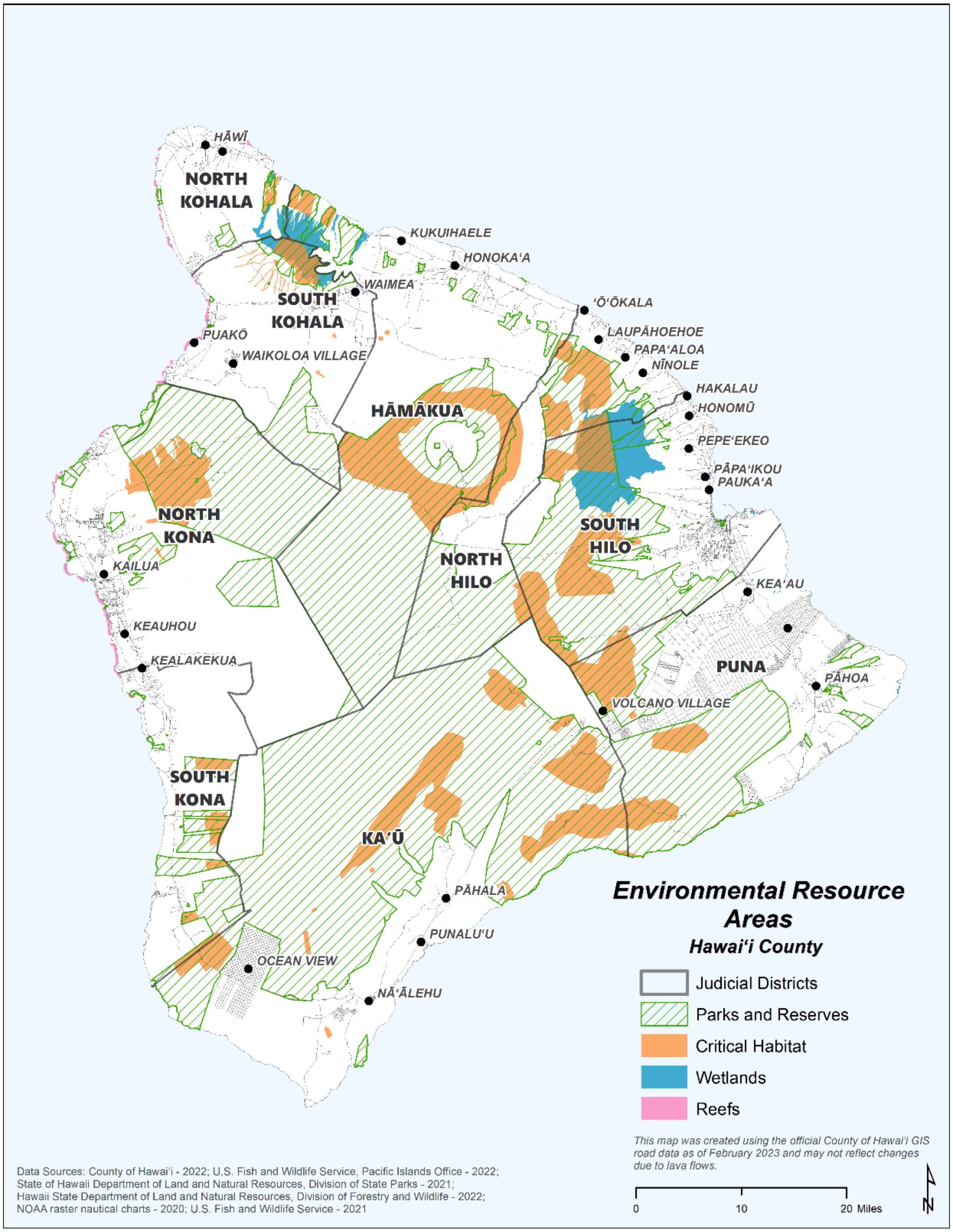


Figure D-19. Projected Development Areas in the County of Kauaʻi

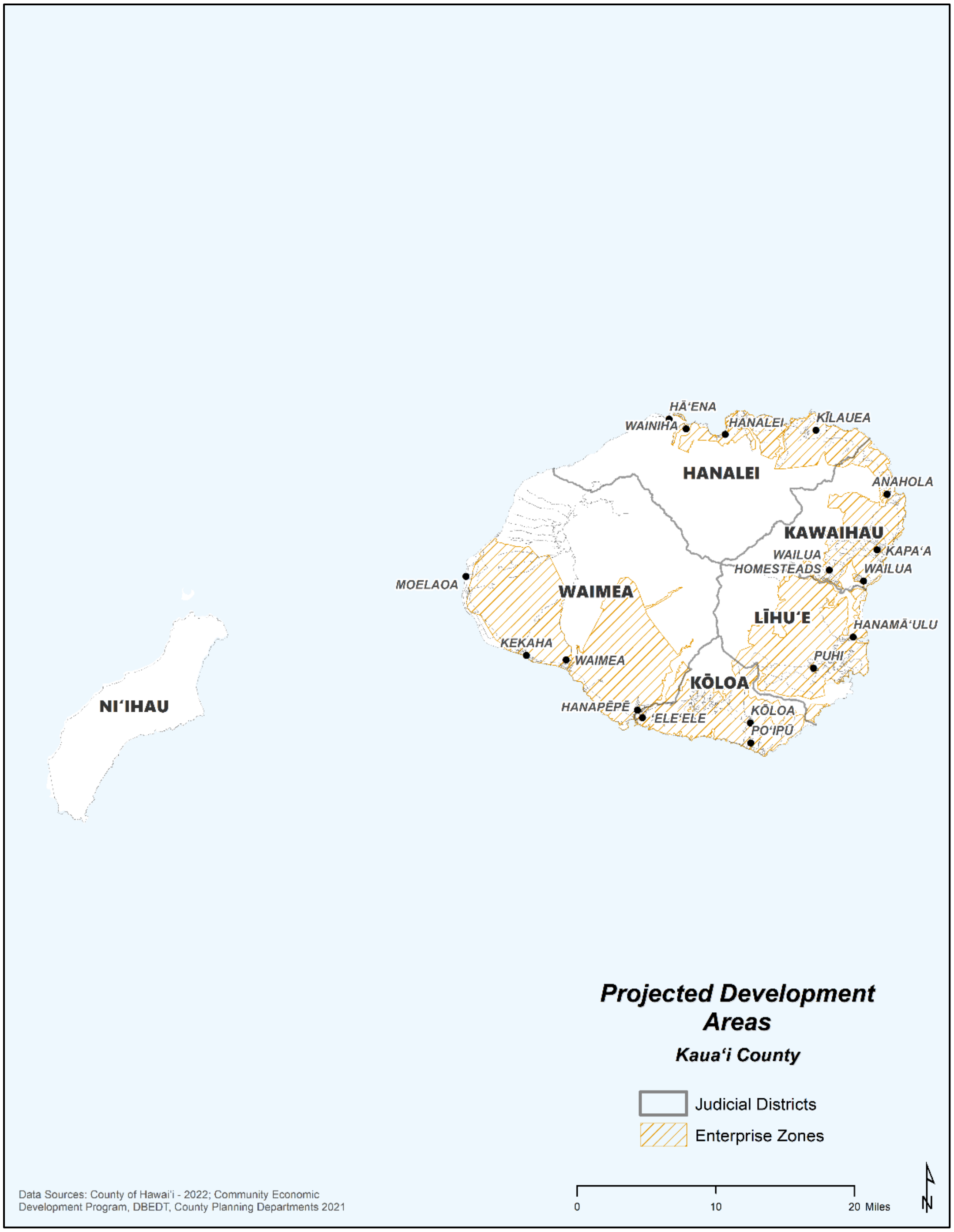


Figure D-20. Projected Development Areas in the City and County of Honolulu

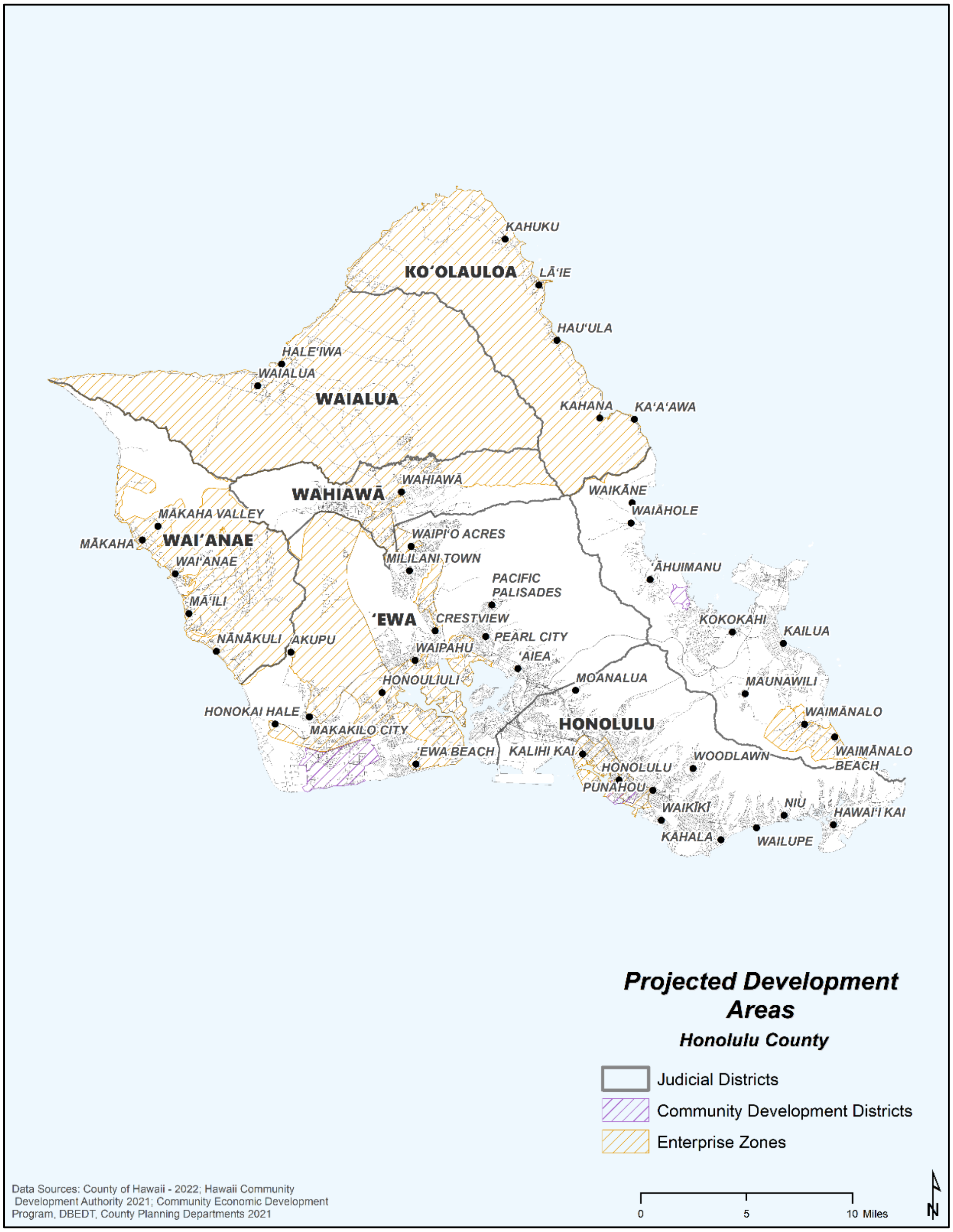


Figure D-21. Projected Development Areas in the County of Maui

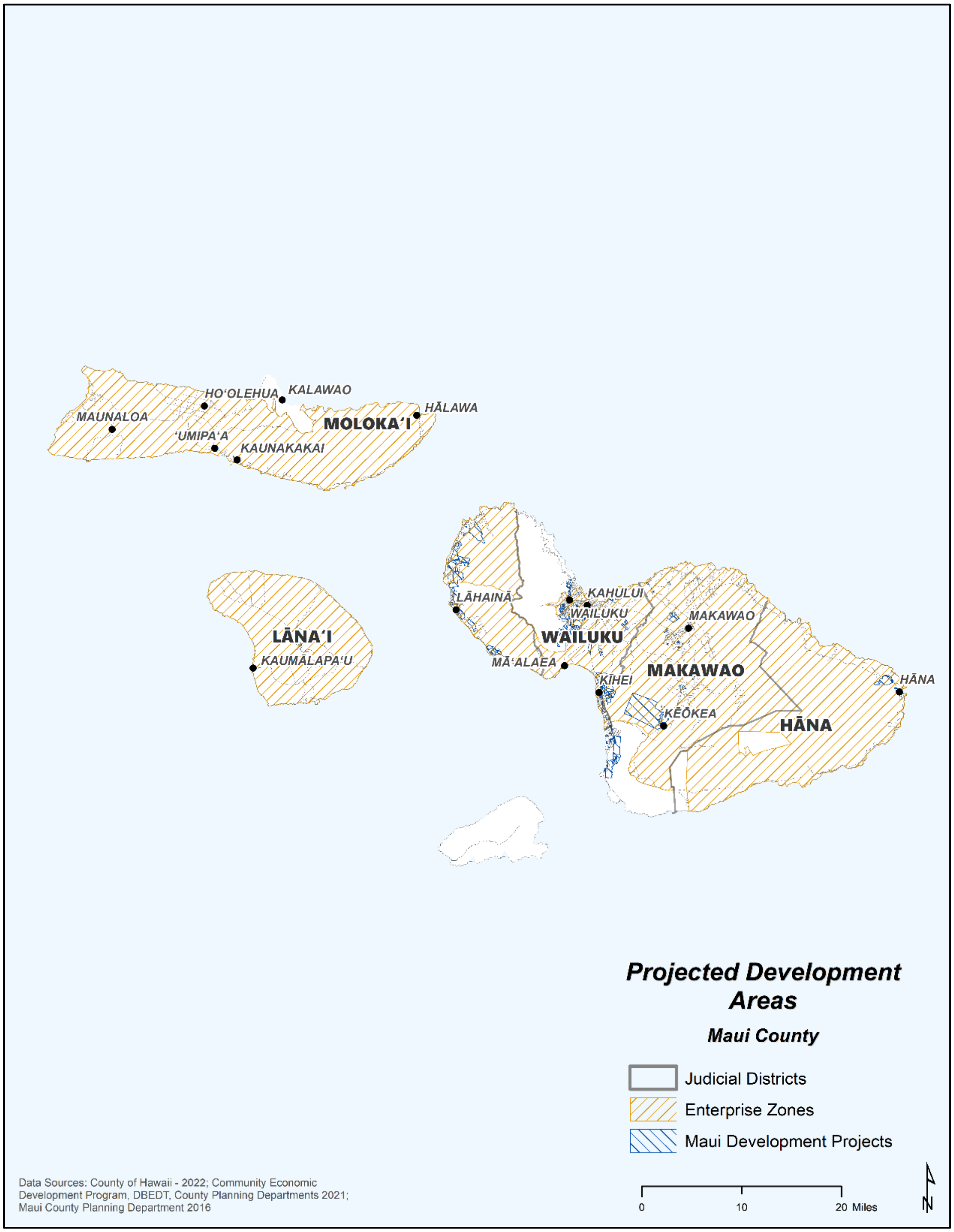
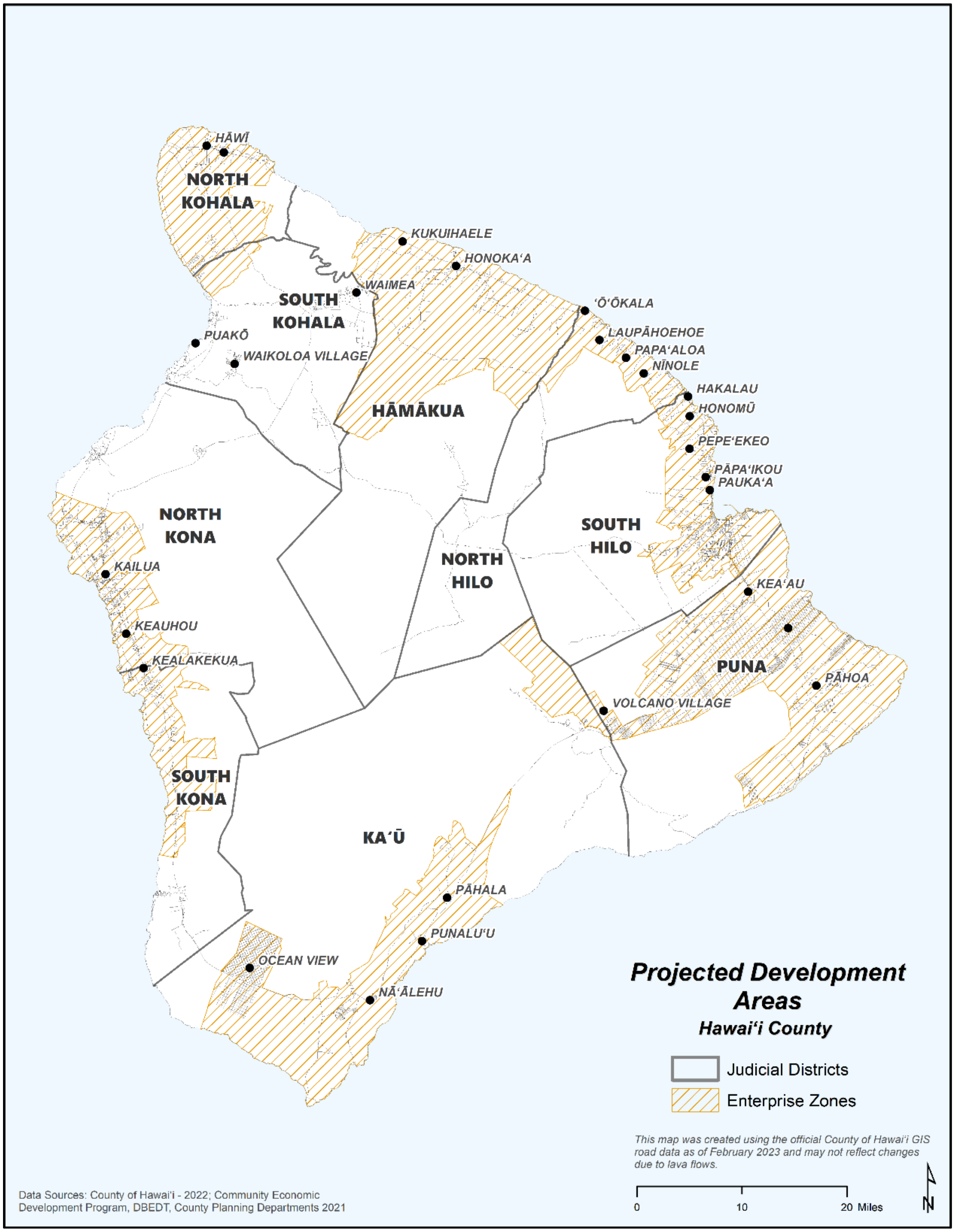


Figure D-22. Projected Development Areas in the County of Hawaiʻi



D.2 Climate Change and Sea Level Rise

There are no additional maps to support Section 4.2 (Climate Change and Sea Level Rise). Additional maps may be viewed on the Hawaiʻi Sea Level Rise Viewer located at: http://www.pacioos.hawaii.edu/shoreline/slr-hawaii/.

D.3 Cyber Threat

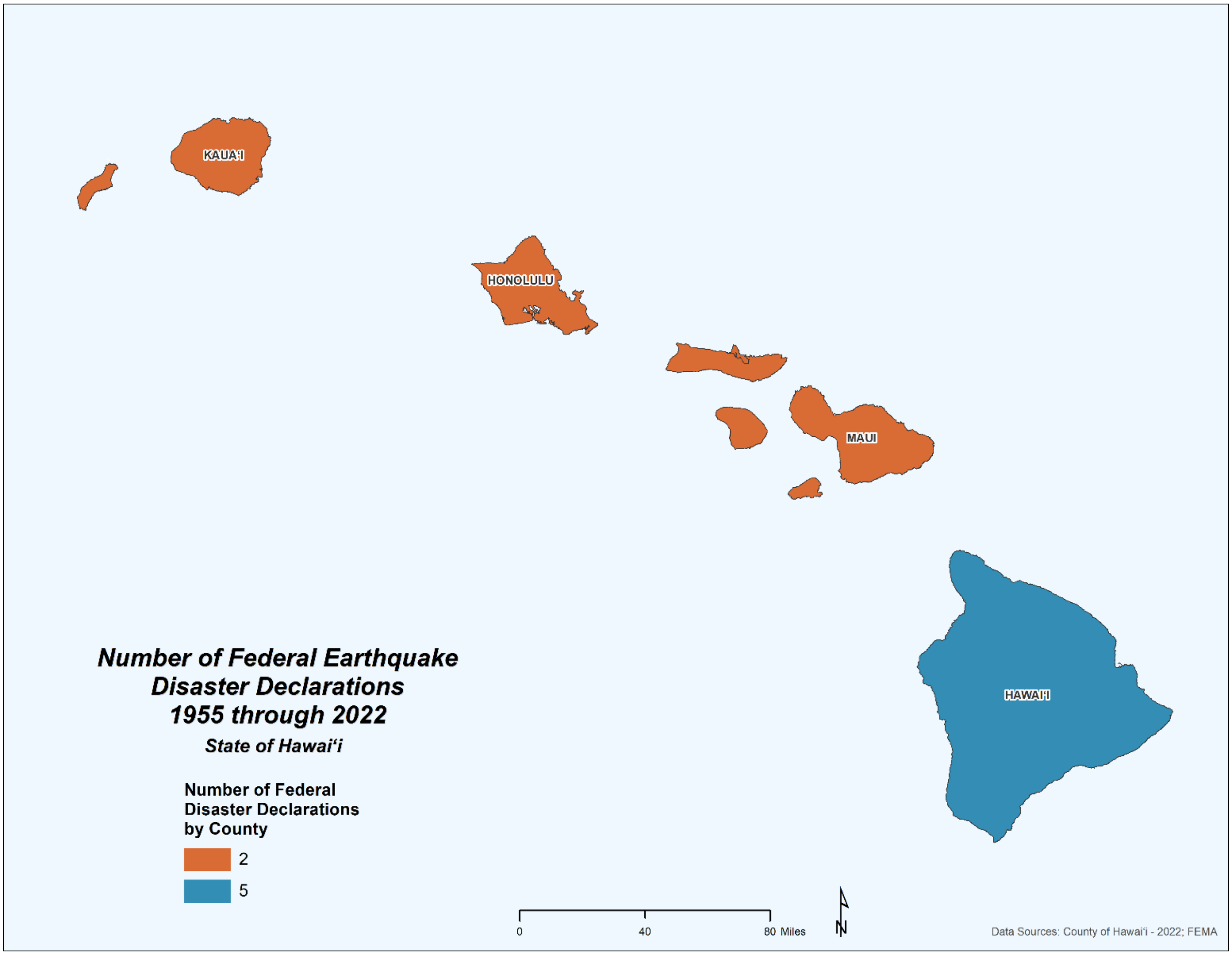
There are no additional maps to support Section 4.3 Cyber Threat.

D.4 Drought

There are no additional maps to support Section 4.5 (Drought).

D.5 Earthquake

Figure D-23. Number of Federal Earthquake Declarations in the State of Hawaiʻi (1955 through 2022)



Note: The figure illustrates the Federal declarations (DR) or emergencies (EM) declared for the State of Hawaiʻi associated with earthquakes. The FEMA Disaster Declarations Summary Open Government Dataset was queried for the earthquake hazard event. While earthquake was used to query the dataset, the incident type and title of declaration included one or a combination of the following hazard types: volcanic eruption, earthquake, seismic waves, and volcanic disturbances. More than one hazard type may be named and associated with earthquake Federal declarations.

D.6 Flood

Figure D-24. Chronic Coastal Flood Hazard Area (SLR-XA-1.1) for the County of Kauaʻi

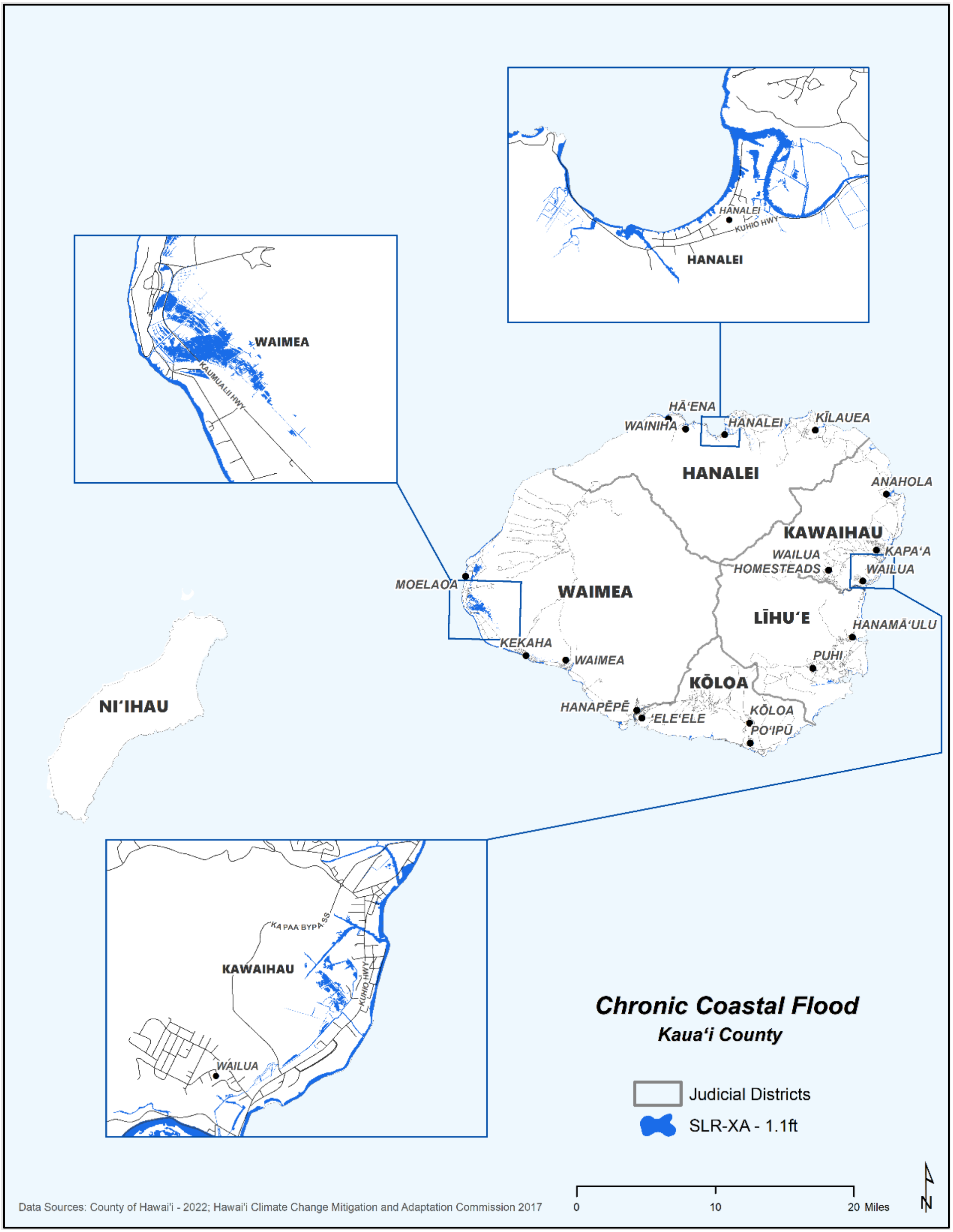


Figure D-25. Chronic Coastal Flood Hazard Area (SLR-XA-1.1) for the City and County of Honolulu

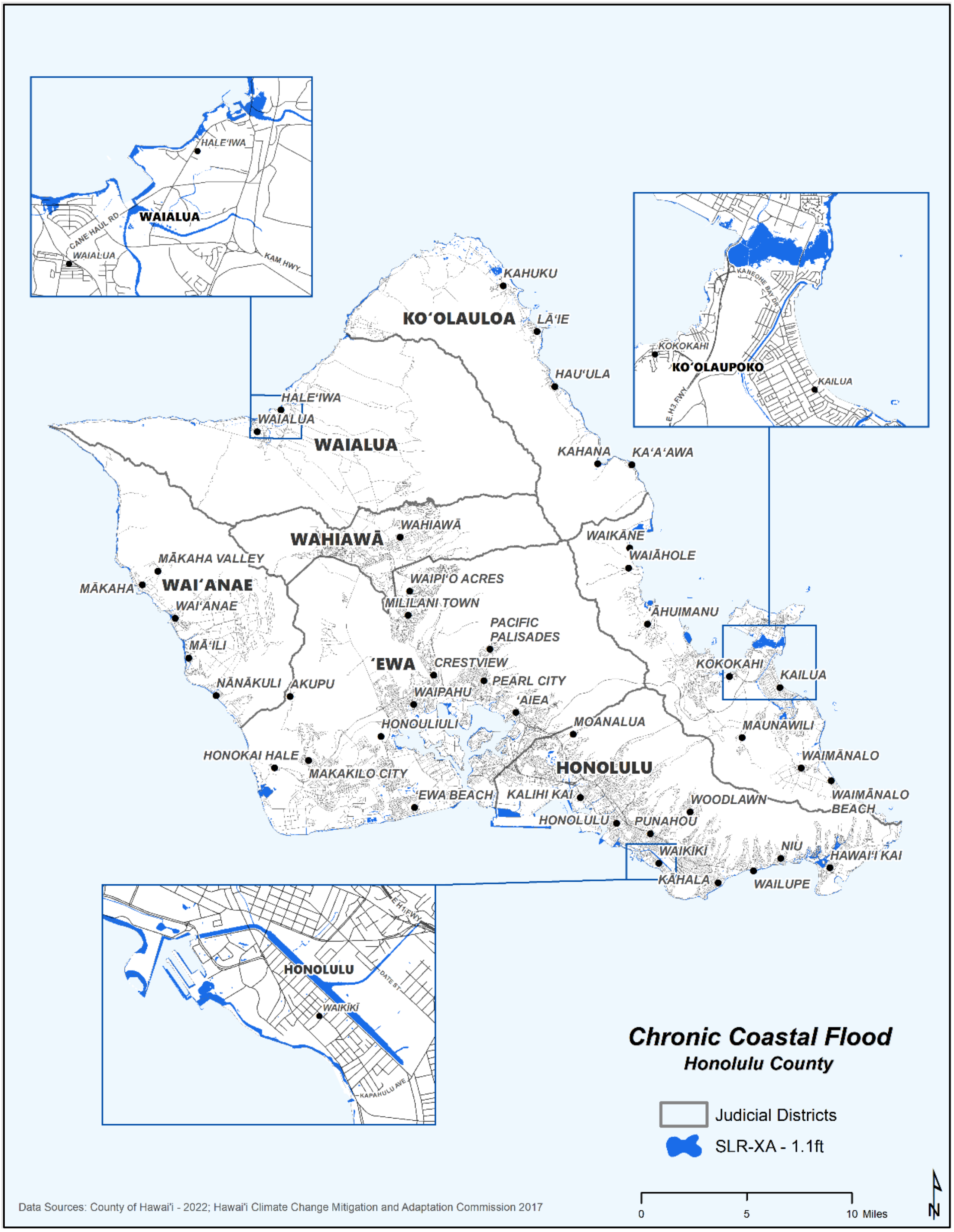


Figure D-26. Chronic Coastal Flood Hazard Area (SLR-XA-1.1) for the County of Maui

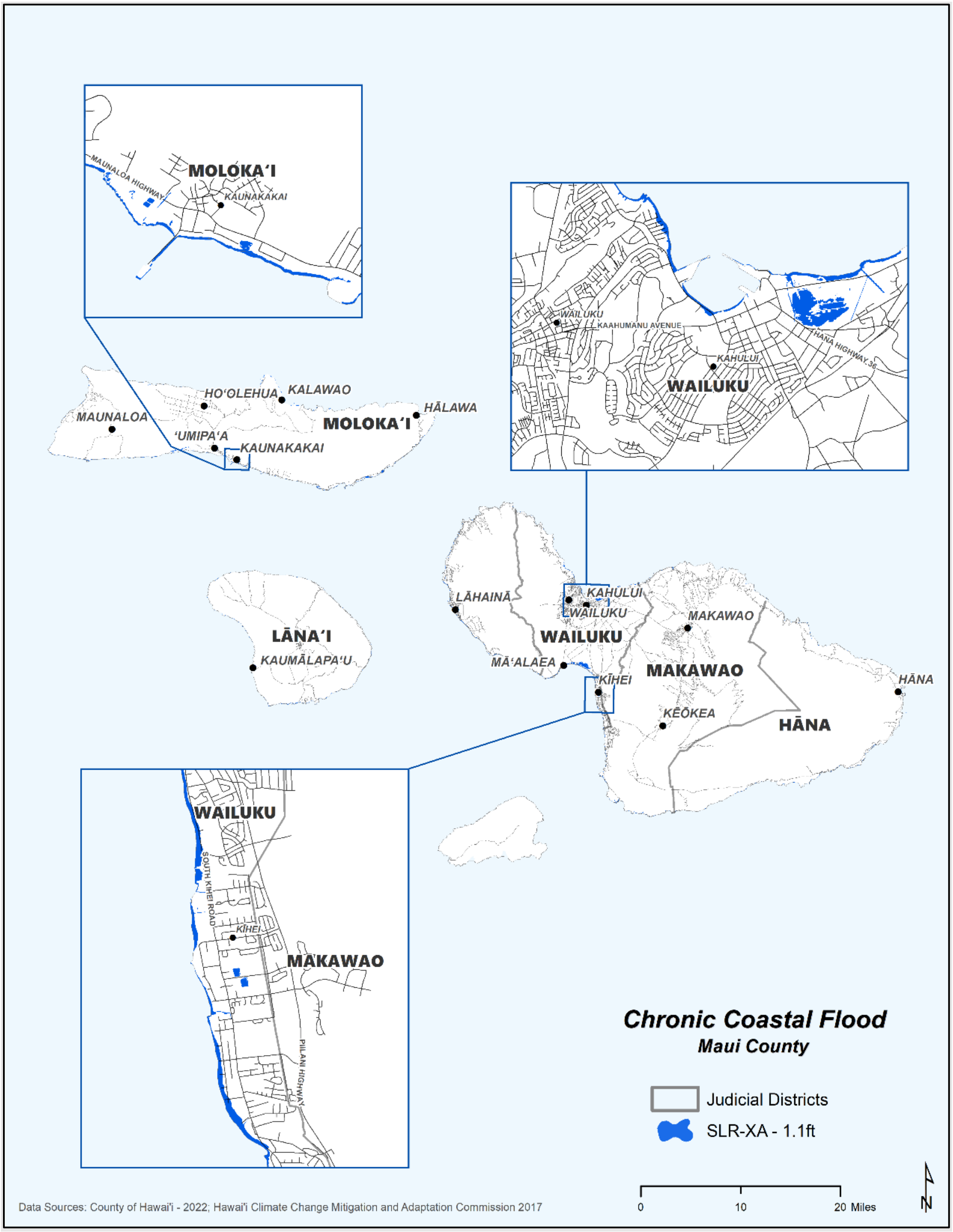


Figure D-27. Chronic Coastal Flood Hazard Area (SLR-XA-1.1) for the County of Hawai‘i

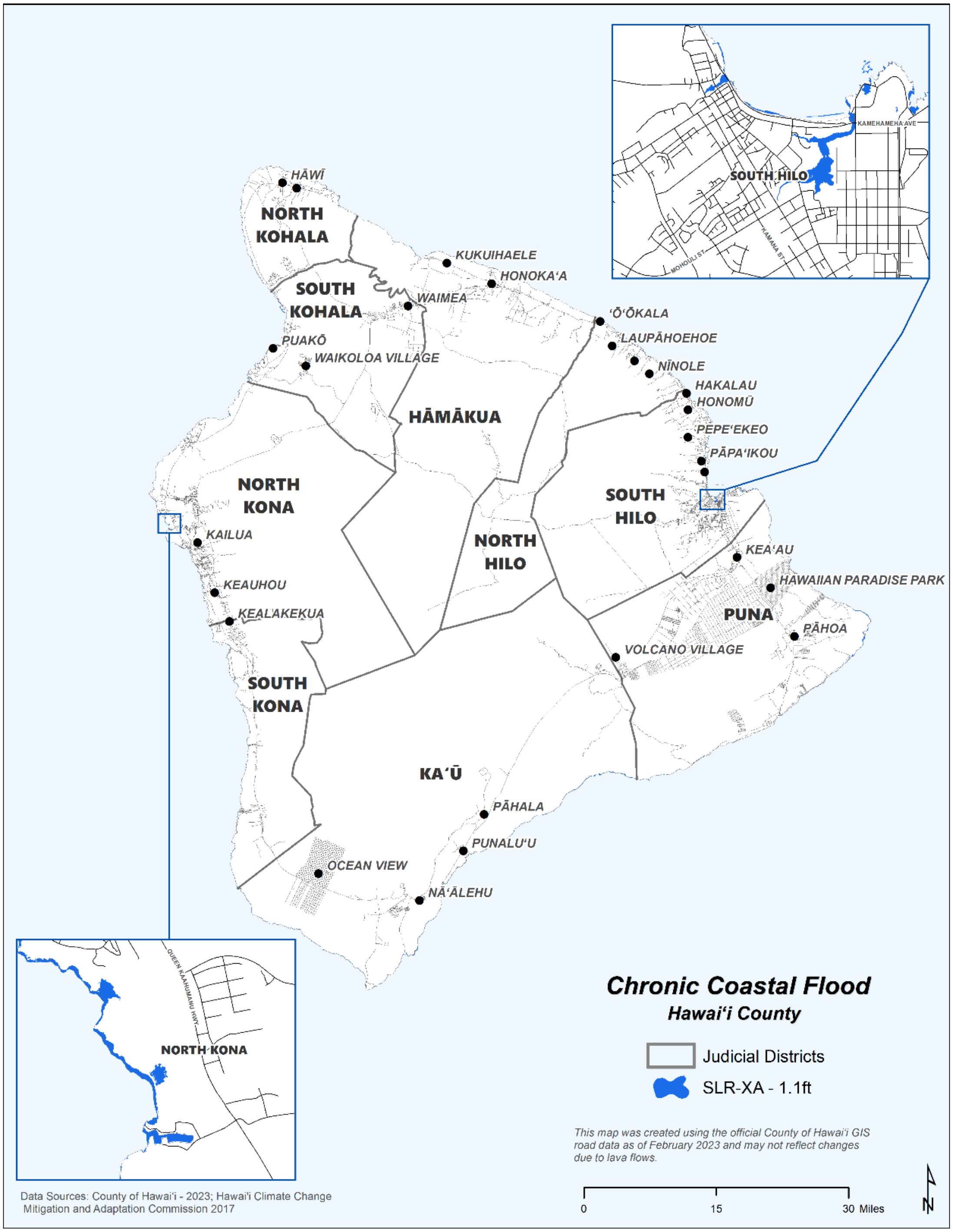
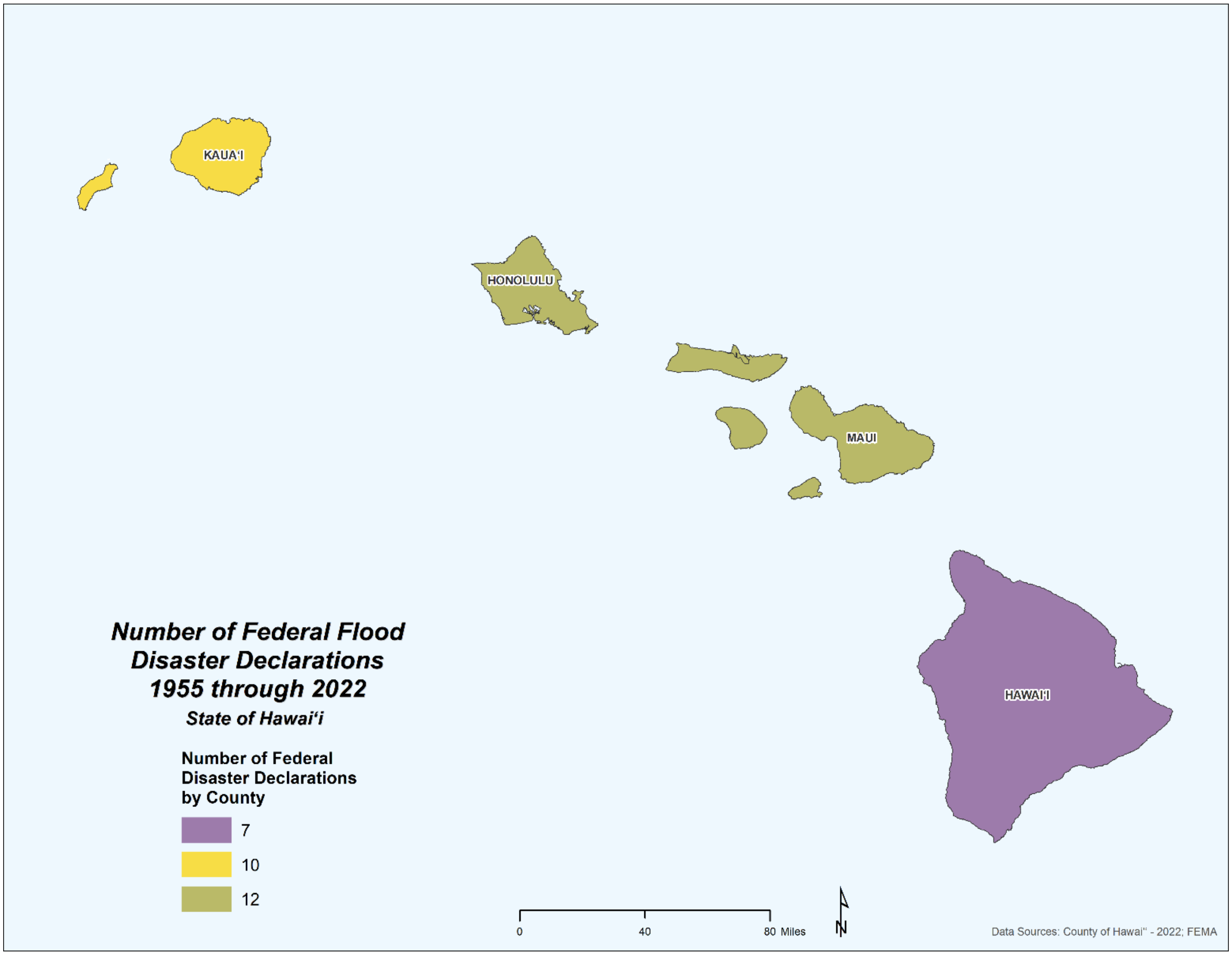


Figure D-28. Number of Federal Flood Declarations in the State of Hawaiʻi (1955 through 2022)



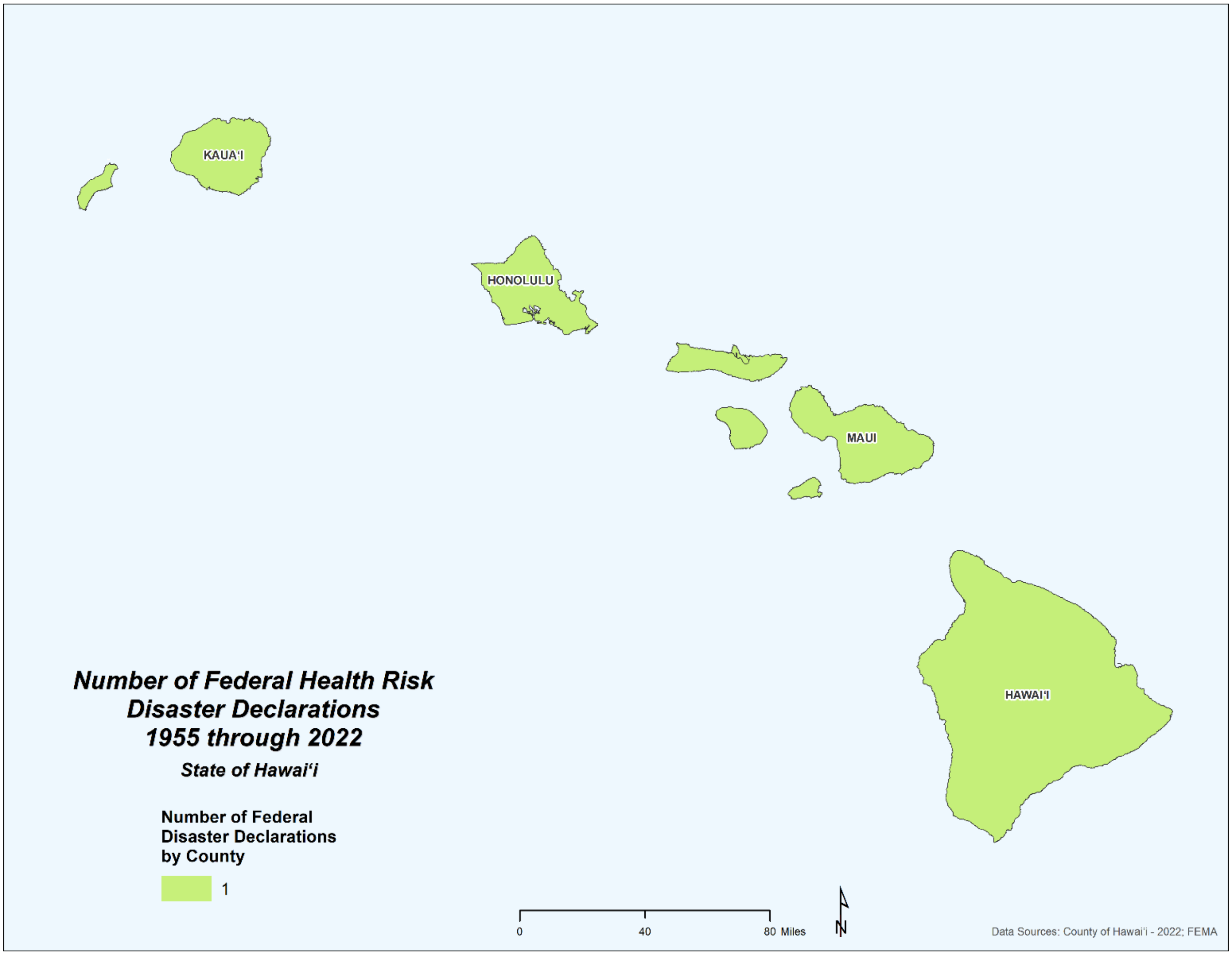
Note: The figure illustrates the Federal declarations (DR) or emergencies (EM) declared for the State of Hawaiʻi associated with chronic coastal flooding. The FEMA Disaster Declarations Summary Open Government Dataset was queried for events associated with chronic coastal flooding, including high surf. The Federal declarations associated with chronic coastal flooding include one or a combination of the following: severe storms, high wave flooding, flooding, heavy rains, and land/mudslides. One or more other hazard types, such as mudslides and landslides, may be named and associated with these disaster events.

D.7 Hazardous Materials

There are no additional maps to support Section 4.7 (Hazardous Materials).

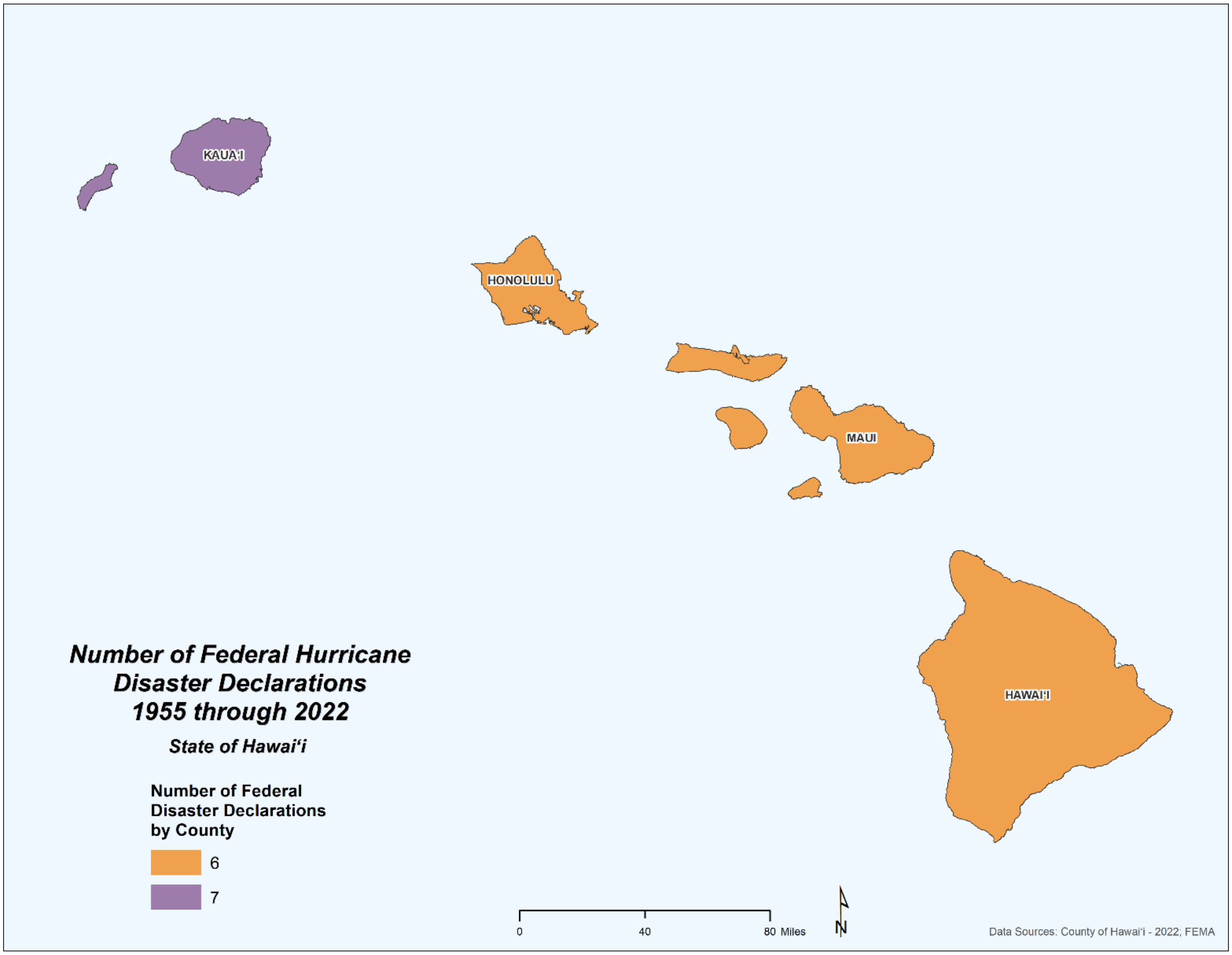
D.8 Health Risks

Figure D-29. Number of Federal Health Risk Declarations in the State of Hawaiʻi (1955 through 2022)



D.9 Hurricane

Figure D-30. Number of Federal Hurricane Declarations in the State of Hawaiʻi (1955 through 2022)

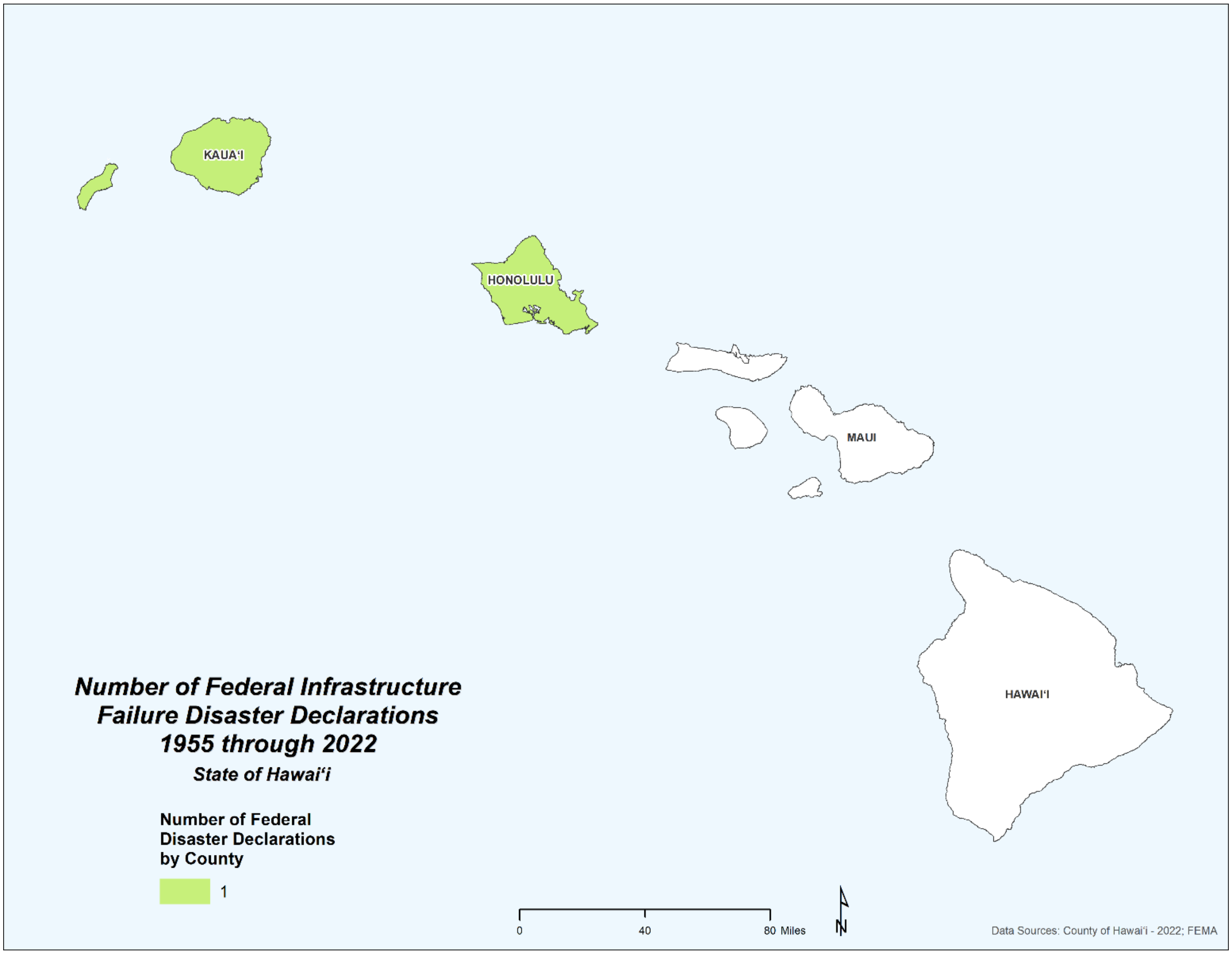


Note: The figure illustrates the Federal declarations (DR) or emergencies (EM) declared for the State of Hawaiʻi associated with hurricanes and tropical storms. The FEMA Disaster Declarations Summary Open Government Dataset was queried for events that resulted in hurricanes and tropical storms. These events included those described as tropical storms or hurricanes. More than one hazard type may be named and associated with Federal declarations.

D.10 Infrastructure Failure

Infrastructure failure maps focus on dam failure.

Figure D-31. Number of Federal Declarations that included Infrastructure Failure in the State of Hawai'i (1955 through 2022)



Note: The figure illustrates the Federal declarations (DR) or emergencies (EM) declared for the State of Hawai'i associated with a dam failure. Other hazard types are named and associated with this disaster event (DR-1640, Severe Storms, Flooding, Landslides, and Mudslides); however, it involved a dam failure event.

Figure D-32. Dam Failure Inundation Area Assessed for the County of Kauaʻi

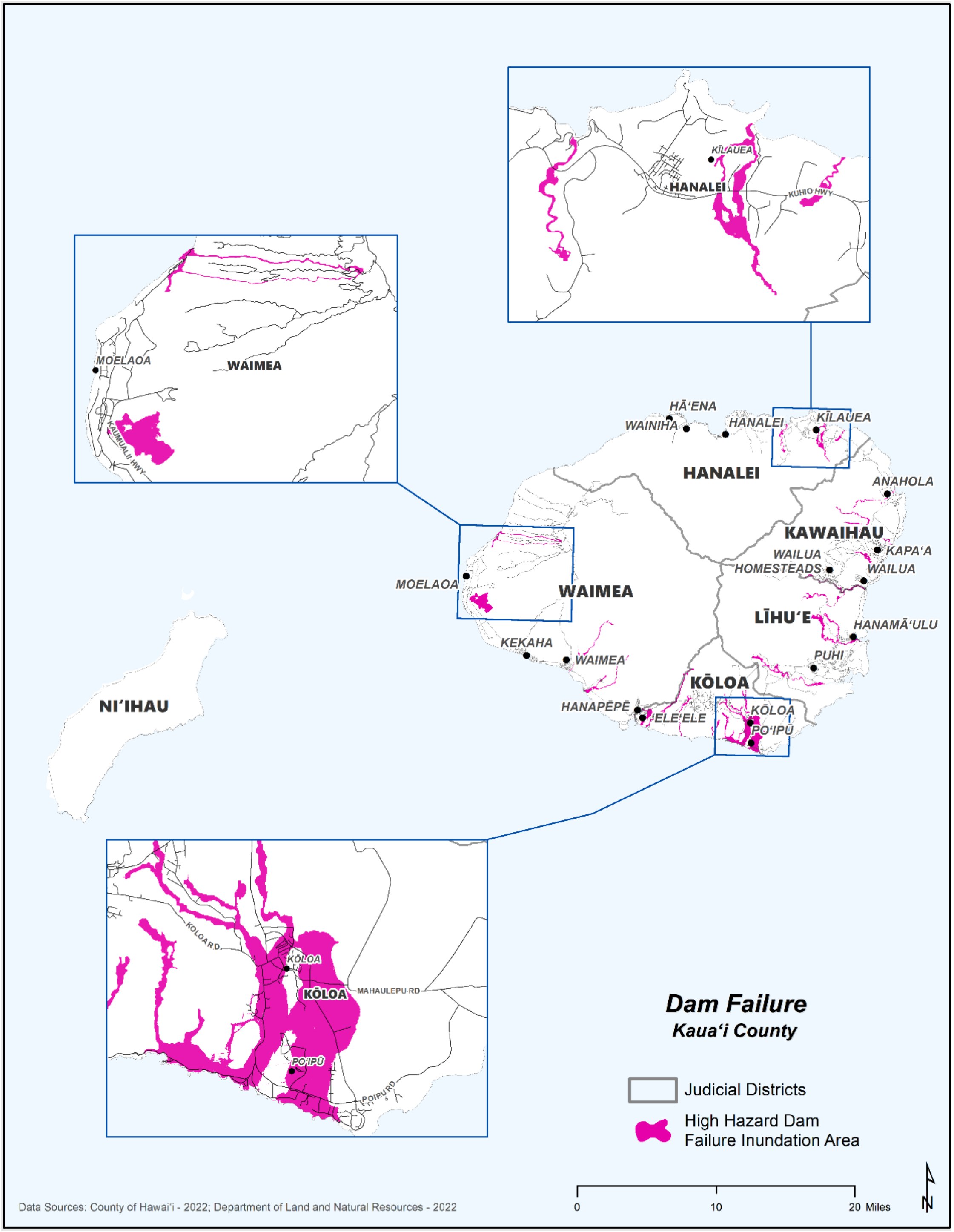


Figure D-33. Dam Failure Inundation Area Assessed for the City and County of Honolulu

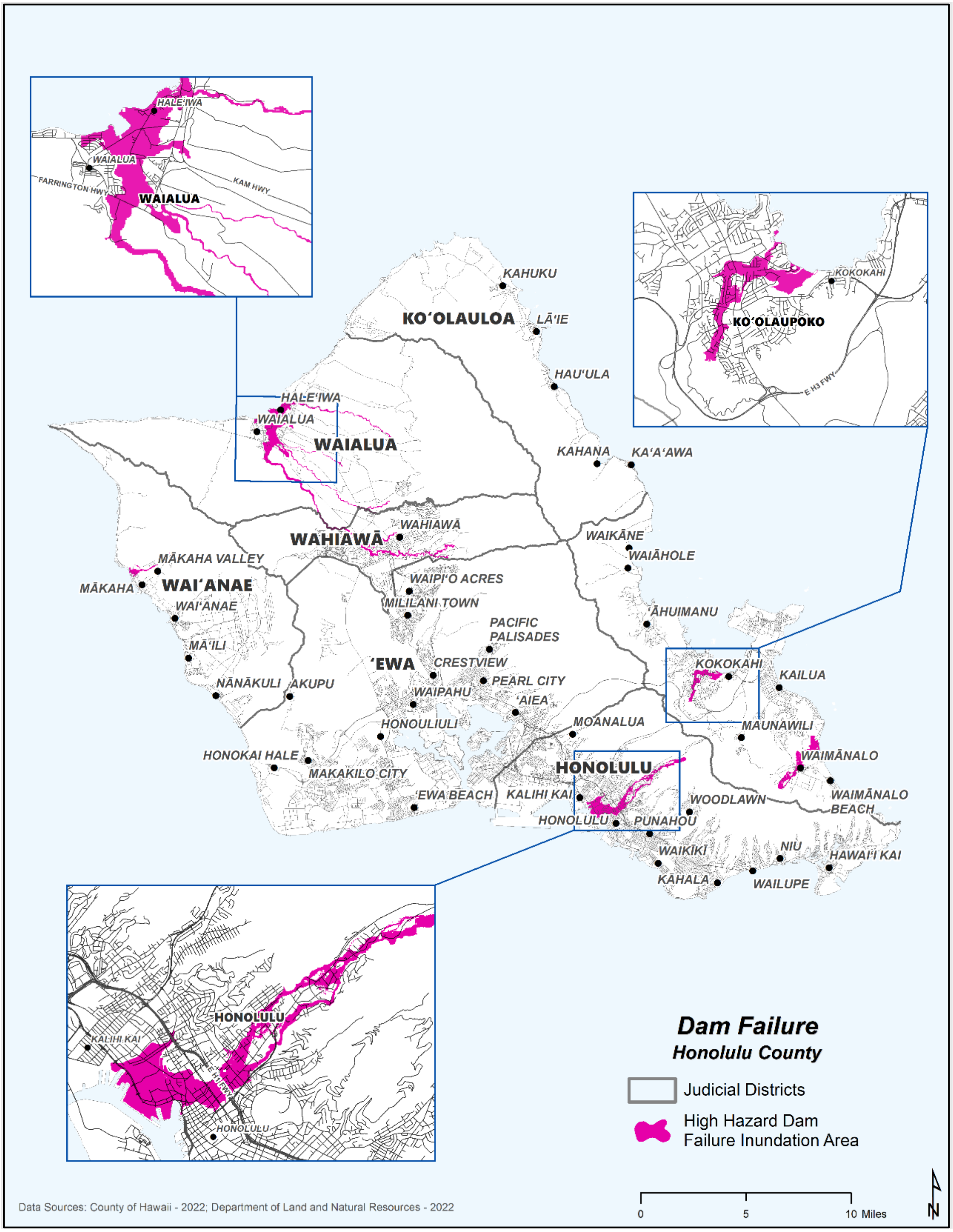


Figure D-34. Dam Failure Inundation Area Assessed for the County of Maui

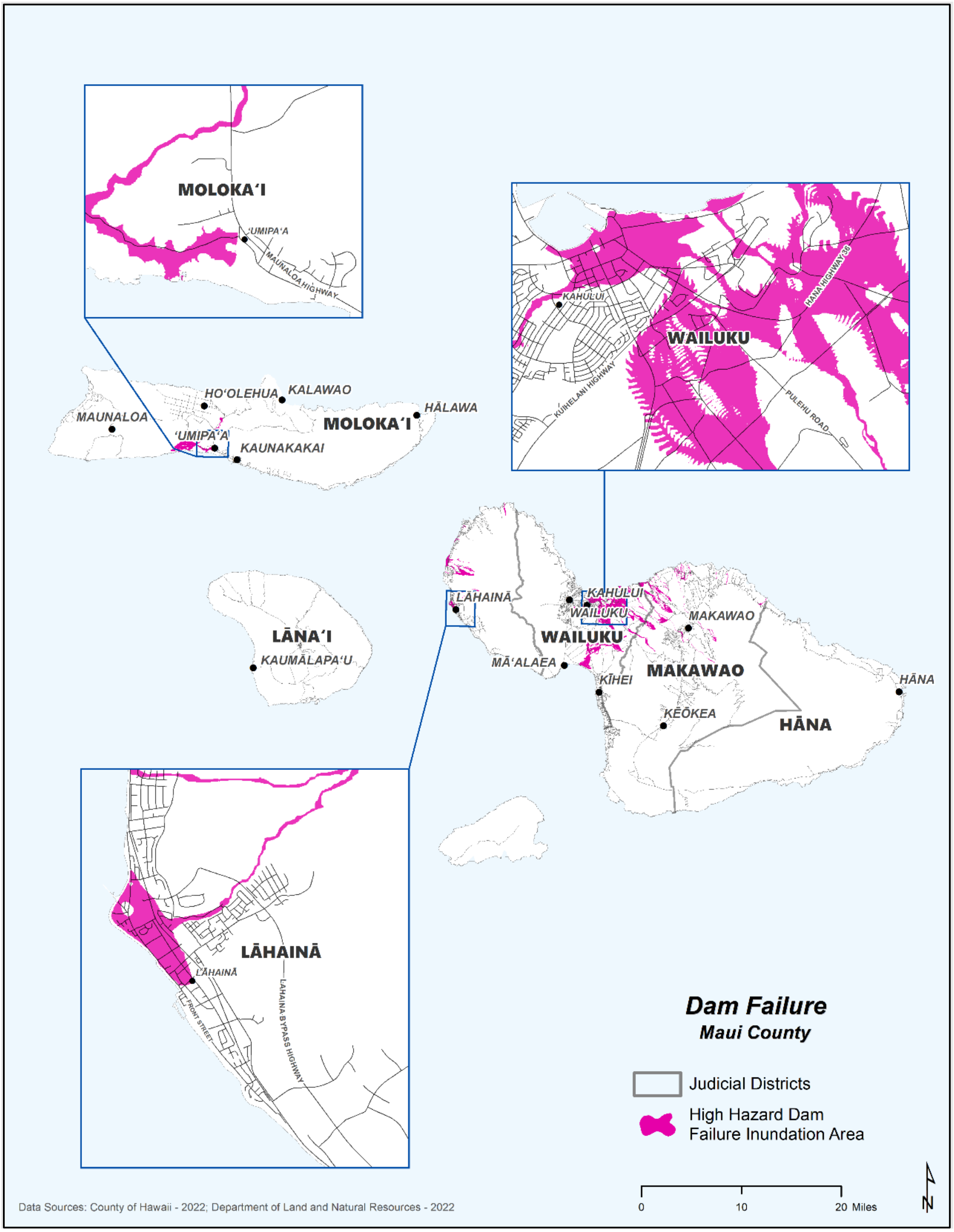
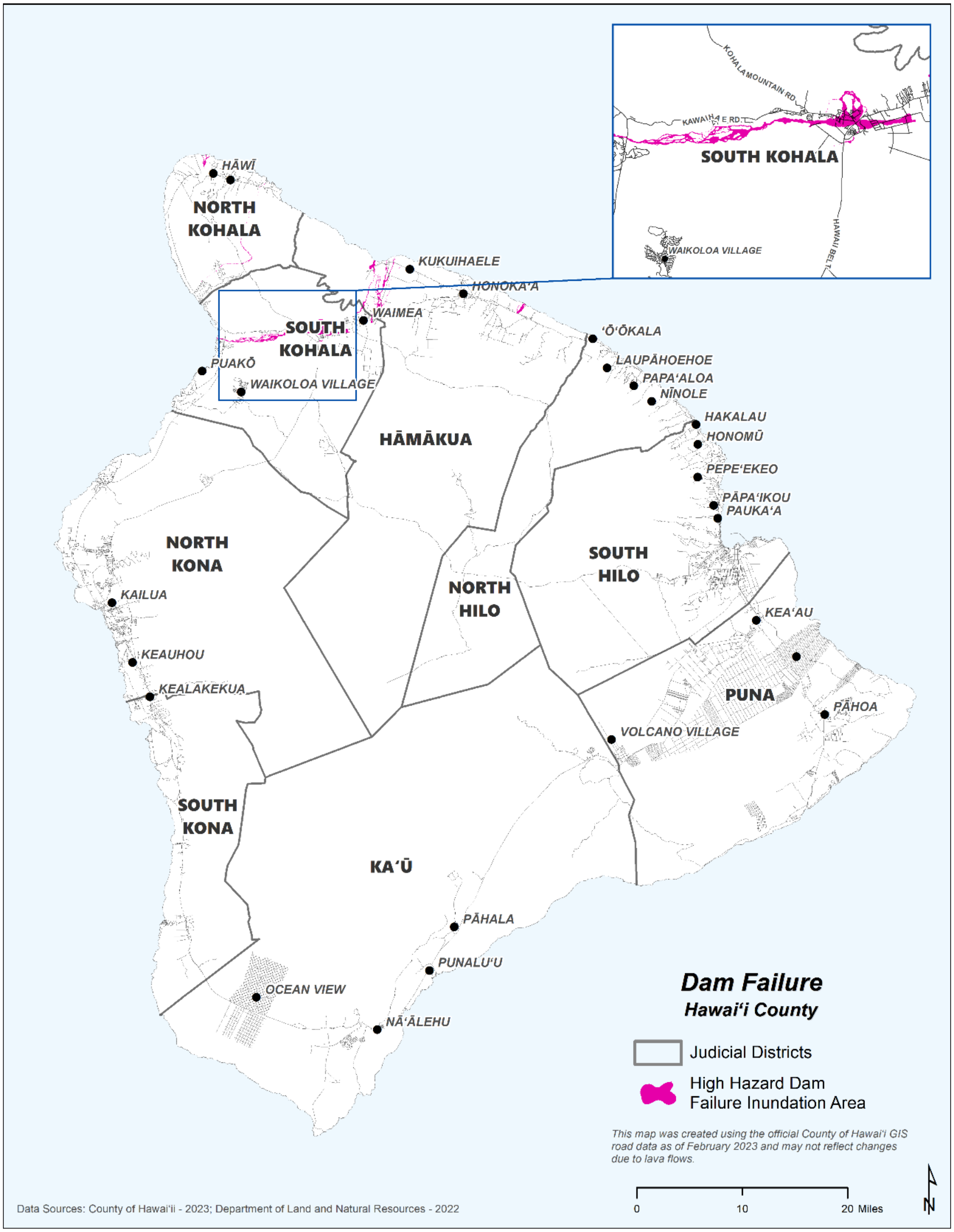
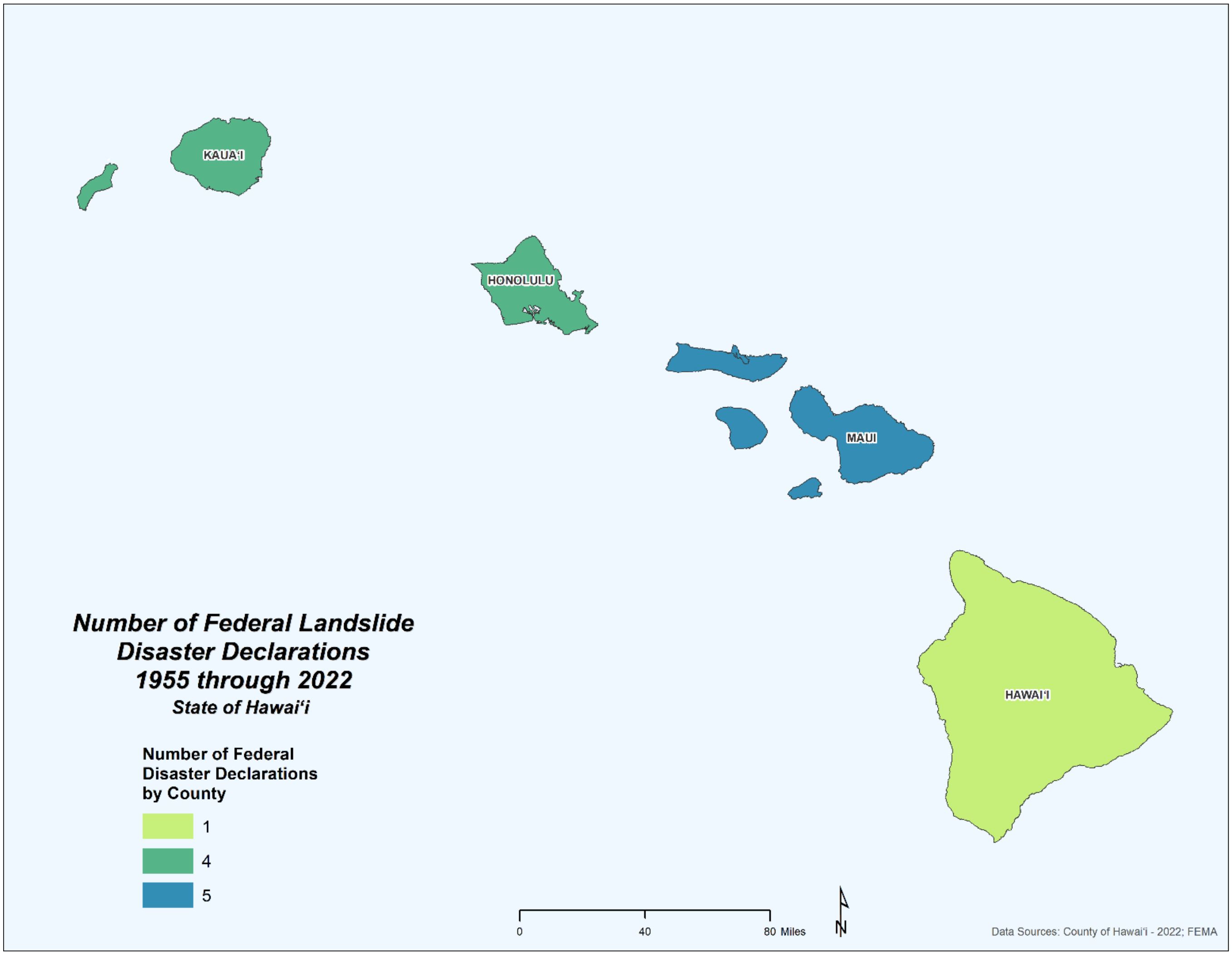


Figure D-35. Dam Failure Inundation Area Assessed for the County of Hawai'i



D.11 Landslide and Rockfall

Figure D-36. Number of Federal Landslide Declarations in the State of Hawaiʻi (1955 through 2022)



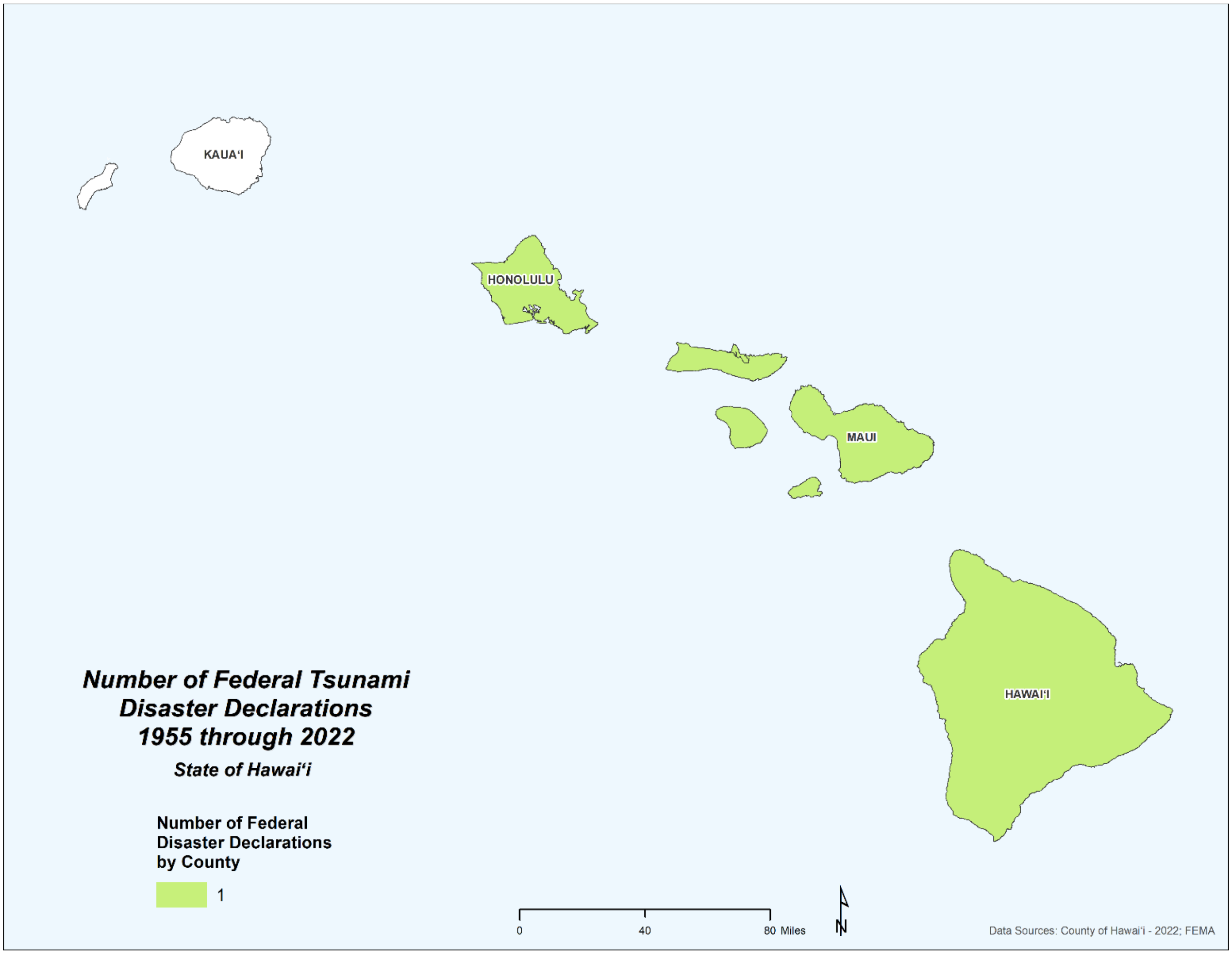
Note: The figure illustrates the Federal declarations (DR) or emergencies (EM) declared for the State of Hawaiʻi associated with landslides. The FEMA Disaster Declarations Summary Open Government Dataset was queried for hazard events associated with landslides, including landslides and mudslides. While landslide and mudslide events were used to query the dataset, the incident type and title of declaration included one or a combination of the following hazard types: heavy rains, high surf, flooding, severe storms, landslides, and mudslides. More than one hazard type may be named and associated with landslide Federal declarations.

D.12 Terrorism

There are no additional maps to support Section 4.12 (Terrorism).

D.13 Tsunami

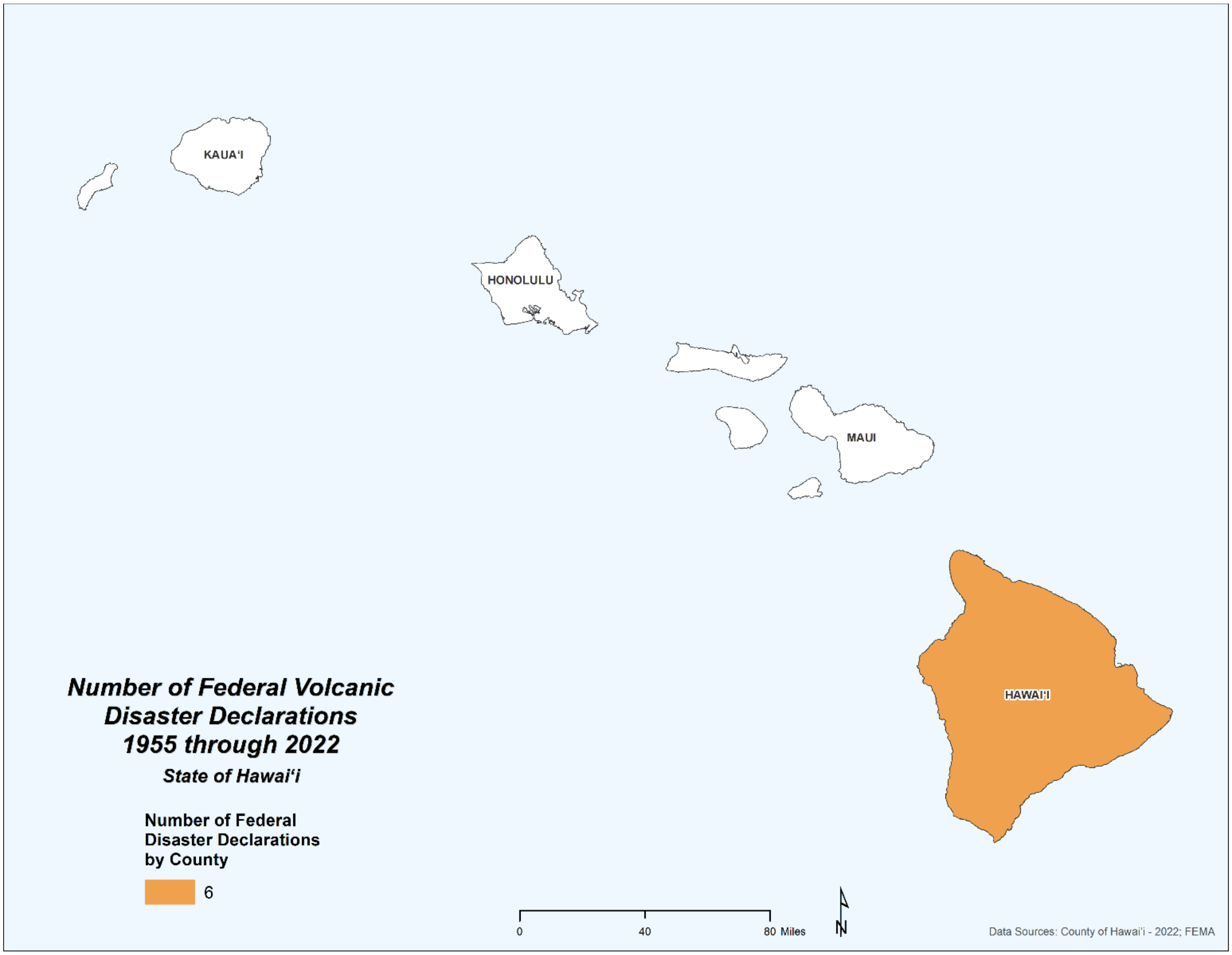
Figure D-37. Number of Federal Tsunami Declarations in the State of Hawaiʻi (1955 through 2022)



Note: The figure illustrates the Federal declarations (DR) or emergencies (EM) declared for the State of Hawaiʻi associated with tsunamis. The FEMA Disaster Declarations Summary Open Government Dataset was queried for the tsunami hazard event. While tsunami was used to query the dataset, the incident type and title of declaration included one or a combination of the following hazard types: tsunami waves and tsunami. More than one hazard type may be named and associated with tsunami Federal declarations.

D.14 Volcanic

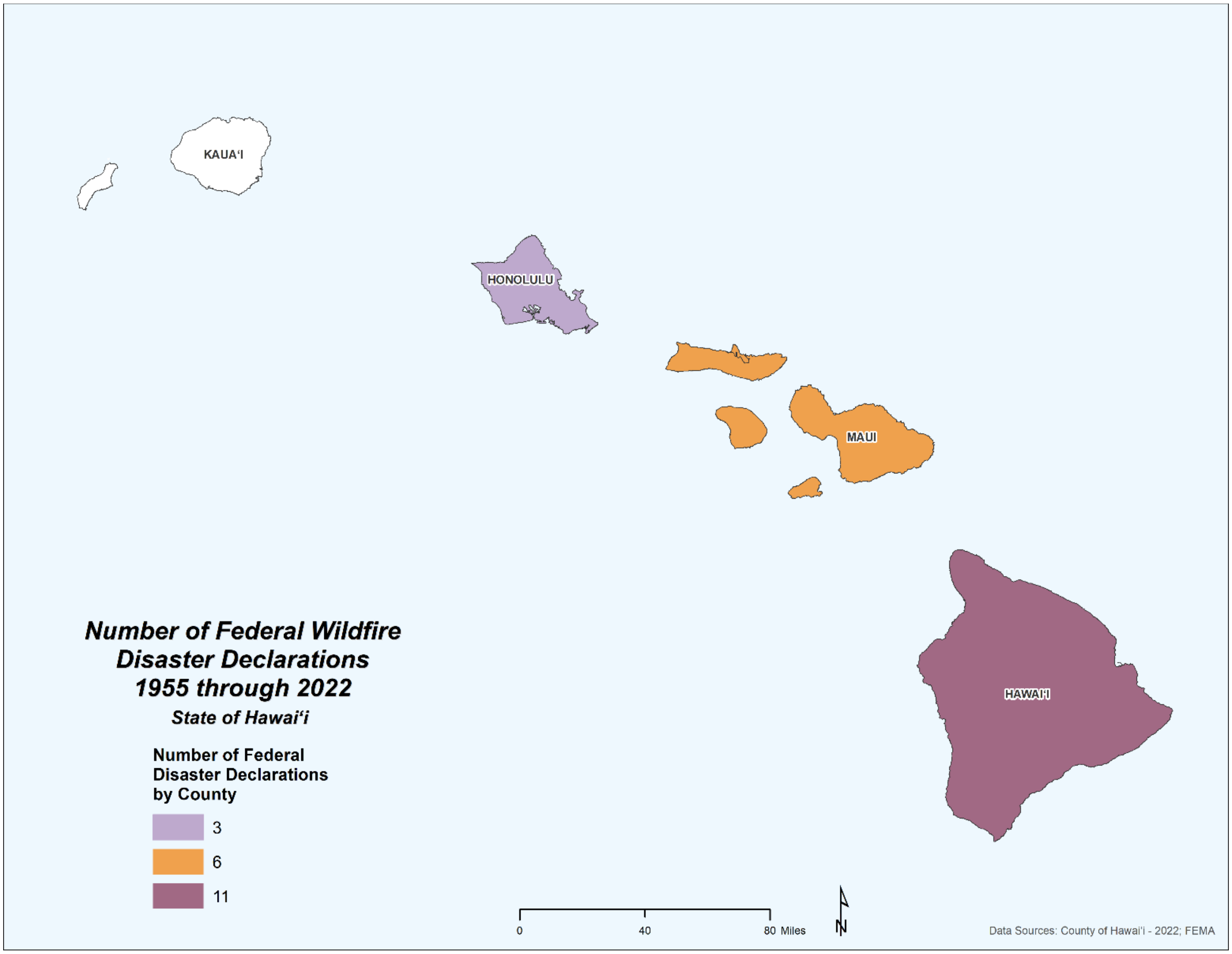
Figure D-38. Number of Federal Volcanic Declarations in the State of Hawaiʻi (1955 through 2022)



Note: The figure illustrates the Federal declarations (DR) or emergencies (EM) declared for the State of Hawaiʻi associated with volcanic events. The FEMA Disaster Declarations Summary Open Government Dataset was queried for the volcano hazard. While the term volcano was used to query the dataset, the incident type and title of declaration included one or a combination of the following hazard types: volcanic eruption, earthquakes, lava flow, seismic waves, and volcanic disturbances. More than one hazard type may be named and associated with volcano Federal declarations.

D.15 Wildfire

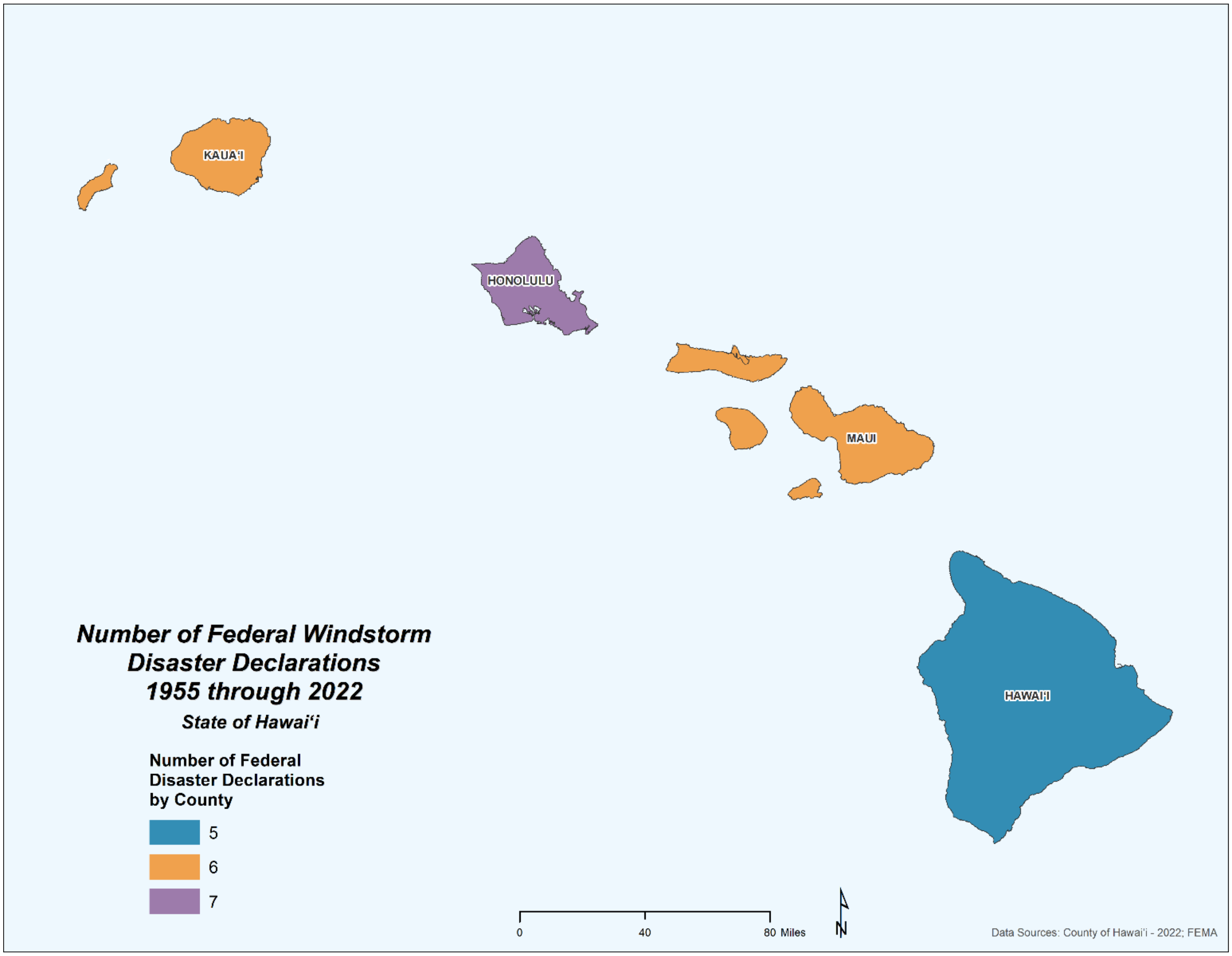
Figure D-39. Number of Federal Wildfire Declarations in the State of Hawai'i (1955 through 2022)



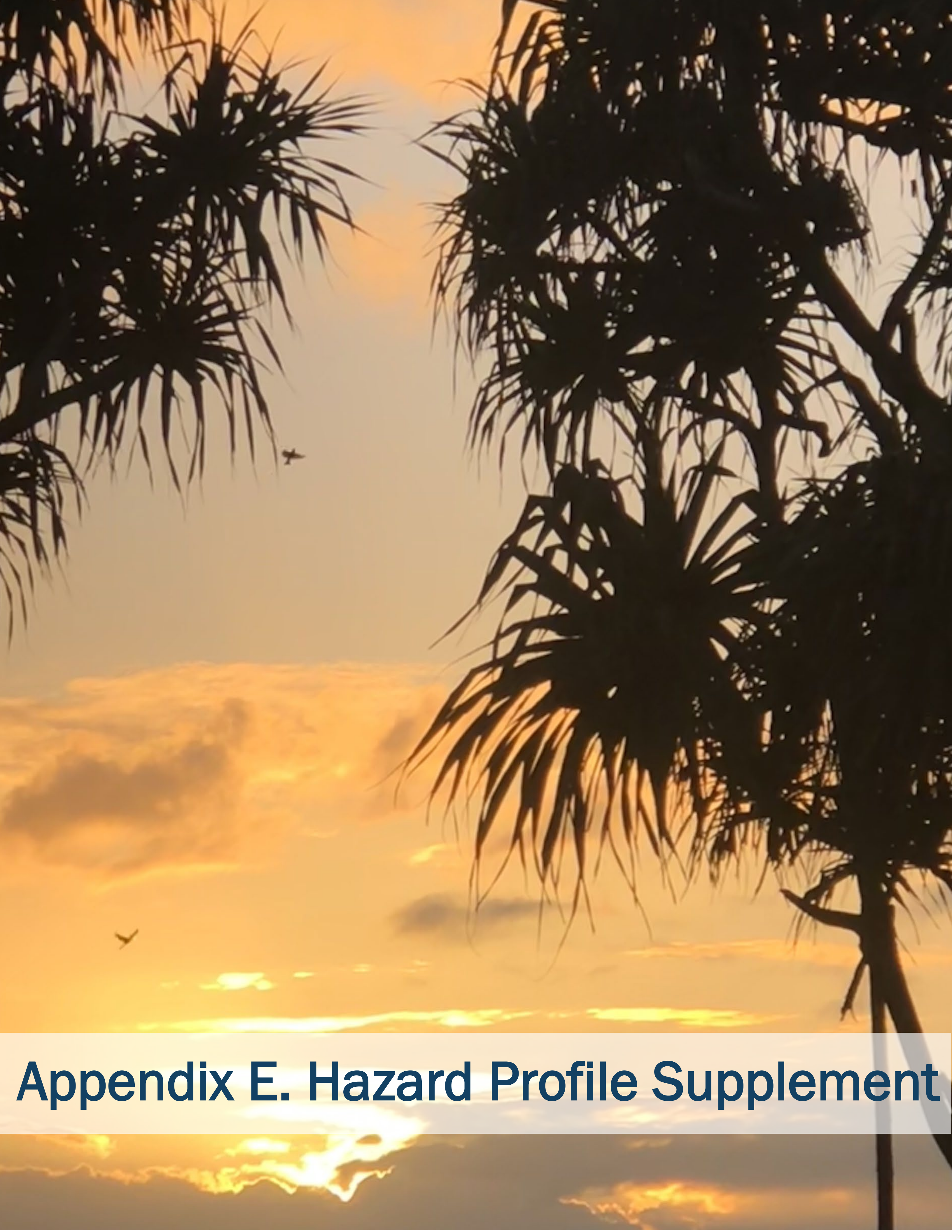
Note: The figure illustrates the Federal declarations (DR) or emergencies (EM) declared for the State of Hawai'i associated with wildfire events. The FEMA Disaster Declarations Summary Open Government Dataset was queried for the wildfire hazard.

D.16 Windstorm

Figure D-40. Number of Federal Windstorm Declarations in the State of Hawaiʻi (1955 through 2022)



Note: The figure illustrates the Federal declarations (DR) or emergencies (EM) declared for the State of Hawaiʻi associated with high wind events. The FEMA Disaster Declarations Summary Open Government Dataset was queried for hazard events associated with high wind events, including severe storms. While 'severe storms' was used to query the dataset, the incident type and title of declaration included one or a combination of the following hazard types: flooding, heavy rain, high surf, mudslides, landslides, and severe storms. More than one hazard type may be named and associated with event-based flooding Federal declarations. Additionally, it should be recognized that Federal declarations may not specify the event as a "windstorm" and may refer to the event type as a severe storm, making it challenging to distinguish whether or not the declaration is associated with tropical cyclones.



Appendix E. Hazard Profile Supplement

CONTENTS

TABLES

FIGURES

[1] *Section Cover Photo: Puna sunrise. Photo by Megan Brotherton*

APPENDIX E. HAZARD PROFILE SUPPLEMENT

This appendix contains excerpts of previous events as described in the 2013 and 2018 SHMPs. This information is compiled into one appendix for ease of reference; and is reproduced as documented in the 2013 and 2018 plans.

E.1 Climate Change and Sea Level Rise

The following presents climate change events that occurred in the State of Hawaiʻi between 1993 and 2017, as presented in the 2013 and 2018 HMPs. The information is reproduced as documented in the 2013 and 2018 plans.

E.1.1 RECOGNIZING EL NIÑO

In December 1993, the sea surface temperatures and the winds were near normal, with warm water in the Western Pacific Ocean (in red on the top panel of December 1993 plot), and cool water, called the "cold tongue" in the Eastern Pacific Ocean (in green on the top panel of the December 1993 plot). The winds in the Western Pacific are very weak (see the arrows pointing in the direction the wind is blowing towards), and the winds in the Eastern Pacific are blowing towards the west (towards Indonesia). The bottom panel of the December 1993 plot shows anomalies, the way the sea surface temperature and wind differs from a normal December. In this plot, the anomalies are very small (yellow/green), indicating a normal December. December 1997 was near the peak of a strong El Niño year. In December 1997, the warm water (red in the top panel of the December 1997 plot) has spread from the western Pacific Ocean towards the east (in the direction of South America), the "cold tongue" (green color in the top panel of the December 1997 plot) has weakened, and the winds in the western Pacific, usually weak, are blowing strongly towards the east, pushing the warm water eastward. The anomalies show clearly that the water in the center of Pacific Ocean is much warmer (red) than in a normal December.

December 1998 was a strong La Niña (cold) event. The cold tongue (blue) is cooler than usual by about 3° Centigrade. The cold La Niña events sometimes (but not always) follow El Niño events. The most recent El Niño appeared throughout 2010 with contributions to drought impacts.

E.1.2 SEA LEVEL RISE

Sea level has been rising in the State of Hawaiʻi for the past century or more (refer to Table E-1). Rates of rise vary amongst the islands due to differing rates of subsidence based on distance from the actively-growing Island of Hawaiʻi. Other observations related to climate change and sea level rise in the State of Hawaiʻi include 70% of the beaches in the State of Hawaiʻi are undergoing chronic erosion (landward retreat) and over 13 miles of beach have been completely lost to erosion over the past century fronting seawalls and other shoreline structures. This dominant trend of beach erosion appears to be driven in part by local sea level rise (Romine et al., 2013).

Table E-1. Linear Mean Sea Level Trends and 95% Confidence Intervals

Station Name	First Year	Year Range	MSL Trend (mm/year)	+/- 95% Confidence Interval	Equivalent To
Nāwiliwili	1955	61	1.65	0.45	0.54 feet in 100 years
Mokuolo'e	1957	59	1.43	0.54	0.47 feet in 100 years
Honolulu	1905	111	1.48	0.21	0.49 feet in 100 years
Kahului	1947	69	2.21	0.42	0.73 feet in 100 years
Hilo	1927	89	3.08	0.3	1.01 feet in 100 years

Source: NOAA 2018
Notes:
mm/year millimeter per year
MSL Mean Sea Level

Shoreline retreat, wetland migration, and cliff collapse due to erosion are occurring on many of the coastlines in the State of Hawaiʻi. Groundwater tables in the state's low-lying coastal plains will rise with sea level rise and increasingly contribute to chronic coastal flooding and flooding (i.e. reduced drainage) with heavy rainfall events (e.g., Habel et al., 2017). In addition, rising sea level will reduce the effectiveness and cause flooding through the state's coastal storm water drainage infrastructure.

E.2 Cyber Threat

Specific events involving cyber threat incidents were not discussed in the 2013 and 2018 SHMPs.

E.3 Dam Failure (now called Infrastructure Failure in the 2023 HMP Update)

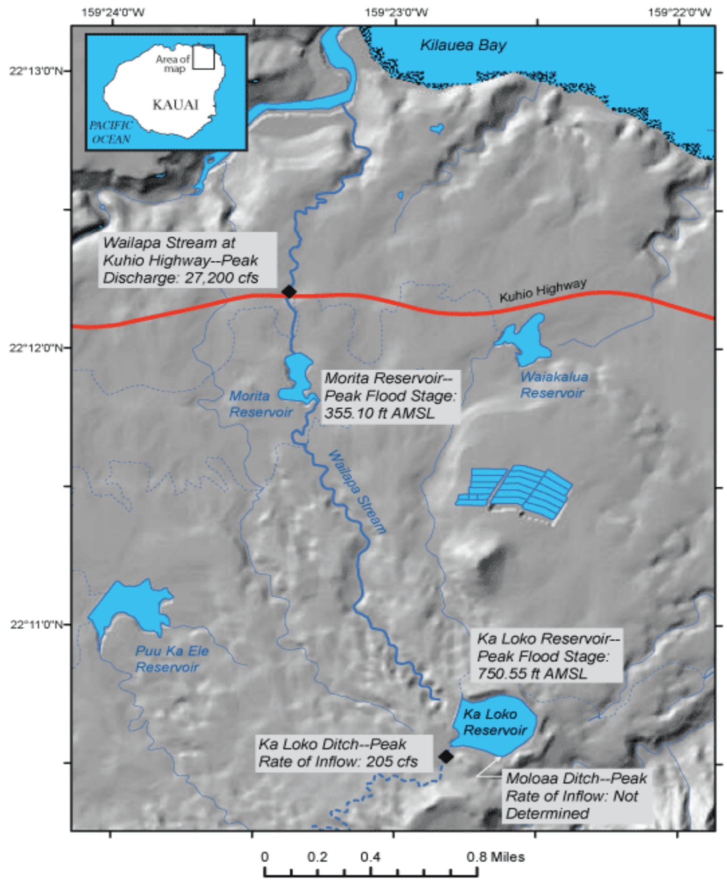
The following presents dam failure events that occurred in the State of Hawaiʻi through 2006, as presented in the 2013 HMP. The information is reproduced as documented in the 2013 plan. No new dam failure incidents occurred to include in the 2018 plan.

E.3.1 KA LOKO RESERVOIR DAM FAILURE

Ka Loko Reservoir created by an earthen dam, on the island of Kauaʻi is located on the north side of the island, at 22°10′55″N, 159°22′56″W. The Ka Loko Dam – created to store water for sugar cane irrigation – was built on the north shore of the island of Kauaʻi, County of Kauaʻi, between 1890 and 1920. Figure E-1 shows a shade relief map of the Ka Loko Dam and its vicinity.

On March 14, 2006, a 120-foot long portion of the dam breached following an unusually prolonged period of torrential rain. In an independent civil investigation of the Ka Loko Dam failure by Robert Godbey, it is acknowledged that starting February 18, 2006, the National Weather Service (NWS) issued flash flood watches for parts of the State of Hawaiʻi for 31 of the next 42 days. The Ka Loko Reservoir rainfall data from this period indicates very unusual, but not unprecedented, rainfall.

Figure E-1. Shaded Relief of Ka Loko Dam and Vicinity, Island of Kaua'i



The approximately 300-million-gallon flood and debris generated by the breach rushed downstream and destroyed several homes, devastated a 300-foot long portion of Kūhiō Highway (State Highway 56), overturned several utility poles and lines, and killed seven people. The flood generated by the Ka Loko Dam failure also affected another dam located downstream from the breach zone – the Morita dam. On March 15, 2006, State of Hawaiʻi Civil Defense officials evacuated the area downhill from Morita Dam and forced search and rescue teams to leave the area. According to a press statement by Major General Robert Lee, "the Morita Dam could go any time since half of the width of the dam's wall was gone along the downslope side". Luckily, the Morita Dam did not fail and thus subsequent damage to property and loss of life was avoided.

According to Godbey's independent civil investigation of the Ka Loko Dam failure, the breach of the dam could be attributed several possible conditions and practices: inadequate inspections of the dams by the State of Hawaiʻi, non-permitted grading operations at the dam site by the owner, inadequate maintenance of the dam by the owner, and non-enforcement of regulations by the County of Kauaʻi. A civil lawsuit by the victim's surviving family resulted in a $25 million settlement to which the State of Hawaiʻi contributed $1.5 million.

E.3.2 KĪHOLO BAY EARTHQUAKE DAMAGE TO DAMS

Following the 2006 Kīholo Bay Earthquake some damage occurred to dams and irrigation ditches in the Waimea-Kamuela area of the Island of Hawaiʻi where recorded peak ground acceleration exceeded 1.0g (soil depths are greater in that region than along the rocky coast nearest the epicenter). At least two dams experienced cracks along their crests; at least two others showed evidence of incipient slope failure on their embankments. The Pacific Disaster Center performed dam break simulations for the County of Hawaiʻi Civil Defense. Two dams located above Waimea were drained after excessive seepage and "water boils" were observed five days following the earthquakes. The Hawaiʻi State Department of Land and Natural Resources (DLNR) had in place post-earthquake dam inspection procedures. Since the Hawaiʻi Dam Safety Guidelines: Seismic Analysis & Post-Earthquake Inspections calls for inspections of dams within 75 miles of the source of an earthquake of magnitude between 6.0 and 7.0. The United States Army Corps of Engineers undertook these comprehensive inspections.

E.4 Drought

The following presents drought events that occurred in the State of Hawaiʻi between 1901 and 2017, as presented in the 2013 and 2018 HMPs. The information is reproduced as documented in the 2013 and 2018 plans.

The most severe drought to affect the Hawaiian Islands since recordkeeping of stream flows began extended from the late 1930's through most of the 1940's, and the effects were felt on all of the main islands. A moderate to severe drought affected the entire state from 1983 to 1986. Although not as intense on some islands as either the 1938-1947 or the 1970-1979 droughts, or as long, this drought caused cumulative stream flow deficits at some gaging stations that rank second for the period of record.

The period between late 1997 and early 1998 was also a year of severe drought across the state. In January 1008, for example, 36 out of 73 rain gages set up by the National Weather Service on all islands registered less than 25 percent of the norm for that period. According to the 2005 State of Hawaiʻi Drought Plan, parts of the island of Hawaiʻi (County of Hawaiʻi) received less than 10% of the average rainfall until May 1998. Similarly, rainfall was lower than the average across the island of Oʻahu, with many areas receiving less than 30 percent of normal levels. The severe drought of the late 1990's extended well into the first few years of the twenty first century.

The next period of severe drought to affect the State of Hawaiʻi was declared in 2008. El Niño conditions in the latter part of 2009 and into 2010 resulted in fewer winter storms putting the islands in severe drought conditions. On July 21, 2010, the United States Department of Agriculture designated all counties in the State of Hawaiʻi a primary disaster area due to drought that began in January 2010. In 2010, the State of Hawaiʻi was designated as the state with the worst drought in the nation. During the 2012-2013 wet season, increased rainfall helped the western half of the state (County of Kauaʻi and City and County of Honolulu) to emerge from drought conditions. However, in the County of Hawaiʻi, extreme drought conditions have persisted for five seasons, and on Maui for seven.

Table E-2 provides a summary of drought events that have impacted the State of Hawaiʻi between 1901 and 2017.

Table E-2. Drought Events and Impacts, 1901-2017

Year	Area	Remarks
1901	North Hawaiʻi	Severe drought, destructive forest fires.
1905	Kona, Hawaiʻi	Serious drought and forest fires.
1908	Hawaiʻi and Maui	Serious drought.
1912	Kohala, Hawaiʻi	Serious drought and severe sugarcane crop damage for two years.
1952	Kauaʻi	Long, severe dry spell.
1953	Hawaiʻi, Kauaʻi, Maui and Oʻahu	Water rationing on Maui; Water tanks in Kona almost empty; 867 head of cattle died; Pineapple production on Molokaʻi reduced by 30 percent; Rainfall in the islands had been 40 percent less than normal.
1962	Hawaiʻi and Maui	State declared disaster for these islands; Crop damage, cattle deaths, and sever fire hazards; Losses totaled $200,000.
1965	Hawaiʻi	State water emergency declared; Losses totaled $400,000.
1971	Hawaiʻi and Maui	Irrigation and domestic water users sharply curtailed.
1975	Kauaʻi and Oʻahu	Worst drought for sugar plantations in 15 years.
1977-1978	Hawaiʻi and Maui	Declared State disaster for these islands.
1980-81	Hawaiʻi and Maui	State declared disaster; Heavy agricultural and cattle losses; Damages totaling at least $1.4 million.
1983-1985	Hawaiʻi	El Niño effect; State declared disaster; Crop production reduced by 80 percent in Waimea and Kamuela areas; $96,000 spent for drought relief projects.
1996	Hawaiʻi, Maui, and Molokaʻi	Declared drought emergency; heavy damages to agriculture and cattle industries; Losses totaling at least $9.4 million.
1998-1999	Hawaiʻi and Maui	State declared drought emergency for Maui; County declared emergency for Hawaiʻi due to water shortages; heavy damages to agriculture and cattle industries; Statewide cattle losses alone estimated at $6.5 million.
2000-2002	Hawaiʻi, Maui, Molokaʻi, Oʻahu, Kauaʻi	Counties declare drought emergencies; Governor proclaims statewide drought emergency (2000); Secretary of the US Department of Interior designates all Counties as primary disaster areas due to drought (2001); East Maui streams at record low levels; Statewide cattle losses alone projected at $9 million.
2003-2004	Hawaiʻi, Maui, Molokaʻi, Oʻahu, Kauaʻi	Governor proclaims statewide drought emergency (2003); County of Hawaiʻi Mayor issues drought emergency proclamation (2003); Secretary of the U.S. Department of the Interior designates all counties as a primary disaster area due to drought (2004).
2007-2008	Hawaiʻi, Maui, Molokaʻi, Oʻahu, Kauaʻi	Counties experience drought emergencies and wildfires associated with drought. County of Hawaiʻi Mayor issues drought emergency proclamation (2007); County of Maui Department of Water Supply places 10% mandatory water conservation on Upcountry customers.
2009	Hawaiʻi, Maui	Drought lessens in some places, but continues in other areas.
2010	Hawaiʻi, Maui, Molokaʻi, Oʻahu, Kauaʻi	U.S. Drought Monitor records Hawaiʻi State as worst drought area in country. USDA Designates Four Counties in Hawaiʻi as Primary Disaster Areas. All Hawaiʻi Counties designated due to losses caused by drought that began January 1, 2010, and continues. The USDA Farm Service Agency is making loan and assistance programs available to qualified farmers and ranchers. All counties implement various water conservation measures (www.hawaiidrought.com).
2012-2013	Hawaiʻi, Maui, Molokaʻi,	Increased rainfall helped islands in the western half of the state to emerge from drought during the 2012-2013 wet season. According to the National Weather Service, rainfall produced by late-season cold fronts improved vegetation conditions and remedied what had been a drought. Several rain gauges in West Oʻahu recorded their highest April rainfall totals in more than 20 years, the weather service reported.

Year	Area	Remarks
2012-2014	Hawai'i, Maui, Moloka'i, O'ahu, Kaua'i	All portions of the state experienced abnormally dry to extreme drought conditions, particularly Hawai'i and Maui Counties. In 2012, the Counties of Maui, Kaua'i, and Hawai'i were declared Primary Natural Disaster Area (USDA) due to drought. Between 2013 and 2014, Maui and Hawai'i Counties were designated Drought Disaster Areas (USDA).
2014- 2015	Hawai'i, Maui, Moloka'i, O'ahu, Kaua'i	All portions of the state experienced abnormally dry to extreme drought conditions, particularly Hawai'i and Maui Counties. In 2015, the County of Hawai'i was in moderate drought. Less than one-fifth the normal average of rainfall fell at Hilo Airport in Hawai'i County.
2015-2017	Hawai'i, Maui, Moloka'i, O'ahu, Kaua'i	All portions of the state experienced abnormally dry to extreme drought conditions, particularly in the Counties of Hawai'i and Maui. In 2016, wildfires developed on Diamond Head on O'ahu (City and County of Honolulu) and voluntary water reductions were encouraged in certain locations in the County of Maui.

E.5 Earthquake

The following presents earthquake events that occurred in the State of Hawai'i between 1868 and 2017, as presented in the 2013 and 2018 HMPs. The information is reproduced as documented in the 2013 and 2018 plans.

The Island of Hawai'i has experienced 13 damaging earthquakes of magnitude 6 or greater since 1868. The largest of these occurred in 1868 in the Ka'ū district on the southeast flank of Mauna Loa with an estimated magnitude of 7.5 to 8.0. Although the 1868 earthquake caused damage island-wide, the devastation was greatest in Ka'ū where the earthquake triggered a mudflow killing 31 people and coastal subsidence generated a tsunami that destroyed several villages. Approximately 79 people were killed as a result of the earthquake of 1868 with most of the casualties resulting from the mudslide and the tsunami.

In February 19, 1871, the Lāna'i Earthquake had a magnitude of 7 or greater. Massive rock falls and cliff collapse occurred on Lāna'i as well as damages to homes. A house and several churches were flattened on the islands of Maui and Moloka'i. Two houses were reported to have split open on the island of O'ahu. Also, ground fractures and land slippages were reported in Wai'anae (island of O'ahu) and Lahaina (island of Maui).

The 1938 magnitude 6.9 earthquake with epicenter north of the island of Maui has been another of the most significant seismic events to affect the County of Maui. This earthquake was of tectonic nature, resulting from loading and bending of the earth's crust by the immense weight of the islands. The earthquake occurred on January 22 and had submarine hypocenter located about 12 miles northeast of Ke'anae Point in East Maui. Of all the Hawaiian Islands, the island of Maui suffered the greatest damage. Damage on Moloka'i and Lāna'i was small and resulted from a few ground cracks. The Hawai'i Volcano Observatory describes the damage in the island of Maui as follows:

"Landslides blocked the roads to Hāna [Pi'ilani Highway] and completely severed communications for several days. Two large oil tanks near Hāna shattered, and 30,000 gallons of oil flowed into the ocean. Ranches in southeastern Maui suffered heavy damage as water tanks and stone walls were razed. Fortunately, no lives were lost, and injuries were few. No tsunami accompanied the shock. Central and west Maui were not spared from damage. Concrete buildings cracked from Kahului to Lahaina. The fire station tower in Kahului shifted half an inch."

The Oʻahu Earthquake of 1948 was measured between 4.8 and 5.0 and resulted in broken store windows, plaster cracks, ruptures in building walls, and a broken underground water main.

A large earthquake, unrelated to volcanic activity, was located 25 miles beneath Honomū in the South Hilo district in 1973. This earthquake had a magnitude of 6.2 and caused $5.6 million worth of damage and injured 11 people.

The largest earthquake on the island during the 20th century occurred on the south flank of Kīlauea in 1975. This earthquake had a magnitude of 7.2 and caused coastal subsidence at Kalapana, generated a tsunami that killed 2 people in the Hawaiʻi Volcanoes National Park, destroyed houses in the Kaʻū district, sank fishing boats in Keauhou Bay within the North Kona district, and damaged boats and piers in Hilo, within the South Hilo district.

The most recent large magnitude earthquakes to affect the Hawaiian Islands were the Kīholo Bay and Māhukona earthquakes of October 2006. Both earthquakes, with epicenters in the Island of Hawaiʻi, were felt throughout the state. These two earthquakes, and the damage caused by them, will be discussed in further detail later in this chapter.

Two other moderate magnitude earthquakes have been recorded since the 2006 Kīholo Bay and Māhukona earthquakes, both having epicenter in Island of Hawaiʻi. The M5.4 earthquake with the epicenter at 19.346°N, 155.066°W on August 14, 2007 and the M5.2 earthquake with the epicenter at 19.328°N, 155.210°W on April 14, 2009, however, did not cause any damage . Table E-3 presents a list of earthquakes with magnitude 6.0 or greater that have occurred in the Hawaiian Islands since the mid 1800's.

Table E-3. History of Earthquakes in Hawaiʻi, Magnitude 4.0 and Greater, 1868–June 2018

Year	Date	Richter Magnitude	Source / Epicenter
1868	28-Mar	6.5 – 7.0	Mauna Loa south flank
1868	2-Apr	7.5 – 8.1	Mauna Loa south flank
1871	19-Feb	7	South of Lānaʻi Island
1908	20-Sep	6.7	Kīlauea South Flank
1918	2-Nov	6.2	Kaʻōiki, between Mauna Loa & Kīlauea
1919	14-Sep	6.1	District, Mauna Loa south flank
1926	19-Mar	>6.0	NW of Hawaiʻi Island
1927	20-Mar	6	NE of Hawaiʻi Island
1929	25-Sep	6.1	Hualālai
1938	22-Jan	6.9	North of Maui Island
1940	16-Jun	6	North of Hawaiʻi Island
1941	25-Sep	6	Kaʻōiki
1948	28-Jun	4.6	South of Oʻahu Island
1950	29-May	6.4	Kona
1951	22-Apr	6.3	Lithospheric
1951	21-Aug	6.9	Lithospheric
1952	23-May	6	Kona
1954	30-Mar	6.5	Kīlauea south flank
1955	14-Aug	6	Lithospheric
1962	27-Jun	6.1	Kaʻōiki
1973	26-Apr	6.3	Lithospheric
1975	29-Nov	7.2	Kīlauea south flank
1983	16-Nov	6.6	Kaʻōiki
1989	25-Jun	6.1	Kīlauea south flank
2006	15-Oct	6.7	Kiholo Bay, Hawaiʻi Island

Year	Date	Richter Magnitude	Source / Epicenter
2006	15-Oct	6	Māhukona, Hawaiʻi Island
2012	23-Jan	4.8	Hawaiʻi region, Hawaiʻi
2012	24-Feb	4.1	Hawaiʻi region, Hawaiʻi
2012	24-Feb	4.5	Hawaiʻi region, Hawaiʻi
2012	24-Mar	4.6	Hawaiʻi region, Hawaiʻi
2012	25-Nov	4.3	Hawaiʻi region, Hawaiʻi
2013	05-Jan	4.3	Hawaiʻi region, Hawaiʻi
2013	13-Apr	4.3	50 km northeast of Honokaʻa, Hawaiʻi
2013	05-Jun	5.3	54 km southeast of Pāhala, Hawaiʻi
2013	21-Jun	4.5	48 km north of Kualapuʻu, Hawaiʻi
2013	11-Aug	4.9	10 km south-southwest of Volcano, Hawaiʻi
2014	07-Jun	4.1	34 km southwest of Kaunakakai, Hawaiʻi
2014	07-Aug	4.5	14 km west-northwest of Waimea, Hawaiʻi
2014	12-Aug	4	30 km east-northeast of Honokaʻa, Hawaiʻi
2014	22-Aug	4.2	74 km west-northwest of Lānaʻi City, Hawaiʻi
2014	22-Aug	4.2	61 km south of Waimānalo Beach, Hawaiʻi
2014	13-Oct	4	13 km west-southwest of Pāhala, Hawaiʻi
2014	13-Oct	4	13 km west-southwest of Pāhala, Hawaiʻi
2014	13-Dec	4.2	53 km west-northwest of Kalaoa, Hawaiʻi
2015	09-Feb	4.25	12 km west-southwest of Volcano, Hawaiʻi
2015	05-Apr	4.5	12 km west of Kalaoa, Hawaiʻi
2015	09-May	4.46	13 km west-southwest of Pāhala, Hawaiʻi
2015	23-Jun	5.2	11 km south-southeast of Volcano, Hawaiʻi
2016	12-Feb	4.1	18 km south of Fern Acres, Hawaiʻi
2016	20-Mar	4.59	14 km southeast of Waikoloa, Hawaiʻi
2016	01-Apr	4.2	72 km north-northeast of Honokaʻa, Hawaiʻi
2016	23-Jul	4.32	3 km west-southwest of Honalo, Hawaiʻi
2016	06-Sep	4.05	28 km east of Hōnaunau-Nāpoʻopoʻo, Hawaiʻi
2016	18-Dec	4.5	77 km south-southeast of Hawaiian Ocean View, Hawaiʻi
2017	17-Feb	4.66	28 km west-northwest of Waikoloa Village, Hawaiʻi
2017	09-Mar	4.71	75 km north-northeast of Kualapuʻu, Hawaiʻi
2017	23-Mar	4.49	17 km south-southeast of Volcano, Hawaiʻi
2017	08-Jun	5.28	16 km southeast of Volcano, Hawaiʻi
2017	21-Jun	4.51	28 km east-southeast of Hawaiian Ocean View, Hawaiʻi
2017	30-Jun	4.21	33 km west-northwest of Hawi, Hawaiʻi
2017	19-Aug	4.1	107 km east-northeast of Hawaiian Beaches, Hawaiʻi
2018	May-Jun	0.5-6.9	Kilauea Volcanic Eruption and Earthquakes (DR-4366)

E.5.1 KĪHOLO BAY AND MĀHUKONA EARTHQUAKES

The most recent major earthquakes in the State of Hawaiʻi were the Magnitude 6.7 Kīholo Bay and Magnitude 6.0 Māhukona earthquakes that occurred on October 15, 2006 at 7:07am and 7:14 am respectively. Within a 48-hour period of these earthquakes, several aftershocks of varying magnitude occurred. Figure E-2 and Figure E-3 depict the location, magnitude, and depth of the two initial earthquakes and their aftershock. As can be seen on the figures, both the Kīholo Bay and Māhukona earthquakes were centered near the Kona coastline of the island of Hawaiʻi.

Figure E-2 Earthquakes within 48 hours of the Kīholo Bay and Māhukona Earthquakes

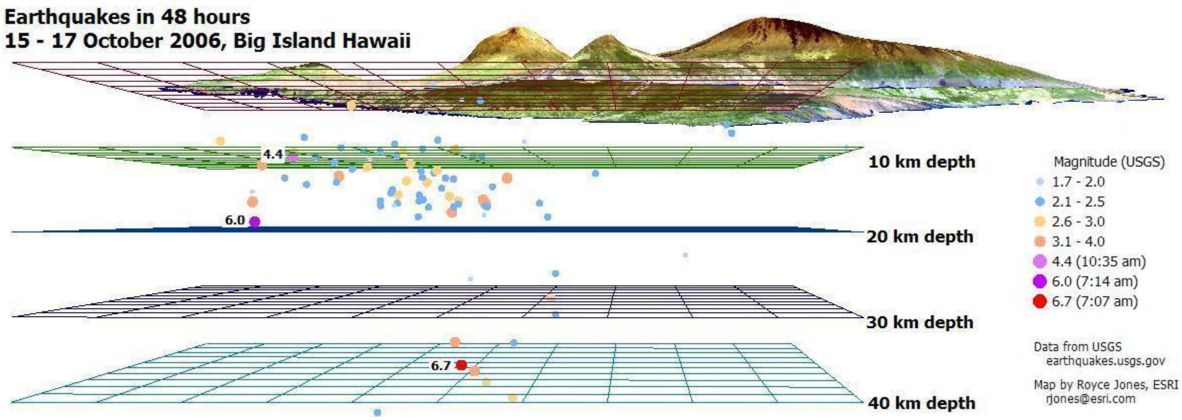
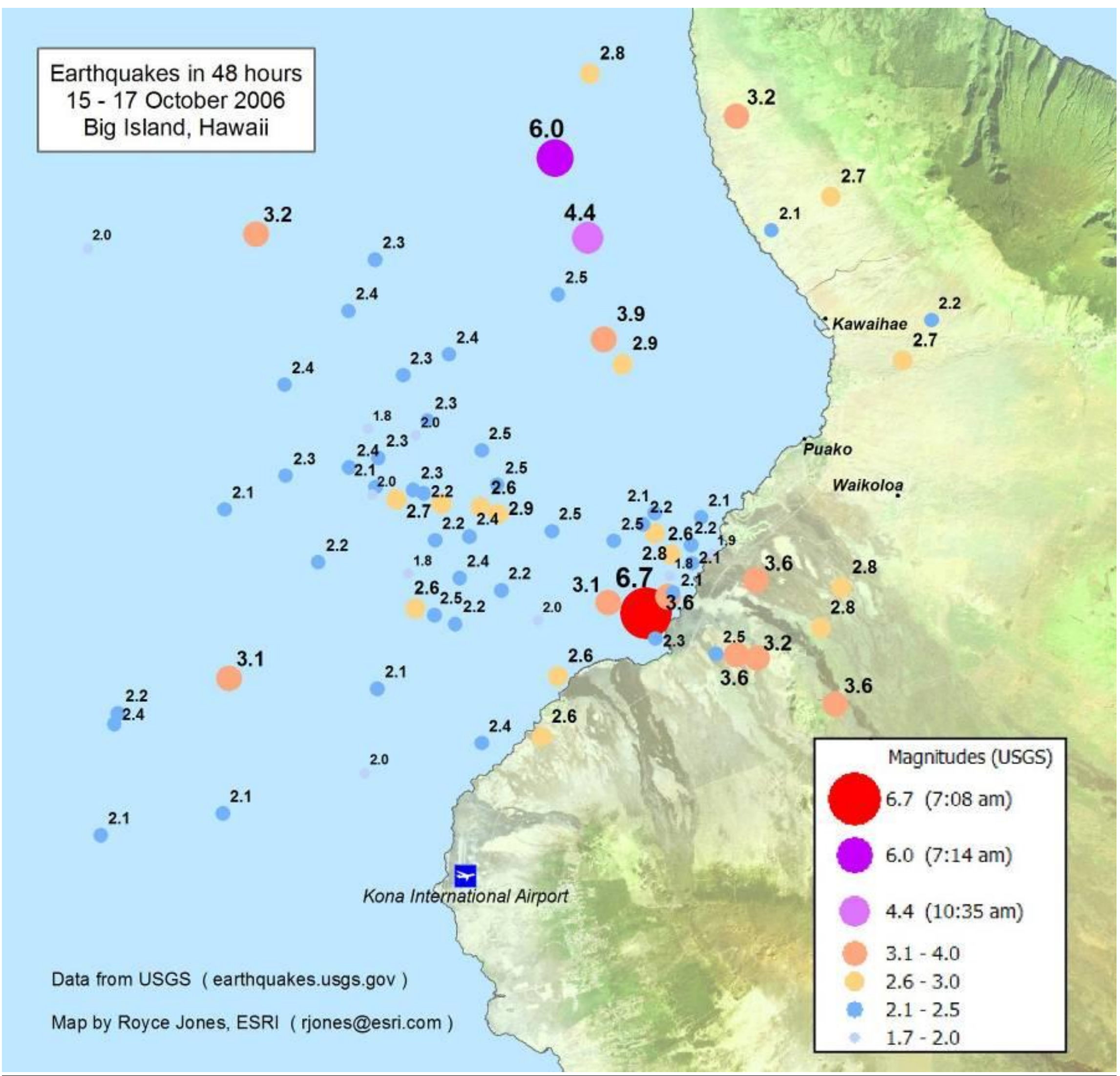
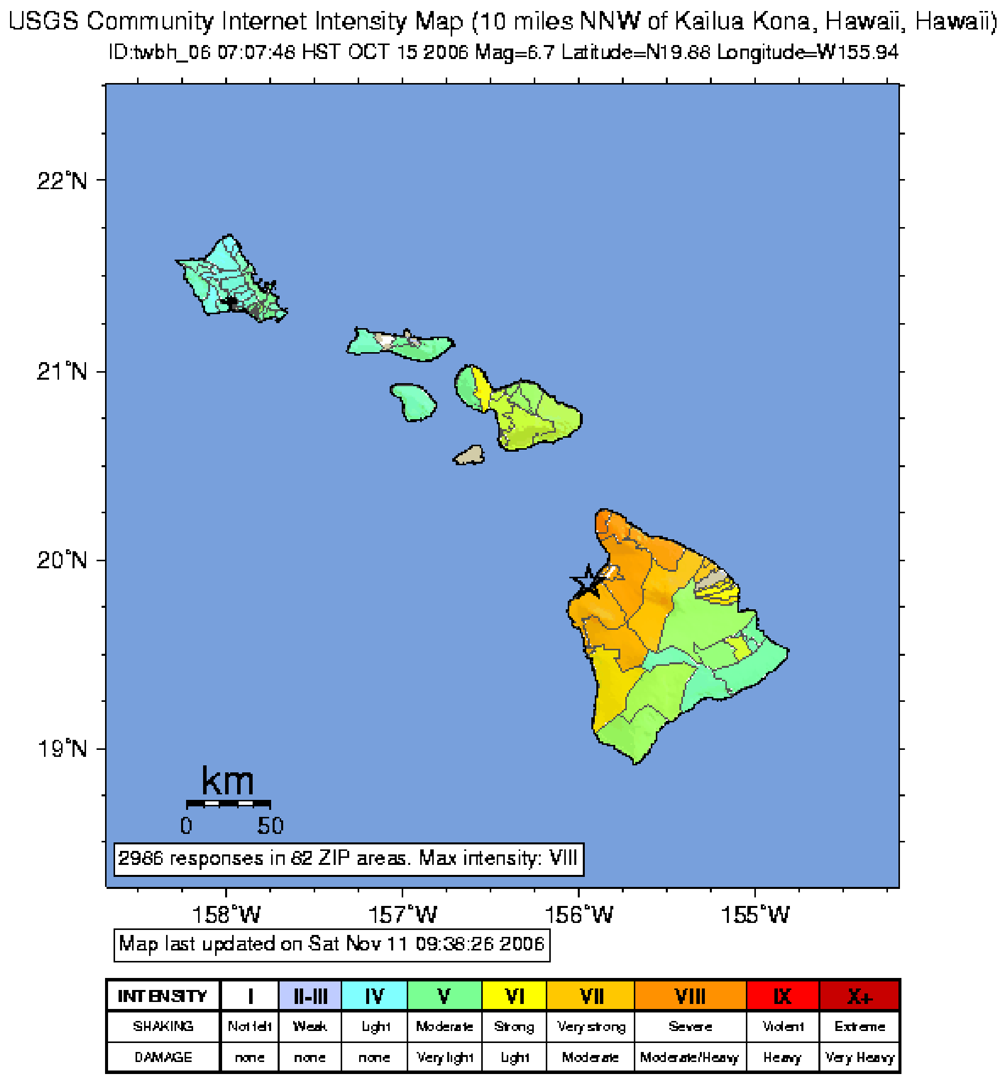


Figure E-3. Earthquakes within 48 hours of the Kīholo Bay and Māhukona Earthquakes



The largest ground shaking for these earthquakes was at the northern end of the island, but did not directly coincide with the epicenters of the earthquakes. The largest ground motions were recorded at the towns of Waimea and Hāwī. These areas had amplified ground motion due to softer soil conditions at these locations. The most heavily damaged buildings were concentrated in the Waimea and Hāwī areas with some damage also in the Honokaʻa and Kona areas. There was very little damage at the south end of the island. For reference, an intensity map of the Hawaiian Islands for the Kīholo Bay Earthquake is included in Figure E-4.

Figure E-4. USGS Community Internet Intensity Map for the Kīholo Bay Earthquake



The main October 15 Kīholo Bay earthquake probably reflected the long-term accumulation and release of lithospheric flexural stresses. The long-term stresses consist in part of stresses generated in the crust and mantle by the weight of the volcanic rock that composes the islands. Such deeper mantle earthquakes at approximately 30 to 40 km depth result from flexural fracture of the underlying lithosphere in long-term geologic response to the load of the island mass. This is one of the seismotectonic mechanisms for damaging (but not the largest) earthquakes in the Hawaiian Islands. Past examples of such "mantle" earthquakes include the 1973 M6.2 Honomū (on the northeast coast of the island of Hawaiʻi), the 1938 M7 Maui, and the 1871 M7 Lānaʻi earthquakes.

The Kīholo earthquake was the first earthquake greater than 6.0-magnitude in almost twenty years. It was not actually a single earthquake, and several aftershocks of lower magnitude followed for more than a month after the major tremors on October 15, 2007.

E.6 Flood

The following presents flood events that occurred in the State of Hawaiʻi between 1900 and 2008, as presented in the 2013 and 2018 HMPs. The information is reproduced as documented in the 2013 and 2018 plans.

E.6.1 COUNTY OF KAUAʻI

Flash floods resulting from a storm on December 14, 1991 that dropped over 20 inches of rain in 12 hours over Anahola, caused five deaths, intense flooding, bank failures, erosion, and slides, totaling more than $5 million in property damages. During recent recorded history, such events are not uncommon. On January 24-25, 1956, 42 inches of rain fell in 30 hours on the northeast side of Kauaʻi leading to 10 feet of floodwaters in the streams between Kīlauea and Anahola. The Hanalei River, which most directly drains the wettest region of Mt. Waiʻaleʻale, overflows its banks at the coast nearly every year.

On March 14, 2006, unprecedented thunderstorms and heavy rains resulted in the failure of the Ka Loko Dam on Kauaʻi, which killed seven people.

In September of 1996 for instance, 9 inches of rain were recorded in 12 hours along the coast, and an uncertain amount fell in the uplands. This event led to flooding of Hanalei town and temporary closure of the Hanalei Bridge, the residents' sole access to the rest of the island. In the western portion of Kauaʻi, the flooding hazard is primarily due to overland flows, especially after storms. The Waimea River, for example, has a long record of flooding dating back to 1916 and includes numerous occasions where its channels overflowed after storm-fed precipitation in Waimea Canyon above.

Heavy rainfall in October 31 to November 2, 2006 across much of Hawaiʻi during the period was the result of two systems. The first being left over moisture from an old front that pooled along the windward sides of the islands. The light easterly wind flow helped push the moisture over windward sections of the islands, resulting in some showers on October 30. By October 31, the destabilized further as an upper level trough of low pressure moved toward Hawaiʻi. The more unstable conditions resulted in locally heavy rainfall that persisted into the afternoon hours of November 1. Rainfall amounts during the period were quite large, especially along windward sections of Kauaʻi and Oʻahu, with some locations receiving well over 15 inches of rainfall. Some locations received over 3 inches in just a matter of 1 or 2 hours. The excessive rains produced flooding over portions of windward Kauaʻi. Earlier in the year, during the unprecedented extended wet period across Hawaiʻi (Feb 19 to April 2), several locations in Kauaʻi experienced flashflood and overflow of streams. Two subsequent High Winds and Flooding Rains weather events occurred on December 4-11, 2007 and December 10-14, 2008 causing widespread flooding in the county.

Table E-4. County of Kaua‘i Stream Flooding from Atlas of Natural Hazards in the Hawaiian Coastal Zone (updated with Events from the National Weather Service)

Date	Details
Island wide stream flood because of heavy rains	
1963 Apr 15	
1968 Nov 28	24” in 24 hours
1972 Apr 15	
1974 Apr 19	10” rain
1975 Jan 30-31	
1978 Oct 30-31	8.5” in 4 hours
1980 June 16	
1981 Aug 3-4	5-10” rain
1981 Dec 25-26	Up to 12” in 24 hours
1982 Feb 11	
1982 Oct 26-30	15-20” in 5 days
1982 Dec 23-25	3-5” rain
1986 Nov 10-11	Flash flooding
1987 Oct 15	Flash flooding
1987 Nov 4	Flash flooding
1988 Jan 28-29	10” rain
1988 Aug 2-11	
1989 Jan 10-12	Flash flooding
1989 Apr 24	
1990 Nov 20	
1992 Feb 13-14	
1993 July 21-23	Flooding Hurricane Dora
2003 Nov 29 - Dec 8	Up to 27.10” rain
2004 Aug 3-4	Up to 8.02” rain due to remnants of Darby
2005 Sept 14	Flash floods; more than 10” rain, Hanalei bridge closed
2005 Oct 1	Flash floods, Hanalei bridge closed
2006 Feb 19 - Apr 2	Unprecedented extended wet period; up to 138.79” rain; flash flooding; Kuhīo Hwy closed; Hanalei River overflowed; Ka Loko Reservoir breached
2006 Aug 7	Flash flooding; Hanalei bridge closed; Kuhīo Hwy closed; Omao Road closed
2006 Oct 31- Nov 2	Up to 10.9” rain
2007 Feb 23	Flash flooding; Hanalei River overflowed; Hanalei bridge closed; Kuhīo Hwy closed
2007 Nov 28	Flash flooding; Hanalei River rises about 12” on Nāwiliwili Road
2007 Dec 4-11	High winds (60-70 mph gusts) and widespread rains
2008 Feb 3-4	Flash flooding; Hanalei bridge closed; Wainiha bridge closed; Kuhīo Hwy and many roadways closed
2008 Oct 28	Flash flooding; Kawaihau, Kahuna, and Kamalu Roads closed
2008 Dec 10-14	Several rounds of heavy rainfall
2008 Dec 31	Flash flooding; Kuhīo Hwy closed
2009 Mar 9	Flash flooding; Kuhīo Hwy closed; Hanalei River overflowed
Western Watershed Flooding primarily due to overland flow	
1963 Apr 15	2-3 feet
1969 Jan 5	
1975 Dec 1	Kekaha

Date	Details
Wainiha/Lumahaʻl - Since 1956, 6 damaging floods of 2-3 feet	
1956 Feb	40,00cfs, 20’ in 24 hours
1968 Nov/Dec	15” in 24 hours
1971 Apr 6-7	
1974 Apr 19	10” rain at Wainiha
1975 Jan 30-31	Wainiha
1978 June 7	16.2” in 2 days at Hanakapai Stream
1981 Oct 27-28	Wainiha River
1986 Nov 10-11	Lumahaʻi River
1989 July 22-23	Wainiha
Hanalei/Waioli, Waipā Streams	
1868, 1877, 1885, 1905, 1921, 1948, 1952, 1963	serious floods
1893 Feb 14	Flash flood, Kilauea Stream
1946-1963	5 damaging floods
1955 Nov 11-12	26.1” rain, 8 ft. flooding
1956 Jan 24-25	7 ft. 44,900 cfs
1967 Dec 9	Hanalei River
1971 Apr 6-7	5 ft. at Hanalei River
1975 Jan 30-31	Hanalei
1981 Oct 27-28	Hanalei River
1982 Dec 6-7	
1986 Aug 11	Hanalei River
1988 Aug 4-11	
1989 July 22-23	
1990 Nov 16-17	
1994 Apr 12-13	10” Flash flood, mudslide
1996 Sep 7	9” in 12 hrs., Hanalei bridge closed
Kahiliwai/ Anahola	
1914 Sept	2 ft. at Anahola Stream
1932 Feb	Anahola Stream
1948 Apr 1	Anahola Stream
1956 Jan 24-25	42” in 30 hrs., 10 flooding at Kahiliwai, Aiani, Kilauea
1964 Dec	Anahola Stream
1965 May	Anahola Stream, 6 ft overland flows
1968 Nov 28	24” in 24 hours at Anahola Stream
1990 Nov 16-17	15” rain
1991 Dec 14	20” in 12 hrs at Anahola Stream
1992 Feb 13-14	Anahola Stream
1993 Oct 2	3-6” rain flash flood
1994 Apr 13	heavy rain, flash flood
Kapaʻa Stream, Wailua River	
1916 Jan 7	Flash flood
1920 Jan	Wailua River
1940 May 13-14	Wailua River
1955 Nov 11-12	Kapaʻa Stream, Wailua River 85,000 cfs

Date	Details
1956 Jan 24-25	Kapaʻa Stream, Wailua River
1963 Apr 15	Wailua River
1965 Apr	Kapaʻa Stream
1967 May	Kapaʻa Stream, 5 ft
1967 Nov 24-27	Wailua River
1968 Dec 29-31	Kapaʻa Stream, 12,800 cfs, 7 ft, 15-20" in 24 hours
1975 Jan 30-31	Wailua River
1981 Oct 27-28	Wailua River
1991 Dec 14	Kapaʻa, flash flood
Hanamāʻulu, Nāwiliwili, Hulēʻia Streams - Flooding is primarily due to runoff/overland flows	
1965 Aug 2	4.5" in 1 hour at Hanamāʻulu Stream
1968 Dec 5	10 ft at Hanamāʻulu, Nāwiliwili, Hulēʻia Streams
1975 Jan 30-31	Nāwiliwili Stream
1978 Oct 30-31	8.5" in 24 hours at Nāwiliwili Stream
Kōloa / Poʻipū - Flooding is due to overland flow	
1954, 1955, 1957, 1963, thrice 1965, 1968	major floods
1965 Aug 13	Poʻipū
1972 Apr 15	Poʻipū
1989 Aug 20-21	Flash flood, Poʻipū
Hanapēpē River, Wahiawa Stream, Kalāheo Gulch	
1879 Jan	Hanapēpē
1924-1959	11 damaging floods at Hanapēpē River
1949 Dec 17	Flash flood, 4-5 ft. at Hanapēpē
1963 Apr 15	5-6 ft. at Hanapēpē River
1967 Nov 24-27	Hanapēpē River
1968 Dec 29-31	3-4 ft. at Hanapēpē
1975 Jan 30-31	
Makaweli, Waimea - Flooding is due to overland flows after storms	
1916, 1921, 1927, 1942	Major floods
1949 Feb 7	3-8 ft., 48,000 cf at Waimea River
1973 Dec 1	
1993 Oct 2	3-6 in, flash flood
2008 Dec 10-14	Flooding in Waimea town, and closing the highway to Hanalei.

E.6.2 CITY AND COUNTY OF HONOLULU

The most frequent and severe flooding occurs where steep sloping hillsides abruptly meet flat or low-lying coastal plains, such as those found in Wāimanalo, Kailua, Kaneʻohe (November 1992), and Lāiʻe (April 1994). The heaviest rainfall during the last decade in Kaneʻohe occurred in October 1991, when 15 inches fell in 48 hours leading to intense flash flooding.

During the first 15 days of November 1996, record-breaking rainfall occurred along the Waiʻanae Coast, where 21 inches fell in an area where the average annual rainfall is 2 inches. In ʻEwa, 12.5 inches of rain fell in 7 hours on the 5th day of that month, inducing flooding of the low coastal plain. A series of slow moving storms with prolonged rains that saturated the soils of south-central Oʻahu culminated on New Year's Day of 1988 in severe runoff and hillside erosion, resulting in catastrophic damage to stream flood mitigation channels, homes, and roads in ʻĀina Haina and Niu Valleys. Other recent severe events on Oʻahu include October 1981 flooding of Wahiawā Stream after heavy rains that lead to $786,000 damage and January 1968 flooding in Pearl City, which caused $1.2 million damage.

During the last few days of November and the first week of December of 2003, several weather systems combined to bring several rounds of heavy rainfall to many parts of the state. A few locations in the Koʻolau Mountains of Oʻahu likely received over 3 feet of rain in just a 10-day period causing flash flooding and stream overruns.

During August 2-4, 2004 the remnant swirl of Darby caused excessive rainfall in all Hawaiian Islands. On August 3, the remnants moved approached Oʻahu, affecting the entire island of Oʻahu and dumping several inches of rain in a few hours. A few streams overflowed their banks and minor landslides occurred, both resulting in some road closures. The main effect was significant ponding of water on the roads, which impacted the morning rush hour.

During the late afternoon on October 30, 2004 an area of showers being pushed west by the low level tradewind flow interacted with the Koʻolau Mountains on the windward (east) side of the island of Oʻahu. As the air was pushed up over the mountains, the unstable environment allowed those showers to rapidly develop into a thunderstorm and remain focused over a small area of southeast Oʻahu. This thunderstorm, locked into place due to the terrain, produced very heavy rainfall totals in just a few hours. The focus of the heaviest rain occurred over the southern portion of the Koʻolau Mountains on the island of Oʻahu, resulting in Mānoa Stream overflowing its banks and causing significant flooding in Mānoa Valley, including the University of Hawaiʻi campus. At the height of the heavy rainfall around 7 pm, rainfall rates recorded at the gauge at the Mānoa Lyon Arboretum, in the upper portion of Mānoa Valley, were over 5 inches per hour. These large rainfall rates are estimated to occur with a return rate of almost 50 years. In other words, in any given year, there is only a 2% probability of such a heavy rainfall event like this occurring in upper Mānoa Valley.

In March 2006, Oʻahu suffered heavy rains, flooding, and severe weather for a period that lasted approximately 40 days. A series of storms around the Hawaiian Islands drew war moist air from the tropics, resulting in continuous torrential rain falling on throughout all regions of the island of Oʻahu. The intense rains resulted in the rupture of a 42-inch diameter sewer line in the tourist district of Waikīkī. As a result of the damaged sewer main, 48 million gallons of raw sewage were spilled into the Ala Wai canal, a canal that forms the northern and western boundary of the district. To repair the damage and to prevent more sewage from spilling over into the canal, an exposed new 48-inch diameter sewer line was installed in the middle and alongside the canal to serve as a temporary bypass line. Seven years later, installation of a secondary 72-inch diameter underground pipe has been completed. The new secondary pipe runs parallel to the temporary exposed bypass line. At a cost of $90 million in 2013, this new secondary line can be used to divert the sewage in case the original main ruptures again. The temporary exposed bypass line is now scheduled to be removed.

Heavy rainfall in October 31 to November 2, 2006 produced flooding over portions of windward Oʻahu and triggered a significant landslide that closed Oʻahu's Pali Highway. Two subsequent High Winds and Flooding Rains weather events occurred on December 4-11, 2007 and December 10-14, 2008 causing widespread flooding throughout Oʻahu. The December 2008 events caused severe damage in the north, west, and central sections of the island.

In January 12-13, 2011 an 11-inch rainfall caused a reservoir to overflow into O'ahu's municipal landfill, sending medical waste (including syringes and vials) and debris into the ocean north of the Ko Olina Resort, and causing closure of their beaches. The landfill was weeks away from completing a bypass route that would have diverted the storm water from the upper reservoir straight into the drainage way, avoiding the landfill cells. Had the improvements been completed, water still would have ended up in the filtration basin at the base of the landfill, but it would not have gone through the landfill cells. Additional measures were required under the latest permit allowed by the State Land Use Commission. Granted in September 2009 after much debate and controversy, the permit allowed the landfill to expand and continue operating.

Table E-5. City and County of Honolulu Stream Flooding from Atlas of Natural Hazards in the Hawaiian Coastal Zone (Updated)

Date	Details
1900 Nov 14	
1921 Jan 16	
1935 Feb 27	
1947 Feb 7	
1948 Jan 23 – 26	
1949 Jan 15 – 17	
1951 Mar 26 – 27	
1954 Jan 21	
1954 Nov 27 – 28	
1956 Jan 24 – 25	
1957 Dec 1	
1958 Mar 5	
1958 Aug 6 – 7	
1959 Jan 17 – 18	
1959 Aug 4 – 7	
1960 May 12 – 13	
1961 Oct 27	
1962 Jan 7	
1963 Jan 15 – 17	
1964 Dec 19 – 23	
1965 Feb 4	
1965 Nov 10 – 15	
1966 Sept 10 – 12	
1966 Oct 10	
1967 July 4 – 8	2 to 3 Inches
1967 July. 5 – 18	
1967 July 11 – 21	
1967 Aug 10 – 14	
1967 Dec 9	
1967 Dec 17 – 18	
1969 Dec 27 – 28	
1972 Aug 8 – 20	
1974 Apr 19	

Date	Details
1975 Jan 30 – Feb. 1	
1975 Nov 23 – 27	
1976 Feb 5 – 7	
1976 Nov 6 – 7	
1978 June 26 – July 3	
1978 Oct 30 – 31	
1980 Mar 18 – 19	
1981 Aug 3 – 4	
1981 Dec 25 – 26	
1982 Sept 1	
1982 Oct 26 – 30	
1982 Dec 23 – 24	
1984 Dec 24 – 25	
1985 Jan 29 – 30	
1986 Nov 10 – 11	
1987 July 21 – 23	
1987 Sept 2	
1987 Dec 11 – 19	
1988 Jan 28 – 29	
1988 Aug 2 – 3	
1988 Sept 26 – 27	
1988 Dec 5 – 6	
1989 Mar 1 - 4	
1989 Apr 24	
1989 July 18 – 20	
1990 Jan 14 – 22	
1991 Oct 10 – 15	
1993 July 21 – 23	
1993 Oct 10	
1994 Apr 13 – 14	
1996 Nov 5	
1996 Nov 15	
2003 Nov 29 - Dec 8	Up to 32.98” rain
2004 Aug 3-4	Up to 9.04” rain due to remnants of Darby
2004 Oct 30 - 31	Up to 10.07” rain in 12 hours, Mānoa Stream overflowing its bank causing significant damage to UH Mānoa
2006 Feb 19 - Apr 2	Up to 87.18” rain
2006 Oct 31- Nov 2	Up to 22.39” rain
2007 Dec 4-11	High winds (60-70 mph gusts) and widespread rains
2008 Dec 10-14	Several O‘ahu rain gauges recorded 10 to 13 inches in a 12-hour period.
Hale‘iwa: Since 1874 – 19 Floods	
1932 Feb 28	Wailua Stream, Flash Flood 26 – 30” in 24 Hrs. at Poamoho, Kikii, Paukauila Stream
1935 Feb 27	20” in 24 Hrs.
1939 Mar 1 – 2	Lowland Flooding
1939 Oct 22 – 23	10 – 12” in 24 Hrs.
1956 Feb 25	Flash Flood, 14” at Wailua

Date	Details
1962 Mar 13 – 15	Flash Flood
1968 Mar 13 – 18	12” in 24 Hrs.
1969 Feb 28	21” in 24 Hrs. at Anahulu, Kaukonahua, Poamoho, Opaeula, Helemano Str.
1974 Apr 19	Opaeula, Helemano, Poamoho, Kaukonahua River
1976 Feb 5 - 7	
1976 Nov 6 – 7	
1982 Jan 6	Waialua
1987 Oct 11	
Sunset Beach	
1935 Feb 27	10.24” in 24 Hrs. at Waimea River
1956 Feb 25	Flash Flood
1962 Mar 13 – 15	Flash Flood
1968 Mar 13 – 15	Waimea River; 5,270 cfs
1969 Feb 1	Waimea River; 3,860 cfs
1996 Nov 14	Widespread Flooding
1975 Jan 30 – 31	Flooding
1987 Oct 11	
1989 July 18 – 20	Waimea River, Sunset Beach
1990 Nov 20	Waimea River
Kahuku: 7 Major Floods	
1962 Mar 13 – 15	
1963 Apr 15	
1982 Feb 21	Kahawainui
1985 Feb 14	5 – 10”
Windward Coast	
1918 Apr 11	Flash Flood, Windward Coast
1924 Oct 11	Flooding of Lowlands, 11” in 11 Hrs.
1927 Mar 5 – 6	Flash Flood, Windward Coast
1932 Feb 13	Flash Flood at Punaluʻu
1956 Jan 26	Streams Overflowed
1959 Jan 17 – 18	Windward Side
1963 Apr 15	19” in 24 Hrs. at Makaua, Kaʻaʻawa, Waiahole Streams
1965 Feb 3 – 4	Flooding in Lowlands, 18” at Waiahole and Kaʻaʻawa Streams
1965 Mar 31	Flash Flood, 4.5” in 1.5 Hrs. at Punaluʻu
1965 May 2-3	Flash Flooding, 8.75” in 3 Hrs. at Kaʻaʻawa
1971 Dec 31	Kaluanui Stream, Sacred Falls, Waiahole
1982 Jan 6	Flash Floods
1982 Sept 1	Flash Floods
1984 Mar 26 – 28	6 – 15”
1985 Feb 14	5 – 10”
1985 May 6	8 – 10”
1985 Nov 18	
1986 May 10	
1986 Sept 28	
1987 Mar 24	Flash Flood at Sacred Falls

Date	Details
1987 May 5	
1987 July 21 – 23	
1992 Oct 11	Windward Oʻahu, Minor Flash Flooding
1994 Apr 12	6” in Kahuku, Flash Flooding
Kahaluʻu: Since 1936 – 20 Floods	
1965 Feb 4	3 Ft.
1965 May 2 – 3	3 – 4 Ft.
1970 Nov 24 – 26	11.5” in 4 Hrs. from Kahaluʻu to Wāimanalo
1976 Feb 5 - 7	
1994 Apr 13	HAUʻULA to Kahaluʻu, Flash Floods, Heavy Rains, Road Closures
Kāneʻohe: Since 1872 – 9 Major Floods	
1963 Apr 15	Kāneʻohe
1965 Feb 4	Kamooalii Stream
1965 May 2 – 3	5,920 cfs at Haʻikū, Lolekaa
1969 Feb 1	4 – 6 Ft.
1970 Nov 24 – 26	
1991 Oct 15 – 16	Kāneʻohe, 15” in 48 hrs., Flash Flooding
1992 Nov 26	Kāneʻohe, Heavy Rainfall, Flooding
Kailua	
1951 Mar 26 – 27	
1963 Mar 6	
1982 July 23	Flash Flooding
1987 Dec 31 – Jan 1	Slow Flood, 2 – 5 ft. at Kawainui Marsh
Wāimanalo	
1957 Feb 7	
1958 Mar 5	13.8” in 24 hrs., 3 Ft.
1963 Mar 6	
1967 Dec 9	
1967 Dec 17 - 18	
1970 Nov 24 – 26	11.5” in 4 Hrs.
1976 Feb 5 – 7	
1982 Jan 6	
East Oʻahu: 9 Major Floods	
1957 Jan	Waiʻalae, Niu Valley
1957 Feb 7	ʻĀina Haina
1958 Mar 5	2170 cfs at Waiʻalae Iki Str., Wailupe Str.
1967 Aug 9	Wailupe
1967 Dec 17 – 18	3600 cfs at Waiʻalae Iki Str., 11” in 8 hrs. at Niu Valley, ʻĀina Haina, Kuliouou
1987 Dec31 – Jan. 1	Flash Flooding at Waiʻalae Iki Str.
1990 Feb 28 – Mar 1	Niu Valley
Mānoa and Pālolo: 12 major Floods	
1904 Feb 10	Mānoa
1918 Dec 3 – 4	Mānoa
1927 May 16	Mānoa
1930 Apr 11	Pālolo

Date	Details
1948 Nov 17	Mānoa , Pālolo
1950 Dec 3	Mānoa
1977 Apr 19	Mānoa , Pālolo
Honolulu	
1898	Flash Flood at Honolulu
1911 Feb 4 – 5	Flash Flood at Waikīkī, Moiliili
1917 Mar 19	Flash Flood at Honolulu
1921 Jan 16	
1927 Dec 27	Flash Flood
1932 Feb 13	Puʻunui
1943 Jan 4 – 5	Kaimukī, Kāhala, Diamond Head, Waikīkī
1957 Feb 7	
1965 May 2	
1968 Jan 27	
1968 Oct 19	
1971 Feb 1	
1974 July 17	Nuʻuanu, Puʻunui Str.
1975 Nov 23 – 25	11” in 4 Days
1976 Feb 5 – 7	
1982 Dec 23 – 24	
1983 Feb 23	Nuʻuanu
1985 July 17	
1991 Sept 21	Kalihi to Hawaiʻi Kai, Street Flooding
1992 Oct 21	Honolulu to Kaimukī, Localized Minor Flash Flooding
1993 Oct 25	Honolulu, 2 – 4” of Rain, Thunderstorms, Flash Flooding, Street Flooding
1996 Nov 14	Honolulu, Widespread Flooding
2004 Oct 30	Mānoa , Widespread Flooding - Up to 10.07” rain in 12 hours, Mānoa Stream overflowing its bank causing significant damage to UH Mānoa
Pearl City and Barbers Point	
1879	Waikele, Honouliuli, Kipapa Str.
1904 Feb 10	Pearl City, ʻEwa
1921	Waikele, Kipapa, Honouliuli Str.
1935 Feb 27	Waikele, Kipapa Str.
1949 Dec 19	ʻEwa
1954 Nov 28	Waiawa Str, 13600 cfs, Waikele
1956 Feb 25	Waiawa Str.
1958 Mar 5	Pearl Harbor
1960 May 14	3710 cfs at Hālawa Str.
1963 May 14	1 Ft. at Pearl City
1967 May 30	Hālawa Str.
1967 Aug 2 – 11	Kipapa, Waiawa Str.
1967 Dec 9	Pearl City
1968 Jan 5	6 Ft. at Waiawa, Honouliuli
1972	Honouliuli Str.
1981 Oct 27 – 28	Waiawa Str.

Date	Details
1985 Oct 23	
1987 Sept 2	Pearl City, Waipāhu
1996 Nov 5	ʻEwa, 12.5” in 7 Hrs.
Waiʻanae	
1927 Dec 27	Flash Flood at Waiʻanae, Wailuku
1954 Nov 24	Mākaha Str.
1962 Mar 13	Mākaha Str.
1964 Dec 12, 23	Mākaha Str.
1965 Nov 13	Mākaha Str.
1976 Feb 5 – 7	Waiʻanae
1985 Jan 29 – 30	Nānākuli, Waiʻanae
1991 Sept 8	Māʻili Area, Minor Damage
1991 Oct 15 – 16	Nānākuli, 15” in 48 Hours, Flash Flooding
1996 Nov 5	Record Breaking 21” Rain for Nov. 1 – 5 (Average in 2”)
1996 Nov 14	Flash Flood, Mudslide
Wahiawā	
1994 Jul 18	4.5” in 6 hrs.
1989 Feb 10 – 11	
1990 Mar 6	Heavy Rain
1992 Oct 14	Wahiawā to Wailua, Funnel Clouds and Flash Floods
1994 Apr 12	6” in Wahiawā and on the North Shore, Flash Flooding

E.6.3 COUNTY OF MAUI

Two of the largest wave events occurred February 1993 and January 1998, when waves reached heights of 30 and 40 feet, respectively.

Of particular significance is the flash flood that occurred on April 2003 on Haleakalā National Park (Kīpahulu area) on the island of Maui. The flash flood, which occurred at the bottom of the 184-foot Makahiku Falls, resulted in the death a 39-year old man and an 8-year old girl as they were swept away by a 6-foot wall of water while crossing the stream at the bottom of the waterfall. The deaths led to a federal lawsuit by the family of the victims – ultimately the United States government agreed to pay the $5 million in 2009. According to Haleakalā National Park officials, there have been nine deaths at the falls since 1983.

Several storm events in recent years have caused flash flooding in the island of Maui. During November 29 - December 8, 2003 several weather systems combined to bring several rounds of heavy rainfall to many parts of the state. In December 1, 2003, some locally heavy rains around Olowalu with radar estimating near 10 inches caused roads flooding in the area. Heavy rainfall in October 31 to November 2, 2006 produced flooding over portions of windward Oʻahu. Along with Oʻahu, the thunderstorms brought one last round of flooding to portions of and then to Molokaʻi and Maui. Two subsequent High Winds and Flooding Rains weather events occurred on December 4-11, 2007 and December 10-14, 2008. While the December 2011 event caused widespread flooding, the December 2008 rainfall on those islands brought much needed drought relief.

Table E-6. County of Maui Stream Flooding from Atlas of Natural Hazards in the Hawaiian Coastal Zone (Updated)

Date	Details
Molokaʻi and Lānaʻi - Island wide stream flood because of heavy rains	
1971 Jan 27-28	Storm, flooding
1980 Jan 6-14	Flooding
1981 Oct 27-28	Flash floods
1981 Aug 3-4	Flooding
1981 Dec 25-26	Flooding
1982 Mar 17	Flooding
1982 Mar 30-31	Flooding
1982 Aug 14-16	H Kristy, flash floods
1983 Dec 24-25	Flash floods
1984 Dec 24-25	Flash floods
1985 Feb 14	Flooding
1985 Oct 17-18	Flash flooding
1986 Nov 10-11	Flash floods
1987 Apr 21-22	Flash floods
1987 May 5-6	Flooding
1988 Sep 26-27	Flooding
1988 Nov 4-5	Flooding, up to 10”rain
1988 Dec 5-6	Flooding, over 10” rain
1989 Feb 10-11	Flooding
1993 July 21-23	Flooding, remnants of H Dora
2003 Nov 29 - Dec 8	Up to 6.46” rain
2004 Aug 3-4	Up to 1.39” rain due to remnants of Darby
2006 Feb 19 - Apr 2	Up to 14.93” rain
2006 Oct 31- Nov 2	Up to 6.51” rain
Kaunakakai, Molokaʻi	
1950 Nov 30	Flash flooding at Kaunakakai
1961 Oct 31-Nov 3	Storm, flash flooding
1997 Jan 19-20	Street flooding
Kamalō, Molokaʻi	
1961 Oct 31-Nov 3	Flash flooding at Kamalō
1965 Apr 13	Flash flooding along SE Molokaʻi
Hālawa, Molokaʻi	
1961 Jan 1	Flooding, 10,900 cfs at Hālawa Stream
1961 Oct 31-Nov 3	Flooding at Kawela Gulch
Kualapuʻu Gulch, Molokaʻi	
1916 Jan 1	Flash floods at Kualapuʻu Gulch
Halepalaoa Landing, Lānaʻi	
1985 Oct 17-18	Flash flooding on Lānaʻi
Maui - Island wide stream flood because of heavy rains	
1900 Nov 14	Flash flood
1906 Dec 23	Flash flood

Date	Details
1916 Jan 14	Flash flood
1918 Apr 18	Flash flooding
1930 Nov 18	Flash flooding
1946 Jan 2	Flood
1946 Dec 20	Flash flooding
1948 Apr 2	Flash flood
1950 Nov 30	Flash flood
1951 Feb 22	Flash flood
1960 May 12-13	Flooding
1961 Oct 24	Flash flooding
1963 Mar 13	Flooding
1965 Jan 23	Flash flood
1968 Mar 13-16	Flooding
1968 Nov 28	Minor Flooding
1971 Jan 28	Flooding
1974 Apr 19	Flash flooding
1980 Jan 6-14	Flooding
1981 Aug 3-4	Flooding
1981 Oct 27-28	Flooding
1982 Mar 30-31	Flooding
1982 Apr 1-3	Flooding
1982 July 16-17	Flooding
1982 Dec 23-24	3-5”rain
1984 May 23	Minor flash floods
1984 Dec 24-25	Flash flooding
1985 Oct 17-18	Flash floods
1985 Nov 18	Minor flash floods
1986 Feb 15	Flash floods
1986 Nov 10-11	Minor flash flooding
1987 Apr 21-22	Minor flash flooding
1987 Apr 26	Flash flooding
1987 May 5-6	10” rain, flash flooding
1988 Jan 28-29	Flash floods
1988 Nov 4-5	Extensive flooding
1988 Dec 5-6	Flash flooding
1989 Feb 10-11	Minor flash flooding
1989 Mar 1-4	Minor flash floods
1990 Jan 14-22	Up to 20” rain, flooding
1991 Jan 27	Flooding
1991 Mar 19-21	Flooding
1993 July 21-23	Flooding, remnants of H Dora
2003 Nov 29 - Dec 8	Up to 22.74” rain
2004 Aug 3-4	Up to 5.05” rain due to remnants of Darby
2006 Feb 19 - April 2	Up to 41.93” rain
2006 Oct 31- Nov 2	Up to 14.06” rain

Date	Details
2007 Dec 4-11	High winds (70-80 mph gusts) and rains, Widespread flooding across portions of central and upcountry Maui
West Maui - Honokōwai and Lahaina are frequently flooded. Since 1879, 19 damaging floods occurred in the Lahaina area.	
1916 Jan 26	Lahaina and Olowalu flooded
1950 Nov 30	Flash flooding at Lahaina
1960 May 13	Kahoma Stream
1961 Oct 31-Nov 3	West Maui, Kahoma Stream
1967 Mar 17-18	7” in 5.5 hours at West Maui
1971 Jan	Lahaina, Kauaʻula Stream (Hale, Cannery, Kelawe Camp)
1972 Feb 24	5-8” in 5 hours at West Maui, Lahaina
1974 Nov 21	Kāʻanapali, Honokōwai
1987 May 5-6	Flash flooding at Lahaina
1988 Dec 5-6	Over 10” of rain
1997 Jan 19-20	Flooding Lahaina
Southwest Maui - Frequent flooding of Kulanihakoi, Waipuilani, Keokia, and Waiakoa streams	
1916 Jan 26	Kīhei
1930 Jan 29	Flash flooding at Kulat, Kīhei
1951 Feb 22	Kīhei
1955 Dec 21	Kīhei
1967 Mar 24	6” in 6 hours at Kīhei
1968 Jan 28	Kīhei
1971 Jan 27-28	6 ft. at Kīhei
1988 Dec 5-6	Over 10” rain at Kīhei
South Slope Haleakalā - Historical flooding of streams between Kīpahulu and Nuʻu	
1968 Apr 15-16	
1986 Nov 10-11	
Windward Haleakalā - Makawao, Kaupakulua, Wailua and Hāna frequently flooded by sheetflows	
1965 Apr 25-28	Flash flood at Hāna
1968 Apr 15-16	East Maui esp. Honomaele Stream
1981 Oct. 27-28	Road to Hāna
1982 Mar 30-31	Road to Hāna
1982 July 21-22	Flash flooding
1982 Aug 1	Flash flooding esp. Kāʻanapali
1984 May 23	Minor flash flooding, road to Hāna
1987 Feb 15	8-10” at Hāna area
1987 May 5-6	10”
1988 Mar 24	Road to Hāna
1991 Mar 19-21	Road to Hāna
1992 Nov 26-27	Severe flooding
1993 Oct 23	Flash flood, mudslide
1994 Apr 12-13	Flash flood, mudslide
North Central Maui - Wailuku and ʻĪao Stream are frequently flooded. Kahului frequently inundated by sheetflow.	
1900 Nov 14	Kahului
1903 Feb 13	Flash flood at Wailuku
1916 Jan 14	17000 cfs at ʻĪao Valley

Date	Details
1920 Dec 24	Storm, flooding at Wailuku
1930 Nov 18	ʻĪao Stream
1948 Jan ?	ʻĪao Stream
1950 Nov 30	Flash flooding at ʻĪao Valley, Wailuku
1950 Dec 3	7550 cfs, 5” rain in 2 hours at ʻĪao Stream
1961 Nov 2	5700 cfs at ʻĪao Stream
1965 Feb 4	Sheetflow
1971 Jan 27-28	5820 cfs at ʻĪao Stream, 2 ft. at Paia
1972 Feb 8	3.5” in 1 hr at Wailuku
1978 Nov 12	Flash flooding at ʻĪao Valley, Kahului
1982 Mar 30-31	ʻĪao Valley
1987 Mar 5-6	Over 10” rain, flash flooding at Wailuku, Kahului
1989 Feb 3-5	Flash flooding near Haʻikū
1994 Apr 12-13	Flash flood, mudslide
2007 Dec 4-11	Flash flooding in the Waiohuli area of Maui sweeping a house from its foundation.
Northwest Maui	
1961 Nov 2	Flash flooding at NW Maui, Nāpili, Honolua
1964 Dec 19	NW Maui
1967 Mar 17	Nāpili Bay
1967 Mar 24	Nāpili Bay, heavy rains
1968 Mar 13-16	24” in 48 hours at Nāpili Beach, Honolua, Paʻakea

E.6.4 COUNTY OF HAWAIʻI

The latest severe flooding occurred in November 2000.

The enormous north swells of February 1993 and January 1998 brought 20-30 foot waves to the north facing shores. Overwash of the Hilo breakwater and flooding of the coastal roads near Hilo, caused damage in November 1996 and January 1998. The summer south swell generally ranges 4-6 feet. Significant south swells also occur, such as in July 1986 and June 1995, producing 8-12 foot surf along southern shores. Aliʻi Drive in Kailua town, for example, is located particularly close to the ocean in many places and suffers periodic overwash.

Homes were flooded, roads closed, and emergency shelters filled as families flocked to find help during the floods that affected the Big Island from October 28-November 3, 2000. According to the National Weather Service, 26.22 inches fell at Hilo airport in 24-hours on November 1, 2000. The previous record was 22.3 inches on February19-20, 1979. Damage in Hawaiʻi County was estimated to be $20 million. Civil Defense Deputy Bruce Butts said 77 businesses and as many as 300 homes were damaged. At Pahala in the Kaʻū District, two bridges on the Hawaiʻi Belt Road were severely damaged. On November 3, Governor Cayetano declared the islands of Hawaiʻi and Maui a disaster area, which authorizes use of major disaster fund, relocation and rehabilitation, housing relief, commercial and personal loan program, and relief to farmers.

On November 9, President Clinton declared Hawaiʻi County a federal disaster area, which authorized federal assistance. More than 1,131 Hawaiʻi Island flood victims registered for assistance through FEMA's toll-free teleregistration number since November 30, 2000. The US Small Business Administration (SBA) approved $2,210,000.00 in low interest disaster loans. For more information on Federal disaster recovery on Hawaiʻi Island, see the County of Hawaiʻi Hazard Mitigation Plan.

During August 2-4, 2004 as the remnant swirl of Darby moved closer to the unstable region, thunderstorms began to develop. The first round of thunderstorms occurred just north and east of the Big Island on August 2. That night, additional showers and thunderstorms formed across parts of the Big Island, particularly the normally dry Kona side. Rainfall amounts of 2 to 5 inches over a few hours were reported, and this led to flooding and closures of several roads. Two subsequent High Winds and Flooding Rains weather events occurred on December 4-11, 2007 and December 10-14, 2008. While the December 2011 event caused widespread flooding, the December 2008 rainfall on the island brought much needed drought relief.

Table E-7. County of Hawaiʻi Stream Flooding from Atlas of Natural Hazards in the Hawaiian Coastal Zone (Updated)

Date	Details
Hawaiʻi - Island wide stream flooding because of heavy rains	
1959 Aug 4-7	H Dot
1979 Feb 19-20	Flooding
1979 Dec 14-18	Flooding
1980 Mar 6-25	Episodes of flooding
1981 Oct 27-28	Flash flooding
1982 July 21-22	TD Daniel, flash flooding
1984 Dec 24-25	Kona storm, flooding
1986 Apr 8	Flooding
1986 Nov 10-11	Flooding
1987 July 21-23	Flooding
1987 Dec 11-19	Flooding
1988 Mar 14-18	Flooding
1988 Aug 4-8	H, flooding
1989 Feb 3-5	Flooding
1989 Mar 1-4	Flooding
1989 July 18-20	TS Dalilia, flooding
1990 Jan 14-22	Flooding
1992 Sep 14	TS Orlene, flooding
1992 Nov 29	Widespread flooding
1993 July 21-22	TS Dora, flooding
2003 Aug 31 - Sep 1	6 to 10” rain due to Jimena
2003 Nov 29 - Dec 8	Up to 11.01” rain
2004 Aug 3-4	Up to 5.56” rain due to remnants of Darby
2006 Feb 19 - Apr 2	Up to 54.72” rain
2006 Oct 31- Nov 2	Up to 3.38” rain
2007 Dec 4-11	High winds (70-80 mph gusts) and rains, Widespread flooding across the county
Kohala	
1918 Apr 9-10	Flash flooding
1936 Jan 17	Flash flooding at N. Hi

Date	Details
1966 Nov 20	Flash flooding at S. Kohala
1967 Jan 11	Flooding
1982 Aug 9-10	Flash flooding
1983 Dec 24-26	Flooding
1986 Feb 16	Localized flooding
1986 Apr 8	Flooding at Waimea, Kohala
1989 Feb 3-5	Flash flooding at Pāhala
1989 Apr 28-29	Flash flooding at Waimea
1991 Aug 5-7	Flash flooding
1996 Sep 8-9	Flash flood S. Kohala and Waikaloa
1997 Jan 5	Widespread floods Waikaloa Village
Kailua-Kona	
1918 Apr 9-10	Flash flood at Kona sugar mill
1922 Oct 22	Flash floods at South Kona
1930 Jan 25	Holualua reservoir burst, flash floods
1961 Oct 30	Flash floods at South Kona
1963 Apr 29	Flash floods at Kainaliu
1965 Sep 25	Capt. Cook, Kainaliu
1966 Oct 3-5	Flash floods at Capt. Cook & Holualua
1967 Oct 12	Overland flow at Hoʻokena
1967 Oct 24	N. Kona
1968 July 17	Local flash flooding at Kealakekua
1968 Oct 3	Flash floods at N. Kona
1974 Oct 15	Flooding Kaloloa to Hōnaunau, 4.5” in 7 hrs.
1976 Apr 26	Flash flooding Hōnaunau
1982 Mar 17	Minor flooding at Kona
1985 Sep 29	Flash flooding Capt. Cook to Kealakekua
1985 Nov 19	
1986 Feb 16	Localized flooding at N. Kona
1989 Feb 3-5	Flash flooding at S. Kona
1992 Sep 17	Heavy thunderstorms, minor flooding
1996 June 22	2.1” in 1 hr., widespread flooding
1997 Jan 5	Widespread floods, Captain Cook to Kona
South Point	
1967 Nov 26-27	Severe flooding at Naalehu
1979 Feb 19-20	Nāʻālehu & Pāhala, 22.3” in 24 hrs.
Kaʻū	
1917 Mar 19	Flash flood
1945 Apr 8	Flash flood
1962 Mar 13-15	Overland flow at Pāhala
1980 Mar 18	Flooding
1982 July 16-17	TS Emilia
1982 Aug 1	TS Gilma
1985 Nov 19	Minor flash flooding in Kaʻu district
1986 Nov 8	Flash floods, 10” rain

Date	Details
1989 July 18-20	TS Dalilia flooding
1990 Jan 14-22	Flooding, over 20” rain
1990 Sep 14-28	Flooding
1990 Nov 18-20	Flooding, 30” rain
2007 Dec 4-11	Ten and twelve inches at the Kapāpala Ranch and Hawaiʻi Volcanoes National Park Headquarters gauges. Up to two feet of water covered portions of Highway 11 in the Kaʻu district
Hilo/Puna	
1928 Oct 1	Flash flood of Wailuku R.
1966 July 25	Sheet flow
1967 Aug 2-11	Flash flood, 12” rain
1971 Apr 23	Flash floods, 9.66” in 24 hrs.
1979 Feb 19-20	Flooding at Hilo, Keaʻau, Pāhoa, Kurtistown
1980 Mar 18	Flooding
1980 Sep 20-22	Flooding
1982 Mar 30-31	Flooding, 10” rain
1982 July 16-17	TS Emilia, flash flooding
1982 July 23	Flash flooding, 29” rain in July
1982 Aug 1	TD Gilma, flash flooding
1984 Nov 3-4	Flooding, 4-6” rain
1985 Sep 25	Flash floods
1986 Apr 3	Flash floods
1986 Sep 26	Flash flooding, 6-10” rain
1986 Nov 8	Flash flooding, 10” rain
1987 Oct 1	Flooding, 10-15” rain
1988 Aug 4-8	H Fabio, flooding in Hilo and Kurtistown
1990 Nov 18-20	Flooding, 30” rain
1991 Aug 3-4	Flash flood, 11” at airport
1992 Sep 14	TS Orlene, widespread flood
1993 Oct 3	5-7” rain Puna and Hilo
1994 Apr 11-12	Floods, landslides
2000 Nov 1-2	Flooding, landslides, 25” in 24 hrs.
Hāmākua Coast	
1890 Dec 9	Flash floods at Hāmākua, Honokaʻa
1902 Mar 6	Flash floods at Hāmākua
1965 Aug 4-5	Sheet flows
1982 July 16-17	Flash flooding at Hāmākua
1982 Aug 1	TD Gilma, flash flooding
1982 Aug 9-10	TS John, flash flooding at Honokaʻa
1983 Oct 26	Hāmākua Coast
1984 Feb 8	Flooding
1985 Mar 11	Flash flooding
1986 Mar 16	Flash flooding
1986 Apr 3	Flash flooding
1986 Apr 8	Flooding
1986 Sep 26	Flash floods, 6-10” rain

Date	Details
1987 May 5-6	Extensive flash flooding, over 10” rain
1987 Oct 1	Flooding, 10-15” rain
1987 Nov 21	Flash flooding
1988 Mar 14-18	Flooding, 5-10” rain
1989 Apr 28-29	Flooding at Honokaʻa
1989 Aug 20-21	Minor flash floods
1990 Dec 18-20	Flooding
1991 Aug 5-7	Flooding
1994 Apr 11-12	Floods, landslides
Waipiʻo Valley	
1902 Mar 6	Flash flooding
1972 Aug 18- Sep 3	Flash flooding
1978 Dec 6	Flooding
1979 Dec 14-18	Severe flooding
1989 Apr 4-9	Flooding
1991 Aug 5-7	Flooding

E.6.5 CHRONIC COASTAL FLOODING

Chronic coastal flooding is defined as the combined effects of annual high wave flooding, passive flooding, and coastal erosion that are being exacerbated by sea level rise.

The 2018 HMP discussed specific coastal erosion and high wave flooding events that occurred in the State of Hawaiʻi through 2017. Table E-8 includes details regarding major chronic coastal flooding that occurred in the state between 2012 and 2017. Major events include those that resulted in losses or fatalities, as reported by NOAA NCEI, events that resulted in the activation of the state and/or county emergency operations center (EOC), and/or events that led to a FEMA disaster declaration.

With flood documentation for the State of Hawaiʻi being extensive, not all sources have been identified or researched. Additionally, loss and impact information for many events could vary depending on the source. Therefore, Table E-8 may not include all events that have occurred in the state and the accuracy of monetary figures discussed is based only on the available information identified during research for the 2018 HMP Update.

Table E-8. Chronic Coastal Flooding Events in Hawaiʻi, 2012 to 2017

Date(s) of Event	Event Type	Counties Affected	Description
2012 Jan 03	High Surf	Honolulu	The County and City of Honolulu partially activated their EOC and opened shelters due to high surf.
2012 Nov 4-7	High Surf	Kauaʻi, Maui, Hawaiʻi, and Honolulu	A combination of swells generated surf of 15 to 25 feet along the north-facing shores of the Islands of Niʻihau, Kauaʻi, Oʻahu, Molokaʻi, Maui, and Hawaiʻi; 8 to 14 feet along the west-facing shores of the Islands of Niʻihau, Kauaʻi, and Molokaʻi; and 6 to 10 feet along the east-facing shores of the Islands of Oʻahu and Hawaiʻi. Lifeguards rescued several individuals who were overwhelmed by the dangerous surf.
2012 Dec 24-26	High Surf	Kauaʻi, Maui, Hawaiʻi, and Honolulu	A swell from a powerful low, far northwest of the islands generated surf of 15 to 25 feet along the north- and west-facing shores of the Islands of Niʻihau, Kauaʻi, and Molokaʻi; and the north-facing shores of the Islands of Oʻahu and Maui; and

Date(s) of Event	Event Type	Counties Affected	Description
			10 to 15 feet along the west-facing shores of the Island of Oʻahu and north-facing shores of the Island of Hawaiʻi. At least three people required assistance by paramedics after getting caught in the surf. Lifeguards performed numerous rescues and provided warnings to beach goers to stay away from the water.
2013 Jan 17-22	High Surf	Kauaʻi, Maui, Hawaiʻi, and Honolulu	A swell from a powerful low, far northwest of the islands generated surf of 15 to 30 feet along the north- and west-facing shores of the Islands of Niʻihau and Kauaʻi, and the north-facing shores of the Islands of Oʻahu, Molokaʻi, and Maui; 10 to 20 feet along the west-facing shores of the Islands of Oʻahu, Molokaʻi, and Maui; 10 to 15 feet along the west-facing shores of the Island of Hawaiʻi; and 8 to 12 feet along the west-facing shores of the Islands of Lānaʻi and Kahoʻolawe. On the Island of Kauaʻi, there were two fatalities associated with this high surf event. Two men were swept away by the large waves on the north shore of the Island of Kauaʻi on January 18. On the Island of Oʻahu alone, lifeguards reported more than 2,000 safety actions as a result of this high surf event. Many beaches were closed for a time because of the rough conditions, and several roadways near the shoreline on the individual isles became covered with debris from waves breaking beyond the beach areas.
2013 Apr 4-6	High Surf	Kauaʻi, Maui, Hawaiʻi, and Honolulu	A swell from a powerful low, far northwest of the islands produced surf of 15 to 25 feet along the north- and west-facing shores of the Islands of Niʻihau and Kauaʻi, and the north-facing shores of the Islands of Oʻahu, Molokaʻi, and Maui; and 10 to 20 feet along the west-facing shores of the Islands of Oʻahu, Molokaʻi and Maui, and the north-facing shores of the Island of Hawaiʻi. Lifeguards issued more than 1,000 warnings during the episode, and conducted several rescues of individuals overwhelmed by the pounding surf.
2013 May 16-22	High Surf	Kauaʻi, Maui and Hawaiʻi	A series of swells from the southern hemisphere generated surf of 6 to 10 feet along the south shores of all islands. Lifeguards were busy throughout the high surf episode. They provided many rescues, and warnings to inexperienced swimmers and surfers. On the Island of Maui, with the high surf, three sailing vessels broke free from their moorings and washed aground near Mala Wharf in Lahaina.
2013 June 4-6	High Surf	Kauaʻi, Maui, Hawaiʻi, and Honolulu	A long period swell from the southern hemisphere generated surf of 6 to 12 feet along the south-facing shores of all the main Hawaiian Islands. In a few instances, water from the high surf flowed over adjacent roads and deposited sand and other debris. Lifeguards rescued more than 100 surfers and swimmers and issued hundreds of warnings. One surfer died from injuries suffered at Ala Moana Bowls on the Island of Oʻahu on June 6. Another surfer sustained serious injuries while surfing at Sandy Beach.
2013 Oct 20-21	High Surf	Kauaʻi, Honolulu, and Maui	A swell from a strong low, far northwest of the islands generated surf of 15 to 20 feet along the north- and west-facing shores of the Islands of Niʻihau and Kauaʻi; and 10 to 15 feet along the north-facing shores of the Islands of Oʻahu, Molokaʻi, and Maui. On October 21, three individuals were injured when they were swept away on a wave from the Shark's Cove reef area on the Island of Oʻahu's north shore. Ocean safety officials performed rescues, assists and preventative actions.
2013 Oct 28-29	High Surf	Kauaʻi, Honolulu, and Maui	A swell from a strong low generated surf of 15 to 20 feet along the north- and west-facing shores of the Islands of Niʻihau and Kauaʻi; and 10 to 15 feet along the north-facing shores of the Islands of Oʻahu, Molokaʻi, and Maui. Ocean safety officials were busy with rescues, assists and preventative actions.

Date(s) of Event	Event Type	Counties Affected	Description
2013 Nov 13-15	High Surf	Hawaiʻi, Kauaʻi, and Honolulu	A swell from a powerful low north of the islands, in combination with a strong high far to the northwest, generated surf of 20 to 30 feet along the north-facing shores, and 10 to 20 feet along the east-facing shores of the Islands of Niʻihau, Kauaʻi, Oʻahu, Molokaʻi, Maui, and Hawaiʻi. On November 13, a surfer was lost in the churning waters on the north shore of the Island of Oʻahu at Chun's Reef. On the Island of Maui, the parking and pavilion areas of Baldwin Park in Pāʻia were closed due to flooding from high surf wash up. Bayfront Highway on the Island of Hawaiʻi was closed due to the high surf.
2013 Dec 19-22	High Surf	Kauaʻi, Honolulu, Maui, and Hawaiʻi	A swell from powerful low, far northwest of the islands produced surf of 20 to 30 feet along the north- and west-facing shores of the Islands of Niʻihau and Kauaʻi, and the north-facing shores of the Islands of Oʻahu, Molokaʻi, and Maui; 15 to 25 feet along the west-facing shores of the Island of Hawaiʻi; and 10 to 15 feet along the west-facing shores of the Islands of Oʻahu, Molokaʻi, Lānaʻi, and Kahoʻolawe. Lifeguards issued over 4,800 warnings and rescued or assisted more than 50 people on the Island of Oʻahu. Two people were injured by the high surf. Additionally, on the Island of Hawaiʻi, two boating facilities were damaged by high waves.
2014 Oct 9-11	High Surf	Kauaʻi, Honolulu and Maui	A swell from a strong low, far northwest of the islands generated surf of 10 to 20 feet along the north- and west-facing shores of the Islands of Niʻihau and Kauaʻi; the north-facing shores of the Islands of Oʻahu, Molokaʻi, and Maui; and 8 to 14 feet along the west-facing shores of the Islands of Oʻahu and Molokaʻi. One person was injured when they were caught in the shore-break at Waimea Bay on the Island of Oʻahu's North Shore. Ocean safety personnel performed 1,120 preventative actions, just on North Shore beaches alone.
2015 July 25-28	High Surf	Honolulu	A swell from the southern hemisphere generated surf of 8 to 15 feet along the south-facing shores of all the islands. This was unusually high surf that led to lifeguards performing 3,000 preventative actions and 39 rescues on south and west shores of just the Island of Oʻahu alone. There were two deaths associated with this event.
2015 Oct 27-31	High Surf	Maui, Honolulu, and Hawaiʻi	A swell from a powerful low far northwest of the State of Hawaiʻi generated surf of 15 to 25 feet along the north-facing shores of all the islands except Lānaʻi; 10 to 20 feet along the west-facing shores of the Islands of Niʻihau, Kauaʻi, Oʻahu, Molokaʻi, and Maui; and 8 to 12 feet along the west-facing shores of the Island of Hawaiʻi. A large wave near Kaʻena Point on the Island of Oʻahu swept three men into the water on October 27. One man died and the other two were injured. On the Island of Kauaʻi on the same day, a 33-foot sailing vessel ran aground in the high surf after its motor failed. The vessel beached on the west side of Hanalei Bay at Waipā. The boat's owner injured himself trying to leave the boat.
2015 Dec 5-7	High Surf	Kauaʻi, Honolulu, and Maui	A swell from a powerful low, far northwest of the islands generated surf of 20 to 35 feet along the north-facing, and 10 to 20 feet along the west-facing, shores of the Islands of Niʻihau, Kauaʻi, Oʻahu, and Molokaʻi. Surf reached 20 to 35 feet along the north-facing shores of the Island of Maui as well. Lifeguards and other ocean safety officials provided assistance to surfers and other beachgoers in the rough conditions. One surfer nearly drowned at the Banzai Pipeline on the Island of Oʻahu's North Shore due to dangerous surf.

Date(s) of Event	Event Type	Counties Affected	Description
2016 Feb 21-29	High Surf and Coastal Erosion	Kauaʻi, Honolulu, Maui, and Hawaiʻi	Large swells from the northwest generated surf of 20 to 40 feet, with sets as high as 55 feet, on the north- and west-facing shores of the Islands of Niʻihau and Kauaʻi, and the north-facing shores of the Islands of Oʻahu, Molokaʻi, and Maui; and 15 to 25 feet, with sets as high as 35 feet, on the west-facing shores of the Islands of Oʻahu and Molokaʻi, and the north-facing shores of the Island of Hawaiʻi; and 8 to 12 feet along the west-facing shores of the Islands of Maui and Hawaiʻi. The large surf also caused beach erosion and damaged roadways, inundated parking areas of coastal recreation areas, and closed beaches. One person was swept out to sea as a large wave broke where the person was taking pictures on the Island of Kauaʻi.
2017 Jan 28-31	High Surf	Kauaʻi, Maui and Honolulu	Swells from powerful lows far northwest of the islands produced surf of 15 to 30 feet along the north- and west-facing shores of the Islands of Niʻihau and Kauaʻi, and the north-facing shores of the Islands of Oʻahu, Molokaʻi, and Maui; and 10 to 20 feet along the west-facing shores of the Islands of Oʻahu and Molokaʻi. A young woman drowned in the high surf on the Island of Kauaʻi on January 30.
2017 May 5-26	King Tide / High Surf	Kauaʻi, Maui, Hawaiʻi, and Honolulu	The State of Hawaiʻi EOC was partially activated due to King Tides and high surf.

E.6.6 EVENT-BASED FLOOD

Event-based floods are the result of storms that cause temporary inundation of land from excessive rainfall or wave action. Flooding also occurs as a result of other event-types such as storm events which are discussed in other sections of the risk assessment. For the purposes of the 2018 HMP Update, event-based flood includes both coastal and inland flooding as depicted on Flood Insurance Rate Maps (FIRMs).

The 2018 HMP discussed specific flooding events that occurred in the State of Hawaiʻi through 2017. Table E-9 includes details of major flooding events that occurred in the state between 2012 and 2017, with the addition of the April 2018 flood event. These events do not include tropical storms or hurricanes that may also cause flooding. Major events include those that resulted in losses or fatalities, as reported by the National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI), events that resulted in the activation of the state and/or county emergency operations center (EOC), and/or events that led to a FEMA disaster declaration.

Table E-9. Event-Based Flood Events in the State of Hawaiʻi, 2012 to April 2018

Date(s) of Event	Event Type and Federal Disaster Declaration (if applicable)	Counties Affected	Description
2012 Jan 17	Heavy Rain and Flash Flooding	Kauaʻi and Hawaiʻi	Heavy showers fell over the Counties of Hawaiʻi and Kauaʻi. The rain was intense enough in the County of Kauaʻi to cause flash flooding. In Princeville (Kauaʻi), the Kūhiō Highway was closed at the Hanalei Bridge due to flooding in the area of the Hanalei River. In Kapaʻa, there were road closures due to flooding of Keālia Stream. A flash flood warning was issued for the County of Kauaʻi, which led to the activation of County's EOC.

Date(s) of Event	Event Type and Federal Disaster Declaration (if applicable)	Counties Affected	Description
2012 Feb 26	Flash Flood Warning	Kauaʻi and Honolulu	Surface and upper troughs generated heavy rain across the City and County of Honolulu, as well as the County of Kauaʻi, with flash flooding occurring over northern parts of Kauaʻi. In the County of Kauaʻi, Kūhiō Highway was closed at the Hanalei Bridge due to flooding. In Kōloa, Weliweli Road, Hapa Road and Ala Kinoki were closed due to flooding. A flash flood warning was issued for the County of Kauaʻi which led the partial activation of the County's EOC.
2012 Mar 3-11	Severe Weather, Flooding and Tornado (FEMA-DR-4062)	Kauaʻi, Honolulu, and Maui	On March 3 and 4, an upper trough in the vicinity of the Hawaiian Islands brought heavy rain and flash flooding to the County of Kauaʻi and the City and County of Honolulu. Numerous roads and bridges were closed throughout the impacted counties due to flooding. The City and County of Honolulu EOC was activated. This event resulted in a FEMA declaration for the counties of Kauaʻi and Maui. A total of $3.6 million in public assistance was approved for the impacted counties.
2012 Dec 19	Heavy Rain and Flash Flooding	Hawaiʻi	Heavy showers fell over the windward side of the County of Hawaiʻi near Pāpaʻaloa. A motorist tried to cross the swollen Pāhale Stream but was swept away by the current; the motorist died.
2013 Jan 26-27	Severe Weather and Flooding	Kauaʻi, Honolulu, and Maui	A winter storm triggered heavy rain and flash flooding over the Hawaiian Islands from the County of Kauaʻi and the City and County of Honolulu, to the County of Maui. Roadway and property flooding was reported in the impacted counties. The EOCs for these the counties of Kauaʻi, Honolulu, and Maui were activated as a result of this event.
2013 Feb 21	Severe Weather and Flooding	Kauaʻi, Honolulu, Maui, and Hawaiʻi	Heavy rain brought flash flooding, mainly to the County of Maui. In the County of Kauaʻi, approximately 50 hikers were stranded on the Nā Pali Coast on Kauaʻi. One hiker died when swept away into the swollen Hanakāpiʻai Stream. Numerous roads were closed due to flooding throughout the area. The County of Kauaʻi activated its EOC. In the County of Honolulu, heavy rain was observed. In the County of Maui, flash flooding was reported which resulted in road closures. In the County of Hawaiʻi, heavy rain was observed.
2013 Apr 4	Severe Weather and Flooding	Kauaʻi, Honolulu	The County of Kauaʻi and the City and County of Honolulu EOCs were activated.
2013 May 4-5	Flood	Hawaiʻi	Heavy rain produced small stream and drainage ditch flooding, and ponding on roadways near Hawi, Waikoloa Village, Māhukona, and Kawahae in the County of Hawaiʻi. The County of Hawaiʻi EOC was activated as a result of this event.
2013 May 18	Flood	Hawaiʻi	Heavy rain fell over the County of Hawaiʻi. The precipitation led to small stream and drainage ditch flooding and ponding on roadways. Heavy rain led to the activation of the County of Hawaiʻi EOC.
2013 May 28-29	Flood	Kauaʻi, Honolulu, Maui, and Hawaiʻi	A surface trough and upper low brought heavy rain to the State of Hawaiʻi. The showers caused ponding on roadways and small stream and drainage ditch flooding. On May 28, in the City and County of Honolulu, the rainfall was intense enough to overflow the banks of the Kalihi Stream due to clogged culverts. Four people were caught in the swollen stream but were able to make it to safety. The City and County of Honolulu EOC was activated as a result of this event.

Date(s) of Event	Event Type and Federal Disaster Declaration (if applicable)	Counties Affected	Description
2013 Sept 30-Oct 1	Severe Weather and Flooding	Kauaʻi	An upper low just north of the State of Hawaiʻi induced heavy rain and thunderstorms over the County of Kauaʻi. The rain caused ponding on roadways and small stream and drainage ditch flooding. The County of Kauaʻi EOC was activated as a result of this event.
2013 Oct 11	Severe Weather and Flooding	Kauaʻi, Honolulu, and Maui	Heavy rain fell over the Counties of Kauaʻi, Maui and the City and County of Honolulu. The City and County of Honolulu EOC was activated as a result of this event.
2013 Oct 14	Severe Weather and Flooding	Kauaʻi, Honolulu, Maui, and Hawaiʻi	An upper low moving over the State of Hawaiʻi produced heavy showers and thunderstorms, and the occasional funnel cloud and waterspout. There was small hail reported in central Oʻahu. The rainfall led to small stream and drainage ditch flooding, minor debris flows, and ponding on roadways. The City and County of Honolulu EOC was activated as a result of this event.
2013 Oct 27	Severe Weather and Flooding	Hawaiʻi and Maui	An upper trough produced heavy rain and thunderstorms over much of the State of Hawaiʻi. The rain caused ponding on roadways, small stream and drainage ditch flooding, and minor debris flows. The County of Maui EOC was activated as a result of this event.
2013 Nov 9-10	Severe Weather and Flooding	Kauaʻi, Honolulu, and Maui	An upper level low, north of the Hawaiian Islands, combined with a surface trough and shear line produced heavy rain and flash flooding over parts of the State of Hawaiʻi. In the County of Kauaʻi, heavy rain caused the Hanalei River to overflow its banks along Kūhiō Highway. Homes flooded and roadways were inundated with water as a result of the heavy rains. The County of Kauaʻi activated its EOC as a result of this event.
2013 Dec 1	Severe Weather and Flooding	Kauaʻi	An advancing cold front and upper trough brought heavy rain, thunderstorms, and flash flooding to portions of the County of Kauaʻi, the Island of Molokaʻi (located in the County of Maui), and the City and County of Honolulu. Multiple roadways were closed due to flooding. The County of Kauaʻi activated its EOC as a result of this event.
2013 Dec 30	Severe Weather and Flooding	Hawaiʻi	Heavy rain and thunderstorms impacted a large portion of the County of Hawaiʻi. There were reports of flash flooding, hail and microbursts. Roads were closed throughout the county due to flooding. Several roadways washed out. The County of Hawaiʻi activated its EOC as a result of this event.
2014 Jan 11-12	Severe Weather and Flooding	Honolulu, Maui, and Hawaiʻi	Heavy downpours and isolated thunderstorms impacted parts of the State of Hawaiʻi (counties of Honolulu, Maui, and Hawaiʻi). Ponding on roadways, and small stream and drainage ditch flooding occurred in several areas. The County of Maui EOC activated.
2014 Feb 16	Severe Weather and Flooding	Kauaʻi	A surface low and upper trough west of the Hawaiian Islands caused instability over the western parts of the State of Hawaiʻi. Heavy rain and flash flooding occurred over the County of Kauaʻi. Roadways were closed due to flooding. The County of Kauaʻi activated its EOC as a result of this event.
2014 May 24-26	Heavy Rain and Flash Flooding	Kauaʻi and Honolulu	The combination of abundant low-level moisture and an upper trough northwest of the State of Hawaiʻi generated heavy showers and isolated thunderstorms across the County of Kauaʻi and the City and County of Honolulu. The heavy rain caused ponding on roadways, and small stream and drainage ditch flooding. The City and County of Honolulu EOC was activated as a result of this event.

Date(s) of Event	Event Type and Federal Disaster Declaration (if applicable)	Counties Affected	Description
2014 July 19-20	Severe Weather and Flooding(remnants of Tropical Storm Wali)	Honolulu and Maui	An upper trough near the Hawaiian Islands acted on remnant moisture from former Tropical Storm Wali to generate heavy showers and thunderstorms. The rain was intense enough to produce flash flooding in windward parts of the Island Oʻahu and in windward West Maui. Strong winds accompanied the precipitation, and blew down trees and damaged homes. Also, a man, snorkeling with a group, died when he succumbed to high waves that battered the area off the County of Maui on July 20. Flooding inundated roads in the impacted areas. The City and County of Honolulu activated its EOC as a result of this event.
2015 July 22	Heavy Rain and Flash Flooding	Kauaʻi	Heavy showers and isolated thunderstorms impacted the western portion of the state. The heavy rain led to flash flooding in the County of Kauaʻi near Hanalei as the Hanalei River overflowed its banks and inundated Kūhiō Highway near Hanalei Bridge. The County of Kauaʻi EOC was activated as a result of this event.
2015 Aug 17	Flooding	Honolulu, Maui, and Hawaiʻi	Heavy showers and isolated thunderstorms developed over parts of the State of Hawaiʻi, causing small stream and drainage ditch flooding, ponding on roadways, and flash flooding. In the County of Hawaiʻi, 14 hikers were rescued by the fire department after the trail they were on was blocked by high water after flash flooding. Many roads were closed throughout the County of Hawaiʻi as a result of flooding. In the City and County of Honolulu, officials reported between 8 and 12 inches of water on the Kamehameha Highway near Waikane Valley Road in windward Oʻahu. In the County of Maui, water over the road forced the closure of Piʻilani Highway at Mile Marker 29 in the Nuʻu area. As a result of this event, the County of Maui and County of Hawaiʻi EOCs were activated.
2015 Aug 25	Flash Flood and Severe Weather	Kauaʻi and Maui	Heavy rain, thunderstorms and flash flooding impacts parts of the State. In the County of Maui, lower Honoapiʻilani Highway was flooded by excessive rainfall near Kahana and Honokōwai. The County of Kauaʻi EOC was partially activated as a result of this event.
2015 Sept 3	Flash Flood and Severe Weather	Honolulu	With a moist air mass over the islands, warm ocean temperatures, and low-level instability; heavy showers and thunderstorms brought flooding to parts of the State of Hawaiʻi (City and County of Honolulu). In the City and County of Honolulu, one foot of water flooded Liliha Street, Dillingham Boulevard, and North King Street in Honolulu. More flash flooding was reported at the intersection of Dillingham Boulevard and Alakawa Street. Liliha Street was closed in both directions from North King Street to Vineyard Boulevard because of excessive ponding on the roadway. In the Iwilei section of Honolulu, Dole Cannery and surrounding offices had to be evacuated due to flooding on the first floor, including rooms with electrical equipment. The City and County of Honolulu EOCs were activated as a result of this event.

Date(s) of Event	Event Type and Federal Disaster Declaration (if applicable)	Counties Affected	Description
2015 Sept 11	Flash Flood and Severe Weather(remnants of Hurricane Jimena)	Honolulu	Another round of heavy rain and flooding developed over parts of the State of Hawaiʻi (City and County of Honolulu) as the remnants of former Hurricane Jimena passed north of the islands. Warm ocean temperatures and the added instability from the tropical disturbance helped generate deep convection over the area. In the City and County of Honolulu, Waikane Bridge along Kamehameha Highway was closed due to flooding from Waikane Stream in windward Oʻahu. The City and County of Honolulu activated its EOC as a result of this event.
2015 Sept 14	Heavy Rain and Flash Flooding	Hawaiʻi	High running water at Wailuku River's Boiling Pots in the County of Hawaiʻi resulted in one drowning fatality after the swimmer was pulled downstream.
2015 Nov 20	Flash Flooding	Honolulu	An area of deep tropical moisture moving from the southeast brought heavy showers to most of the Hawaiian Islands, with a majority of impacts in the City and County of Honolulu. The rainfall was intense enough to cause flash flooding over a portion of windward Oʻahu. Most of the showers, however, produced mainly small stream and drainage ditch flooding, and ponding on roadways. The City and County of Honolulu EOC was activated as a result of this event.
2016 May 26	Flash Flooding and Landslide	Kauaʻi and Honolulu	Heavy rain fell in the County of Kauaʻi and the City and County of Honolulu. The City and County of Honolulu EOC was activated as a result of this event.
2016 Sept 11-14	Severe Storms, Flooding, Landslides and Mudslides (FEMA-DR-4282)	Maui and Hawaiʻi	As a weak tropical disturbance with abundant low-level moisture moved through the Hawaiian Islands, an upper low moved in from the northwest. This combination generated heavy showers and thunderstorms, which then resulted in flash flooding over the County of Maui. In the County of Hawaiʻi, flash flooding was reported closing roadways in the Mountain View area of the county. Other parts of the state received heavy rainfall as well. Overall damages were estimated at $15 million.
2016 Dec 3	Heavy Rain and Flash Flooding	Statewide	An upper low and a separate upper trough produced heavy rain and showers, isolated thunderstorms, and flash flooding over much of the state. The system also produced snow in the upper elevations of the County of Hawaiʻi. A woman was swept away and killed during flash flooding on the County of Kauaʻi during a kayak and hiking tour near the Wailua River.
2017 Jan 21	Heavy Rain and Flash Flooding	Hawaiʻi	Strong wind and heavy rains impacted the County of Hawaiʻi, downing trees and power lines, causing power outages, and bringing flash flooding. A woman attempted to cross fast-moving water in Ahumoa but was swept away and died.
2017 Feb 28-Mar 1	Heavy Rain and Flash Flooding	Kauaʻi, Honolulu, and Maui	Heavy showers and thunderstorms impacted parts of the State of Hawaiʻi, mainly the Counties of Kauaʻi and Maui, and the City and County of Honolulu. Some of the rainfall led to flash flooding. In the City and County of Honolulu, an elementary school and church were damaged. Police closed Kamehameha Highway in the area because of deep water on the roadway. Waimea Valley Park and a home were also damaged due to flooding. The Counties of Maui and Kauaʻi, and the City and County of Honolulu EOCs were partially activated as a result of this event.

Date(s) of Event	Event Type and Federal Disaster Declaration (if applicable)	Counties Affected	Description
2017 Mar 7	Heavy Rain and Flooding	Maui	An upper trough near the Hawaiian Islands induced heavy downpours and thunderstorms over the County of Maui, particularly the leeward Haleakalā area. Intense rainfall inundated Kūlanihāko'i Gulch, which then led to South Kihei Road being flooded. Seven individuals trapped by the deluge had to be rescued by fire crews. The flood waters damaged several vehicles and condominiums. The storm system also produced heavy rain and thunderstorms over the County of Hawai'i and the City and County of Honolulu. In the County of Maui, several roads were closed due to flash flooding and individuals were evacuated from their homes. The County of Maui EOC was activated as a result of this event.
2017 Aug 21	Flash Flood	Kaua'i and Maui	An upper trough brought heavy showers and thunderstorms over the Counties of Kaua'i and Hawai'i. Most of the rain caused ponding on roadways and small stream and drainage ditch flooding. In the County of Kaua'i, the rain caused flash flooding. The Kūhiō Highway in Hanalei (Kaua'i) became impassable, and county officials were forced to close the Hanalei Bridge. The County of Kaua'i and the County of Maui activated their EOCs as a result of this event.
2017 Oct 23-24	Severe Weather and Flooding	Maui and Hawai'i	Periods of strong winds, heavy rain, thunderstorms, and flash flooding impacted the counties of Maui and Hawai'i. Lightning strikes led to power outages, and gusty winds downed trees and power lines. In the County of Maui, the strong winds led to island-wide power outages after lightning hit the electrical system. The storm downed trees and power lines in multiple areas; and flash flooding occurred as well. The County of Maui EOC was partially activated. In the County of Hawai'i, the storms brought strong winds, lightning strikes, and heavy rain. The County of Hawai'i EOC was fully activated.
2017 Oct 31-Nov 1	Severe Weather and Flooding	Kaua'i	Flooding conditions in the County of Kaua'i resulted in several road closures, including Kūhiō Highway in the vicinity of the Hanalei Bridge. County officials were warning motorists of ponding, low visibility, and other hazardous driving conditions. The County of Kaua'i EOC was partially activated as a result of this event.
2017 Nov 11-12	Severe Weather and Flooding	Honolulu	Rainfall totals ranged from 3.74 inches to 4.37 inches. Multiple car accidents were reported due to water on the roadways. Water rescues were performed near the intersection of Waialae Avenue and Koali Road, where two people were in need of assistance amid rain-swollen stream conditions. The City and County of Honolulu EOC was partially activated.
2017 Dec 20	Flash Flood	Honolulu and Maui	Heavy rain, flash flooding, and isolated thunderstorms impacted the counties of Honolulu and Maui. In the City and County of Honolulu, the intersection at Pu'unēnē and Wakea Avenues near Christ the King Church were closed in all directions due to flooding. In the County of Maui, on Kahekili Highway in the area of Mile Marker 7, the road was impassable due to flooding.
2017 Dec 26	Flash Flood	Honolulu	An area of showers formed over the County of Honolulu, becoming intense and isolated thunderstorms developed. The storm led to flash flooding conditions in the county; however, no significant injuries were reported. Water was flowing into stores at Market City between Kapiolani Boulevard and Kapahulu Avenue.

Date(s) of Event	Event Type and Federal Disaster Declaration (if applicable)	Counties Affected	Description
2018 April	Heavy Rains, Flooding, and Mud and Rock Slides	Kauaʻi and Honolulu	Heavy rains and flooding caused damages and losses to areas in the City and County of Honolulu and the County of Kauaʻi. According to NOAA, a rain gauge on Kauai's North Shore recorded 49.69 inches of rain in 24 hours. In the County of Kauaʻi, heavy rain caused extensive damage to the slopes adjacent to Kūhiō Highway and impacted the communities of Wainiha and Hāʻena. Multiple landslides led to the closure of the road. Numerous road closures reported in the impacted areas. Many homes were damaged or destroyed. American Red Cross conducted damage assessments and distributed clean up kits to residents in Aina Haina, Niu Valley, Kuliʻouʻou, Waimānalo, and Kailua. In the County of Kauaʻi, the American Red Cross opened five shelters. Ten residents from Wainiha were airlifted to be taken to a shelter. Between April 13 and 19, the American Red Cross provided shelter to 110 individuals on the County of Kauaʻi. Governor Ige declared the District of Hanalei in the County of Kauaʻi a disaster area. This declaration provided relief for damage caused by the event. Details regarding monetized impacts are not available at the time of this 2018 HMP Update.

E.7 Hazardous Materials

The following presents hazardous materials events that occurred in the State of Hawaiʻi between 2012 and 2017, as presented in the 2013 and 2018 HMPs. The information is reproduced as documented in the 2013 and 2018 plans.

E.7.1 FIXED-SITE HAZARDOUS MATERIALS

The release of hazardous materials has occurred frequently throughout the state. Releases are reported to the Hawaiʻi DOH HEER Office. Table E-10 shows the number of releases reported to the HEER Office in 2012 through 2017. In the five-year period between 2012 and 2017, there have been 2,065 instances of fixed-site hazardous material releases, equating to over one incident per day across the state over a five-year period.

Table E-10. Hazardous Materials Releases Reported to the HEER Office by County, 2012 to 2017

Year	County of Kauaʻi	City and County of Honolulu	County of Maui	County of Hawaiʻi	Total
2012	8	291	45	34	378
2013	10	301	56	29	396
2014	14	275	45	45	379
2015	3	158	18	18	341
2016	9	205	63	33	310
2017	16	214	57	35	261
Total	**60**	**1,444**	**284**	**194**	**2,065**

E.7.2 IN-TRANSIT HAZARDOUS MATERIALS

The Pipeline and Hazardous Materials Safety Administration (PHMSA) tracks in-transit hazardous material releases through its nationwide database. Regulations in 49 CFR 171.15 and 171.16 govern situations where hazardous materials are released and the resulting required notifications and reporting. Unless they are properly reported, it is difficult to identify and track past hazardous materials releases that occur in-transit. Between 2012 and 2017, there were 14 highway incidents and three pipeline incidents reported, according to PHMSA's database (PHMSA 2017a.

Table E-11. In-Transit Hazardous Material Incidents from 2012 to 2017

Date of Incident	Event Type	Counties Affected	Impacts
2012 June 25	Vehicular Incident (highway)	Hawaiʻi	4,000 gallons of jet fuel released; $209,254 in damages
2013 Jan 10	Excavation Damage (pipeline)	Honolulu	20 gallons of naphtha released; $52,040 in damages
2013 Oct 23	Excavation Damage (pipeline)	Honolulu	$172,747 in damages
2013 Nov 15	Vehicular Incident (highway)	Hawaiʻi	1,900 gallons of fuel released; $60,776 in damages
2013 Dec 16	Burst Gasoline Line	Hawaiʻi	Burst gasoline line in downtown Hilo led to the partial activation of the Hawaiʻi County Emergency Operations Center.
2015 Feb 16	Corrosion (pipeline)	Honolulu	1,300 barrels of refined petroleum product spilled; $2,816,000 in damages
2015 June 15	Excavation Damage (pipeline)	Honolulu	1 injury; $613,900 in damages
2017 Sept 2	Vehicular Incident (highway)	Honolulu	1 fatality and 1 injury; $66,700 in damages; 1,500 gallons of liquefied petroleum gas released

E.8 Health Risks

The following presents health risk events that occurred in the State of Hawaiʻi between 1840s and 2017, as presented in the 2013 and 2018 HMPs. The information is reproduced as documented in the 2013 2018 plans.

The Hawaiʻi State Department of Health Disease Outbreak Control Division (DOCD) maintains case records on a wide variety of health risks. In 2015, state data shows 7,477 cases of influenza, representing the highest number of cases of any health agent tracked by the DOCD. The state also saw 215 cases of dengue fever in 2015, and 54 in 2016 (238 of these cases were in the outbreak on Hawaiʻi County). Table E-12 shows significant health events that have occurred in the state between 2012 and 2017.

Table E-13 shows the number of reported cases of notifiable diseases (diseases for which statistics are provided to the CDC to monitor national public health) in Hawaiʻi. For the 2018 HMP Update, this includes dengue fever, chikungunya, leptospirosis, Zika, mumps, and influenza.

Table E-12. Health Risk Events in the State of Hawaiʻi, 2012 to 2017

Date(s) of Event	Event Type	Counties Affected	Description
2015 Sept 11 – 2016 Mar 17	Dengue Fever Outbreak	Hawaiʻi	264 confirmed cases of dengue fever. 238 were residents, and 26 were visitors.
2017	Mumps Infection	Honolulu, Hawaiʻi, Kauaʻi, Maui	There were 760 confirmed cases of mumps in 2017. 602 were in Honolulu County, 106 were in Hawaiʻi County, 49 were in Kauaʻi County, and 3 were in Maui County.

Table E-13. Reported Cases of Notifiable Diseases in the State of Hawaiʻi

Disease	2012	2013	2014	2015	2016	2017
Dengue Fever	7	10	14	209	54	15
Chikungunya	Not reported	Not reported	22	6	4	1
Zika	Not reported	Not reported	Not reported	6	22	9
Leptospirosis	11	17	24	22	34	26
Mumps	1	0	1	4	10	760
Influenza (lab-confirmed)	2,811	5,086	5,382	7,477	5,129	9,053

E.8.1 DENGUE FEVER

The first large-scale dengue fever epidemic in the State of Hawaiʻi occurred in the late 1840s. A second outbreak occurred at the turn of the century, with an estimated 30,000 cases. Epidemic dengue occurred again on the island of Oʻahu between 1943 and 1944, when 1,498 infections were reported, mostly in urban areas of the city of Honolulu. *Aedes albopictus* had been introduced into the Hawaiian Islands at the beginning of the century, and by 1940 it was the dominant day-biting *Stegomyia* mosquito species in the islands.

An outbreak that occurred in 2001 and 2002 involved a statewide effort to provide information and testing to the public. Response to the outbreak in 2001-2002 required coordination among the county government, the State Department of Health, State Civil Defense, and the Centers for Disease Control. Excerpts of an article covering the event, prepared by the State of Hawaiʻi Department of Health and the Centers for Disease Control follow

In September 2001, the State of Hawaiʻi Department of Health was notified of an unusual febrile illness in a resident with no travel history; and shortly thereafter dengue fever was confirmed. During the investigation, 1,644 persons with locally acquired dengue-like illness were evaluated, 122 (7%) laboratory-positive dengue infections were identified; and dengue virus serotype 1 was isolated from 15 patients. No cases of dengue hemorrhagic fever or shock syndrome were reported. In 3 instances autochthonous infections were linked to a person who reported dengue-like illness after travel to French Polynesia. Phylogenetic analyses showed the Hawaiian isolates were closely associated with contemporaneous isolates from Tahiti in French Polynesia.

E.8.2 PANDEMIC FLU

While there has been some human-to-human spread of H5N1 (Avian flu), it has been limited and un-sustained. For example, in 2004 in Thailand, probable human-to-human spread in a family resulting from prolonged and very close contact between an ill child and her mother was reported. Most recently, in June 2006, the World Health Organization (WHO) reported evidence of human-to-human spread of the virus in Indonesia. In this situation, eight people in one family were infected. The first family member to be infected is thought to have become ill through contact with infected poultry. This person then infected six family members. One of those six people (a child) then infected another family member (his father). No further spread outside of the exposed family was documented or suspected.

During the period from 2007 to 2010, there were incidents of swine flu (H1N1) outbreaks in the State of Hawaiʻi. Of particular concern is the 2009 the outbreak of H1N1 Pandemic that resulted in several deaths from the flu. Similar to other outbreaks, the virus spread with international travelers. This is particularly concerning for the state since it is among the most remote places on the planet, and it will be difficult to sustain livelihoods should the state lose connection with the United States mainland or international travel.

E.9 High Wind Storms (now called Windstorm in the 2023 HMP Update)

The following presents high wind storm events that occurred in the State of Hawaiʻi between 1871 and 2017, as presented in the 2013 and 2018 HMPs. The information is reproduced as documented in the 2013 and 2018 plans.

During the 1993–1994 and 1994–1995 winter seasons, for example, strong and gusty trade winds of 40 to 50 mph lasted several days and inflicted damage to roof tops, tree limbs, and telephone equipment. In February 2013, gusty trade winds over 50 mph lasted for two days, causing numerous power outages due to damaged electrical transmission and distribution networks.

By far the most notable documented Kona wind event to affect the island of Hawaiʻi (County of Hawaiʻi) was that of January 1980, which caused damages of $42 million. (Disaster Declaration DR-613-HI) The loss on the island of Hawaiʻi was $11.7 million. Agriculture – macadamia, coffee, foliage and flower farms – had major losses. The island of Maui (County of Maui) was also declared a disaster area during this storm The January 1980 severe Kona storm caused closure of all airports with sustained winds of 40-50 mph gusting over 100 mph in certain regions due to topographical features.

In December 26, 2008, the entire electrical grid on the island of Oʻahu was blacked out for around 12 hours due to a Kona storm. The blackout was triggered by lightning strikes on or near the Hawaiian Electric 138 kV transmission system, which short circuited the system and tripped protective relay switches shutting down the entire grid.

Table E-14 provides a comprehensive list of recorded high wind events for over a century. Further information on historic occurrences of strong winds from All Storms Until 2017; trade winds, Kona storms and tropical cyclones, are provided on Figure E-5 through Figure E-9.

Table E-14. High Wind Events

Date	Description	Island
1871 Aug 9	Strong winds	Oʻahu
1896 Dec 7	Strong winds	Maui
1906 Jan 21	High winds	Maui
1906 Mar 6-7	High winds	Oʻahu
1914 Jan 12-13	High NE winds	Oʻahu
1915 Dec 26	High winds	Oʻahu
1916 Jan 10	High winds	Oʻahu
1916 Jan 14	High winds	Maui
1918 Dec 3-4	High winds	Oʻahu
1926 June 8	Possible Tornado	Oʻahu
1948 Jan 17	High winds	Maui
1948 Jan 23-26	High winds	Maui
1949 Jan 15-17	High winds	Oʻahu
1954 Nov 27-28	High winds	Oʻahu
1955 Dec 21	High winds	Maui
1959 Jan 17-18	Storm	Oʻahu, Maui
1961 Oct 24	Strong winds	Oʻahu
1963 Jan 15-17	Strong winds, gusts of up to 70 mph	Oʻahu, Maui
1963 Jan 30-31	Strong winds, gusts of up to 84 mph	Oʻahu, Maui
1963 Feb 28	Tornado	Oʻahu
1963 Mar 31	Strong winds	Oʻahu
1963 Mar 30-31	High winds	Oʻahu
1964 Dec 19-23	Strong winds	Maui
1965 Nov 10-15	High winds	Oʻahu
1966 Dec 18	Whirlwind	Oʻahu
1967 Feb 16-17	Gusty winds	Oʻahu
1967 Nov 2-11	High trade winds	Oʻahu, Maui, Kauaʻi
1967 Dec 9	High winds	Maui
1967 Dec 12	Strong winds, winter storm	Oʻahu, Maui
Jan 16-17	Winter storm, wind gusts > 50 mph	Oʻahu
1968 Feb 15-18	SW winds, gusts to 62 mph	Oʻahu
1968 Apr 9-10	30-50 mph winds	Oʻahu
1968 Nov 28	Strong winds up to 69 mph	Oʻahu, Kauaʻi
1968 Dec 5-6	Storm	Maui
1969 Jan 30	Strong winds	Oʻahu
1969 Feb 20-21	Strong winds	Oʻahu, Maui
1970 Jan 13-15	High winds, 96 mph, gusts to 117 mph	Oʻahu
1970 Dec 25-29	Winter storm, 50-60 mph	Oʻahu, Maui
1971 Jan 5	Strong winds	Oʻahu, Maui, Kauaʻi
1971 Jan 21	Tornado at Whitmore Village	Oʻahu
1972 Feb 4	Gusts to 69 mph	Oʻahu
1973 Aug 15	Dust devil	Oʻahu
1975 Nov 23-27	Storm	Maui
1976 Feb 5-7	Strong winds	Oʻahu, Maui

Date	Description	Island
1976 Nov 6-7	Strong winds	Oʻahu
1978 Oct 22	70 mph winds	Oʻahu
1979 Jan 11-19	High winds in excess of 50 mph	Maui
1980 Jan 8-10	Storm	Oʻahu, Maui, Kauaʻi
1981 Feb 11	Strong winds	Oʻahu
1982 Feb 11	Winter storm, strong winds	Oʻahu, Kauaʻi
1982 Feb 13	Tornado	Oʻahu
1982 Dec 18-19	Gusty trade winds up to 60 mph	Oʻahu, Maui, Kauaʻi
1982 Dec 23-24	High winds	Oʻahu
1983 Sept 23	Tornado at Pearl City	Oʻahu
1983 Sept 29	High winds	Oʻahu
1983 Dec 24-25	Winter storm, gusts > 50 mph	Oʻahu, Maui, Kauaʻi
1984 Mar 1-3	Gusts 30-40 mph	Oʻahu, Kauaʻi
1984 Dec 24-25	Kona Storm	Oʻahu, Maui, Kauaʻi
1985 Jan 29-30	High winds, Nānākuli & Waiʻanae	Oʻahu
1985 Mar 1-11	Gale force trade winds	Oʻahu, Maui
1985 Nov 30	Strong northerly winds	Oʻahu
1986 Apr 8	Strong winds at Nānākuli	Oʻahu
1986 May 13	Small tornado at Waipahu	Oʻahu
1986 Mar 28	Tornado at Barbers Point	Oʻahu
1986 Dec 5	Gusts up to 50 mph	Oʻahu, Kauaʻi
1987 Jan 19	High winds, 35 mph	Oʻahu
1988 Nov 4-5	Storm with gusts of 40-50 mph.	Oʻahu, Maui
1988 Dec 5-6	S winds of up to 50 mph	Oʻahu, Maui
1988 Dec 17-18	Gusty winds	Maui
1988 Dec 30-31	40-50 mph winds	Oʻahu, Maui
1989 Mar 1-4	Storm, strong winds	Oʻahu, Maui
1989 Dec 9-11	Gusty winds	Oʻahu, Maui, Kauaʻi
1990 Feb 6-9	Gusts to 60 mph	Oʻahu
1991 Jan 27	Strong winds	Maui
1993 Mar 9	Frontal system, strong winds, minor damage	Oʻahu Maui
1993 Dec 4-6	Strong trade winds, 60-80 mph	Oʻahu, Maui, Kauaʻi
1994 Mar 12-16	Strong gusty trade winds, 40-50 mph	Oʻahu
1995 Apr 14-19	Strong trade winds, 40-50 mph	Oʻahu
1996 Dec 7-8	N winds, gusts to 60 mph	Oʻahu
1996 Dec 23-25	Southwest winds of 40 mph	Maui
1996 Dec 26-31	S and SW winds, gusts to 75 mph	Oʻahu, Kauaʻi
1997 Jan 2-3	S winds, gusts to 60 mph	Oʻahu, Kauaʻi
1997 Jan 27-29	SW winds, 60 mph	Oʻahu, Maui, Kauaʻi
1997 Feb 25-27	High winds downed several trees and utility poles and blew off part of a roof from a house in the ʻĪao Valley on the island of Maui.	Maui
1998 Jan 5-8	Westerly winds of 40 to 60 mph near the summit of Haleakalā on the island of Maui.	Maui
1998 Jan 29	West to northwest winds of 50 to 60 mph near the summit of Haleakalā on the island of Maui.	Maui

Date	Description	Island
1998 Apr 3-4	West to northwest winds of 40 to 60 mph near the summit of Haleakalā on the island of Maui.	Maui
1998 Apr 9-11	NE winds up to 55 mph, power outages	O'ahu, Maui
1998 Apr 13	West to northwest winds of 40 to 60 mph near the summit of Haleakalā on the island of Maui.	Maui
1998 Nov 30	West to northwest winds of 50 to 60 mph near the summit of Haleakalā on the island of Maui.	Maui
1999 Jan 15	A spotter from upcountry Maui reported strong winds which knocked down power lines. Average sustained winds from 8 a.m. to 6 p.m. at Haleakalā were 40 mph, while a peak wind of 74 mph was recorded at 1:00 p.m.	Maui
1999 Feb 3-4	High winds toppled eucalyptus trees near Seabury Hall and along Kaupakalua Road. A large tree near Seabury Hall broke two power poles, leaving 125 customers in the Olinda area along Pi'iholo Road without electrical service. Another falling eucalyptus tree was blamed for snapping conductor wires along Kaupakalua Road that affected about 50 homes in that area and Kokomo. At 8:00pm at Haleakalā, the peak gust was 68 mph and the highest sustained wind speed was 48 mph.	Maui
1999 Mar 20-21	Wind gusts up to 55 mph, fallen trees, power outages, minor roof damage	O'ahu, Maui
1999 May 5	Dust devil in Kunia	O'ahu
1999 July 26-27	Winds up to 50 mph, fallen trees, power outages, dust storms; winds with gusts over 70 mph in the Mā'alaea on the island of Maui.	O'ahu, Maui
1999 Aug 31	Winds with gusts between 35 and 55 mph in the central valley of the island of Maui.	Maui
1999 Nov 28-29	Strong winds 30-45 mph	O'ahu, Maui
2000 Mar 22-23	Winds of 30 to 35 mph with gusts up to 45 mph along the southern coastal section of the saddle area on the island of Maui, from Mā'alaea to Kīhei.	Maui
2000 Apr 1-5	Trade winds of 20 to 35 mph across all islands. Gusts of up to 60 mph reported on the island of Maui. Winds partially blew off a roof at Lahaina Elementary School and overturned a delivery van along Honoapi'ilani Highway (State Highway 30) near Olowalu on the island of Maui. Also on the island of Maui, blowing dust caused the closure of Kīhei Road near the Maui Zoo.	Maui
2000 Nov 17	Winds of 30 to 40 mph with gusts as high as 50 mph in the saddle, downslope sections, and in the Mā'alaea Bay area of the west side of the island of Maui.	Maui
2001 Jan 14	Northeast winds of 35 to 40 mph with gusts up to 55 mph	All Islands
2001 Feb 14-16	NE winds 35 to 40 mph, gusts to 55 mph, localized power outages	O'ahu
2001 Feb 26	Waterspout ashore at Ehukai beach	O'ahu
2001 Apr 12	30 mph east to northeast winds with gusts up to 43 mph in locales in the central valley and western parts of the island of Maui. Some power outages were attributed to the high winds.	Maui
2001 Aug 31	Sustained winds 25 to 35 mph, gusts to 51 mph	All Islands
2001 Nov 26-27	SW winds 40-45 mph, gusts to 50 mph, fallen trees, localized roof damage, power outages	O'ahu
2001 Dec 2-3	NE to E winds 30 to 40 mph, gusts to 50 mph., fallen trees, power outages, localized roof damage	All Islands
2001 Dec 11-14	NE to E winds 30 to 40 mph, gusts to 55 mph., fallen trees, power outages	All Islands
2002 Jan 17-20	E to E/NE winds 30 to 40 mph, gusts to 50 mph	All Islands
2002 Jan 29-20	E to E/NE winds 30 to 40 mph, gusts to 45 mph	All Islands

Date	Description	Island
2002 Feb 26-27	East to east/northeast winds of 30 to 40 mph with gusts of up to 44 mph on the islands of Maui and Lānaʻi	Maui, Lanai
2002 Mar 17-18	N to NE winds 30 to 40 mph, gusts to 50 mph	Oʻahu, Maui
2002 Apr 1	West to Southwest winds estimated at 50 to 60 mph with gusts up to 65 mph near the summit of Haleakalā on the island of Maui.	Maui
2003 Jan 4-5	SW to W winds, fallen trees, power outages, localized roof damage	Oʻahu, Maui
2003 Jan 14-16	SW to W winds, gusts to 50 mph, fallen trees, power outages; southwest to west winds gusted to 70 mph on the high elevations of the island of Maui.	Oʻahu
2003 Jan 14	Southwest to west winds gusted to 70 mph on the high elevations of the island of Maui.	Maui
2003 June 3	F0 tornado	Oʻahu
2003 Nov 19	NE winds 30 to 40 mph, gusts to 65 mph, fallen trees, power outages, localized roof damage	Oʻahu
2003 Dec 21	North to northeast winds of 35 to 45 mph with gusts of up to 50 mph swept across Haleakalā summit, island of Maui.	Maui
2003 Dec 29	Southwest winds of 40 to 60 mph with one gust over 90 mph at and near Haleakalā summit, island of Maui.	Maui
2004 Jan 12	Southwest to west winds with gusts up to 70 mph affected areas at and near Haleakalā summit, island of Maui.	Maui
2004 Jan 14	High winds, fallen trees, power outages, considerable roof damage, school closures	Oʻahu Maui
2004 Jan 22-23	Thunderstorm, gusts to 60 mph	Oʻahu
2004 Jan 25	Funnel cloud, F0 tornado	Oʻahu
2004 Feb 7	F0 tornado	Oʻahu
2004 Feb 27-28	S thunderstorm winds, gusting to 58 mph, fallen trees, power outages, localized roof damage	Oʻahu, Maui
2004 Mar 11	Strong winds with gusts over 63 mph at Haleakalā summit, island of Maui.	Maui
2004 Nov 14-16	Winds gusting to 46 mph, power outages	Oʻahu
2004 Dec 2	Winds with gusts up to 70 mph at Haleakalā summit, island of Maui.	Maui
2004 Dec 6	East to Southeast winds gusted to 60 mph at Haleakalā summit, island of Maui.	Maui
2005 Jan 8-10	Gusty thunderstorms, fallen trees and fences, power outages	Oʻahu, Maui, Kauaʻi
2005 Feb 11-12	20-25 mph, 50 mph gusts, fallen trees, power outages	Oʻahu
2005 Mar 14-15	Gusty winds, fallen trees, power outages, property damage	Oʻahu, Maui
2005 Dec 4	F0 tornado, minor damage to one house	Oʻahu
2005 Dec 18	Gusty winds, power outages, localized roof damage, 1 fatality	Oʻahu, Maui
2007 Feb 2	High winds, gusts to 70 mph.	Oʻahu
2007 Feb 18	Trade Winds with gusts up to 57 mph at Haleakalā summit, island of Maui	Maui
2007 Dec 4	High winds, gusts to 55 mph; high winds with gusts of up to 82 mph	Oʻahu, Maui, Molokai
2008 Dec 13	Gusty thunderstorms, fallen trees, damages to roadways, homes and other structures, and agriculture; schools closure	Oʻahu, Maui, Kauaʻi
2013 Feb 17-18	Trade winds with gusts up to over 50 mph causes damage to electrical transmission tower, distribution networks, and utility poles.	Oʻahu
2012 Feb 7	A cold front moving through Hawaiʻi brought strong winds and heavy rain. The winds downed power lines and trees. In Waikīkī, a tree branch snapped, injuring three people at the International Market Place.	Honolulu

Date	Description	Island
2012 Mar 9	Significant weather impacted Hawaiʻi, bringing thunderstorms, flash flooding, record-setting hail, and a tornado. There were no reports of fatalities or serious injuries. In Maui County, strong winds destroyed a portion of the roof of the Hana Hotel, causing $25,000 in damages. Maui County had approximately $3.2 million in infrastructure damage from this event. Kauaʻi County had approximately $2 million in infrastructure damage.	Kauaʻi and Maui
2015 Feb 13	Gusty winds moved through Hawaiʻi, downing power lines, utility poles, and trees. The winds damaged roofs and forced roadway closures due to debris. There was one injury reported on Oʻahu (Honolulu County). A firefighter was injured when attempting to secure roof materials in Kāneʻohe in windward Oʻahu.	Honolulu
2016 Feb 16	Strong winds led to power outages, downed trees, and damage to roofs in parts of Oʻahu (Honolulu County), including Mānoa, Aina Haina, Kalihi, and Nuʻuanu. One injury was reported on Oʻahu when a tree fell on a home and pinned a man to his bed.	Honolulu
2016 Mar 8	Gusty north to northeast winds moved over Oʻahu (Honolulu County) and around the state. Power outages, downed trees and power lines were common across the state. On Oʻahu, a downed power line led to road closures. There was one reported injury from of this event. A person was injured at the Koko Head Shooting Complex when the winds blew the roof off the structure and flipped it over.	Honolulu
2017 Jan 21-22	The Maui and Hawaiʻi County EOCs were partially activated because of this event.	Maui and Hawaiʻi
2017 Feb 11	A front moving through the state produced heavy rain and thunderstorms, flash flooding, and gusty winds. This event led to downed power lines and trees, and ponding on roadways. On the south shore of Oʻahu, a tent collapsed at the community college due to the strong winds. Three individuals were injured.	Honolulu
2017 Oct 13-14	Strong winds, heavy rain, thunderstorms, and flash flooding impacted parts of Hawaiʻi. Lightning strikes led to power outages, and gusty winds knocked down trees and power lines. One injury was reported on Oʻahu (Honolulu County) when a tree fell onto a bus stop structure where a woman was standing. In Maui County, wind speeds reached 59 mph.	Honolulu and Maui

Figure E-5. Historic Occurrences of Strong Winds from All Storms Until 1997, Island of Kaua'i

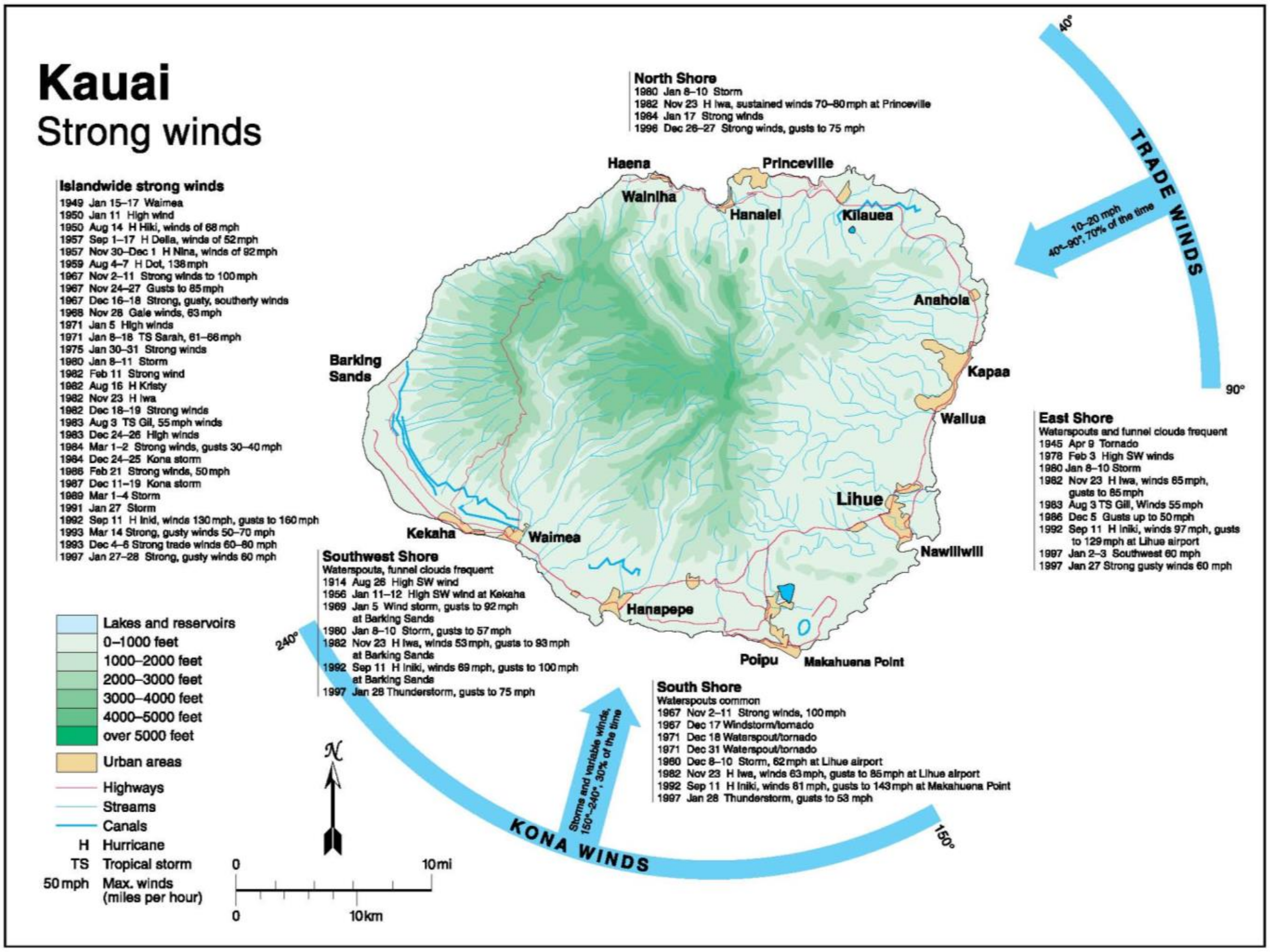


Figure E-6. Historic Occurrences of Strong Winds from All Storms Until 1997, Island of O'ahu

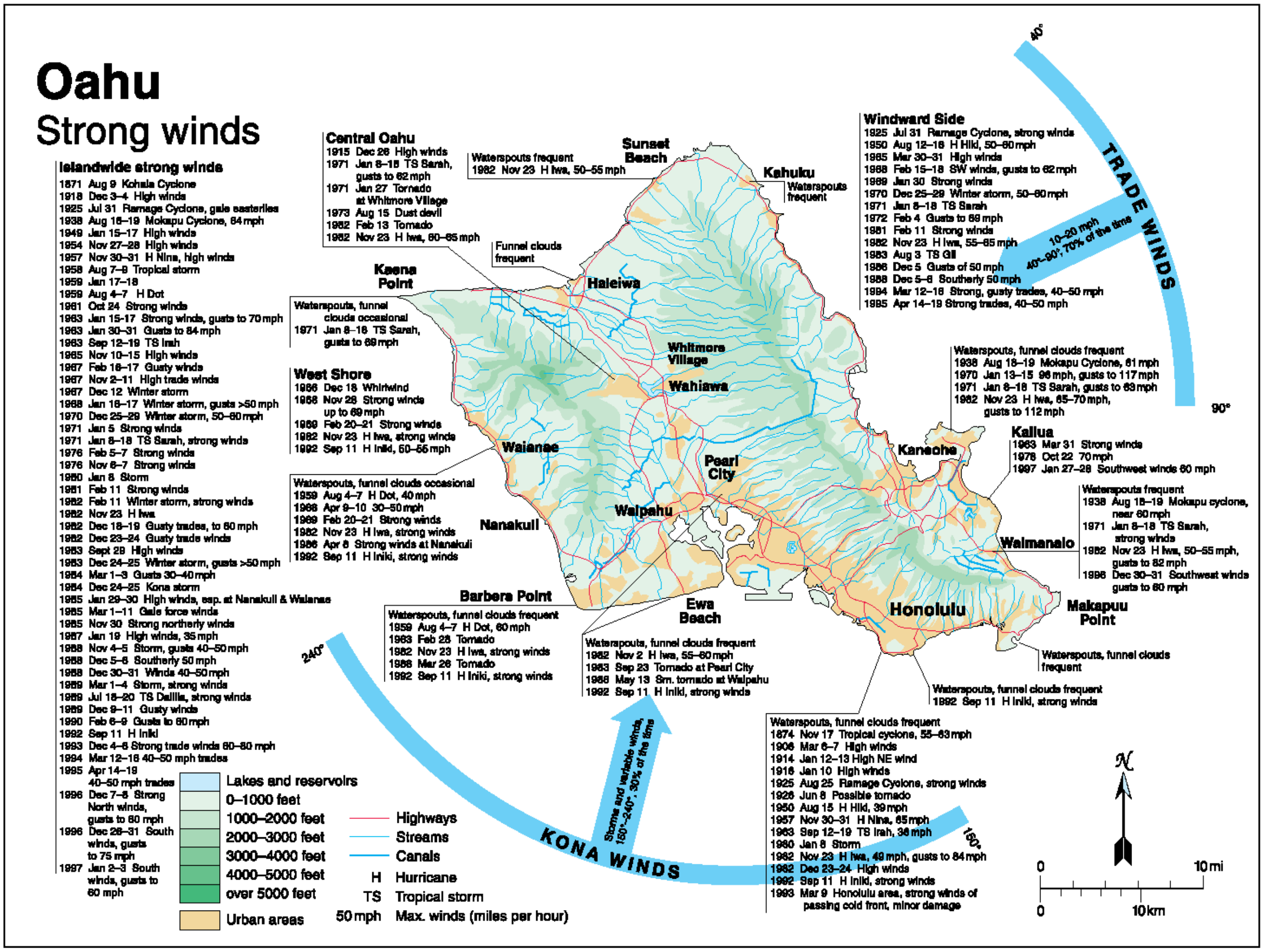


Figure E-7. Historic Occurrences of Strong Winds from All Storms Until 1997, Maui

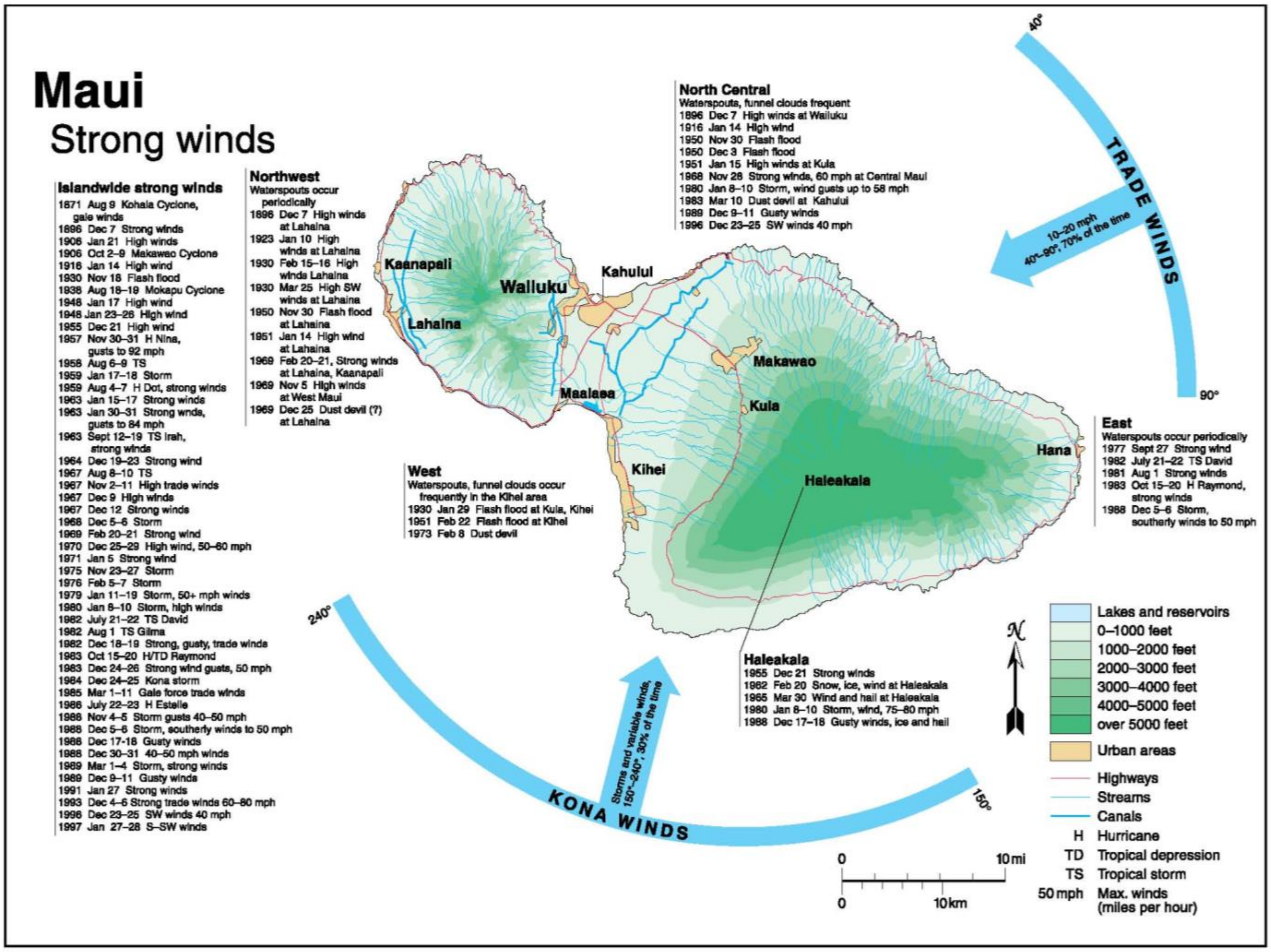


Figure E-8. Historic Occurrences of Strong Winds from All Storms Until 1997, Islands of Molokaʻi and Lānaʻi

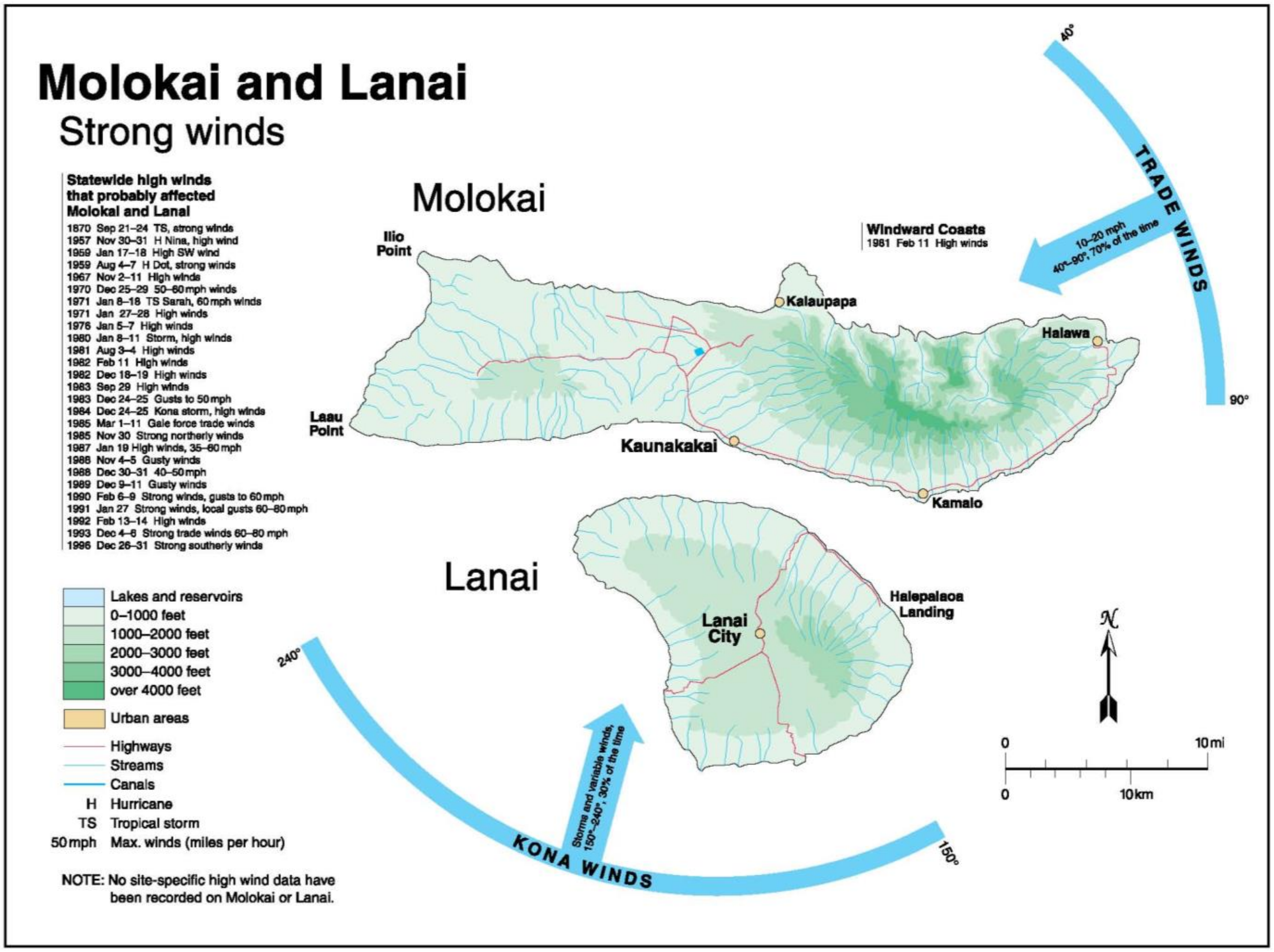
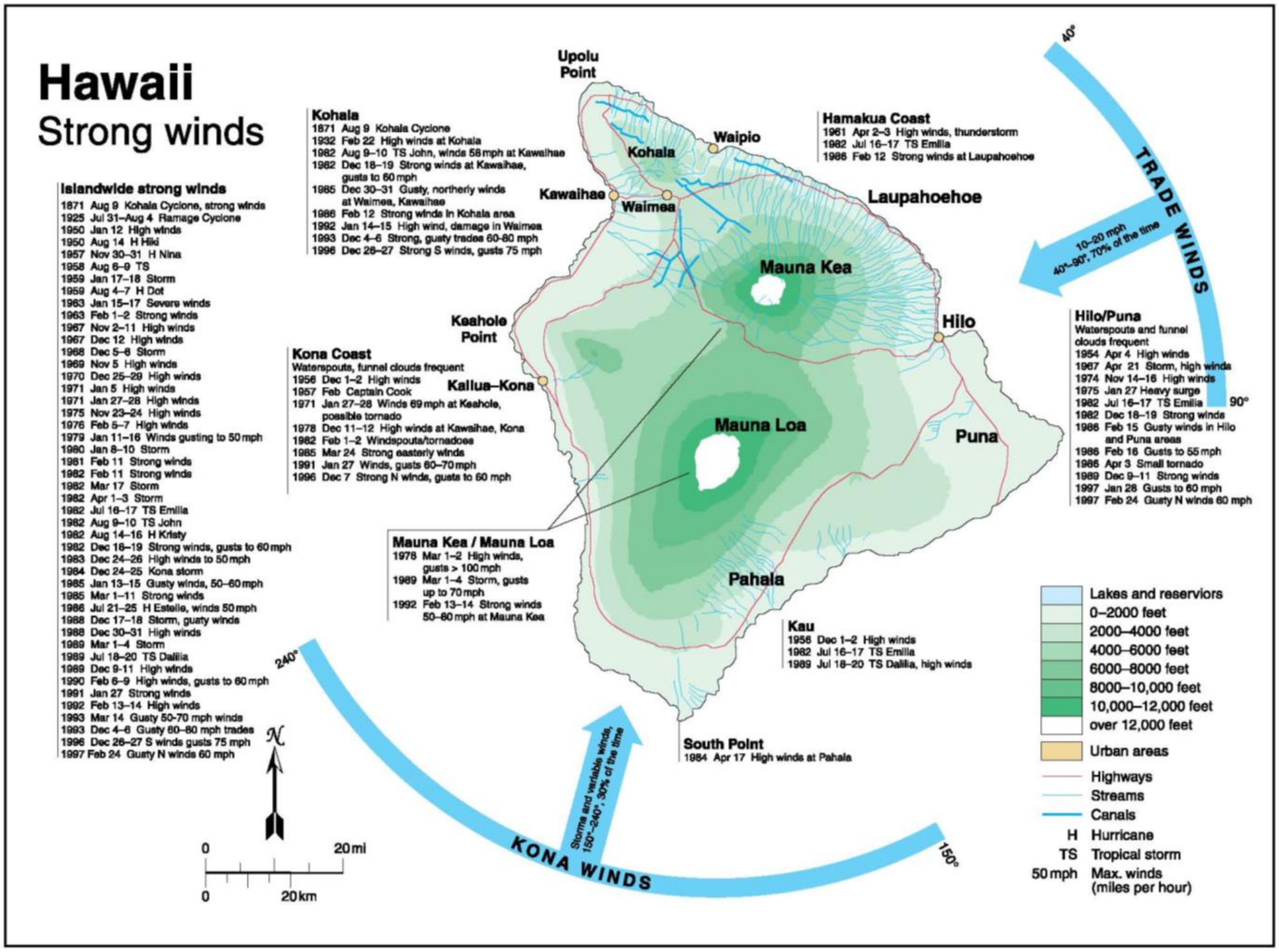


Figure E-9. Historic Occurrences of Strong Winds from All Storms Until 1997, Island of Hawaiʻi



E.10 Hurricane

The following presents hurricane events that occurred in the State of Hawaiʻi between 1871 and 2017, as presented in the 2013 and 2018 HMPs. The information is reproduced as documented in the 2013 and 2018 plans.

On the island of Kauaʻi, numerous high wind events have affected the entire island, and many were associated with passing storms. Hurricanes Dot (1959), ʻIwa (1982), and Iniki (1992) were exceptionally damaging. Hurricane Dot packed sustained winds of 75 mph with gusts of 165 mph as it passed directly over the island of Kauaʻi. Winds and flooding led to $5.5-6 million (at the time) in agricultural losses and hundreds of houses and trees were damaged.

Hurricanes ʻIwa and Iniki both produced high waves ranging 20-30 feet and winds over 125 mph. Although Hurricane ʻIwa passed to the northwest of the island of Kauaʻi, the high surf it produced, combined with a 5-6 foot storm surge, flooded 600 feet inland in areas between Kekaha and Poʻipu and caused $312 million in damage. Ironically, despite the massive flooding and wind damage to the Poʻipu area, redevelopment following ʻIwa occurred in precisely the same location, only to be devastated 10 years later by Hurricane Iniki. Today, these same areas are once again densely developed.

On September 11, 1992, Hurricane Iniki, the strongest and most destructive hurricane to hit the Hawaiian Islands, made landfall just west of Port Allen on the island of Kauaʻi's south shore. Iniki's winds were sustained at 130 mph and gusts topped 160 mph. Winds and waves destroyed 1,421 houses and caused minor to heavy damage to some 13,000 houses. Although Hurricanes ʻIwa and Iniki did not strike the island of Oʻahu directly, communities on Oʻahu's Waiʻanae Coast and Wahiawā-Mililani suffered severe damage.

Of course not all of the storms make landfall in Hawaiʻi and actual hurricane strikes in Hawaiʻi are relatively rare in modern record. Those hurricanes that head north to the east of the Islands cross colder water and tend to dissipate before reaching the Islands. Tropical Storm Felicia (2009) is a recent example of this degradation of intensity over cooler waters. More commonly, near misses that generate large swell and moderately high winds causing varying degrees of damage are the hallmark of hurricanes passing close to the islands.

Table E-15, Table E-16, and Table E-17 provide a summary of significant Hawaiian hurricanes over the last century along with the estimated damage from each hurricane

Table E-15. Significant Hawaiian Hurricanes of the 20th Century

Name	Date	Damage (1990 Dollars)	Deaths
Mokapu Cyclone	1938 Aug 19	Unknown	Unknown
Hiki	1950 Aug 15	Unknown	Unknown
Nina	1957 Dec 2	$900,000	4
Dot	1959 Aug 6	$28,000,000	0
ʻIwa	1982 Nov 23	$394,000,000	1
Iniki	1992 Sept 11	$2,800,000,000	4

Table E-16. Historical Tropical Cyclones Affecting the Hawaiian Islands

Date	Tropical Cyclone
1871 Aug 9	Kohala Cyclone, gale winds
1925 July 31	Ramage Cyclone
1938 Aug 18-19	Mokapu Cyclone
1948 Jan 23-26	High winds
1950 Aug 15	Hurricane Hika
1957 Nov 30-31	Hurricane Nina, gusts to 92 mph.
1958 Aug 6-9	Tropical Storm
1959 Aug 4-7	Hurricane Dot, strong winds
1963 Sept 12-19	Tropical Storm Irah, strong winds
1967 Aug 8-10	Tropical Storm
1971 Jan 8-18	Tropical Storm Sarah
1982 July 21-22	Tropical Storm Daniel
1982 Aug 1	Tropical Storm Gilma
1982 Nov 23	Hurricane ʻIwa
983 Oct 15-20	Hurricane/Tropical Depression Raymond
1986 July 22-23	Hurricane Estelle, rain and high surf

Date	Tropical Cyclone
1989 July 18-20	Tropical Storm Dalilia
1992 Sept 11	Hurricane Iniki, heavy rain, high winds, and high surf
1993 July 16	Hurricane Fernanda, rain and high surf
1994 July 14	Tropical Storm Daniel, moderate surf
1994 July 24	Tropical Storm Fabio, heavy rainfall
1999 Aug 15	Hurricane Dora, mild rain
2003 Sept 1	Hurricane/Tropical Storm Jimena, 4 to 8-foot swell
2004 Aug 3	Hurricane Darby, heavy rain and 4 to 8-foot swell
2005 Sept 22	Hurricane/Tropical Storm Jova, 8 to 12-feet swell
2005 Sept 30	Hurricane/Tropical Storm Kenneth, 8 to 10-foot swell
2007 Aug 13	Hurricane Flossie, rain
2009 Aug 10	Hurricane/Tropical Storm Felicia, rain

Table E-17. Tropical Storm and Hurricane Events in the State of Hawaiʻi, 2012–2017

Date(s) of Event	Event Type	Counties Affected	Description
July 26 to 30, 2013	Tropical Storm Flossie	Maui and Hawaiʻi	Tropical Storm Flossie affected the state, bringing high surf, thunderstorms, heavy rain, flash flooding and strong winds. Strong winds downed trees and power lines across the state, closing roads and leading to power outages. Widespread power outages were reported on the Islands of Hawaiʻi, Maui and Molokaʻi. There were several injuries reported due to lightning strikes. The state EOC was activated during this event. Total cost of damages was not readily available for this event.
August 4 to 21, 2014	Tropical Storm Iselle (FEMA-DR-4194)	City and County of Honolulu, Maui, and Hawaiʻi	Tropical Storm Iselle brought heavy rain, strong winds, downed trees and wires, and widespread power outages. Overflowing streams flooded roadways in throughout the State of Hawaiʻi. There were over 200 reports of damage to homes and businesses and over 100 reports of infrastructure issues (downed utility poles and power lines; damaged roadways). Agriculture was heavily impacted by the storm with approximately 50% of the state's papaya crop destroyed (an estimated $55 million loss). The storm also caused damage to other crops; including flowers, macadamia nuts, and coffee. Estimated total losses ranged from $148 million to $325 million. On September 5, 2014, Governor Neil Abercrombie requested a major disaster declaration due to Tropical Storm Iselle during the period of August 7 to 9, 2014. The Governor requested a declaration for public assistance for three counties and hazard mitigation statewide. On September 12, 2014, President Obama declared that a major disaster existed in the State of Hawaiʻi. The declaration made public assistance available to state and eligible local governments and certain private non-profit organizations on a cost-sharing basis for emergency work and the repair or replacement of facilities damaged by the Tropical Storm Iselle in the City and County of Honolulu, County of Maui, and County of Hawaiʻi. Total public assistance was estimated at over $8 million, with over $4.9 million obligated.
October 13 to 19, 2014	Hurricane Ana	Kauaʻi and Hawaiʻi	Hurricane Ana brought heavy rain to the Counties of Kauaʻi and Hawaiʻi. The system also generated isolated thunderstorms that moved westward. The swell from the hurricane produced high surf that ranged from 8 to 15 feet along the south shores of the islands. Roads were closed throughout the impacted areas due to flash flooding. The state EOC was fully activated as a result of this event. Overall, there were no reports of significant property damage or injuries associated with Hurricane Ana.

Date(s) of Event	Event Type	Counties Affected	Description
July 31 to August 5, 2015	Tropical Storm Guillermo	Kauaʻi, Maui, and Hawaiʻi	A swell from Tropical Storm Guillermo produced surf of 10 to 20 feet along the east-facing shores of the Islands of Kauaʻi, Oʻahu, Molokaʻi, Maui, and Hawaiʻi. The high surf forced county officials to close beaches in the Counties of Maui and Hawaiʻi. The high water also brought debris onto coastal roads near inundated areas. There were no reports of significant property damage or injuries associated with Tropical Storm Guillermo. County EOCs were partially activated as a result of this event.
August 20 to 24, 2015	Hurricane Kilo	Honolulu, Maui, and Hawaiʻi	On August 20, 2015, from west to east, Hurricane Kilo was located 1,200 miles west-southwest of the City and County of Honolulu. It passed over the southern end of the state, bringing heavy rain, thunderstorms, and flash flooding to the area. Many roads were closed throughout the impacted counties due to flash flooding. Several schools were closed for several days due to flooded roadways and power outages. On Oʻahu (City and County of Honolulu), sewers overflowed and water was coming through manholes. Thousands of gallons of water escaped from the sewer system. All county EOCs were monitoring the situation. There were direct impacts to Johnston Island and portions of the Northwestern Hawaiian Islands.
August 26 to September 4, 2015	Hurricane Ignacio	Kauaʻi, City and County of Honolulu, Maui, and Hawaiʻi	On August 30, 2015, from west to east, Hurricane Ignacio was located 515 miles east-southeast of Hilo (County of Hawaiʻi). A swell from the storm generated surf of 10 to 20 feet along the east-facing shores, and 6 to 8 feet along the south-facing shores of all the islands except Lānaʻi. The unusually high surf on eastern shorelines led to the occasional deposited sand and other debris on roadways along the coastlines. There were no reports of serious property damage; however, there was one injury reported on Oʻahu (City and County of Honolulu). All EOCs were monitoring the event. There were direct impacts to Johnston Island and portions of the Northwestern Hawaiian Islands.
September 2 to 9, 2015	Hurricane Jimena	Kauaʻi, City and County of Honolulu, Maui, and Hawaiʻi	On August 30, 2015, from west to east, Hurricane Jimena was located 1,815 miles east-southeast of Hilo. Remnants of Hurricane Jimena moved north of the state. It brought heavy rain and flooding over parts of the state. Roads were closed due to flooding of local streams and creeks. All EOCs were monitoring this event. There were direct impacts to Johnston Island and portions of the Northwestern Hawaiian Islands.
September 22, 2015	Tropical Storm Niala	Kauaʻi, City and County of Honolulu, Maui, and Hawaiʻi	All state and county EOCs were monitoring the event.
October 2 to 5, 2015	Tropical Storm Oho	Kauaʻi, City and County of Honolulu, Maui, and Hawaiʻi	All state and county EOCs were monitoring the event.
October 20 to 23, 2015	Hurricane Olaf	Kauaʻi, City and County of Honolulu, Maui, and Hawaiʻi	A swell from Hurricane Olaf produced surf of 10 to 20 feet along the east-facing shores of the Island of Hawaiʻi, 8 to 12 feet along the east-facing shores of the Island of Maui, and 6 to 9 feet along the south-facing shores of all the major islands of the state of Hawaiʻi. Several roadways were inundated by several inches of water. There were no significant injuries or property damage reported. All EOCs were monitoring the event.

Sources: NOAA-NCEI 2018; FEMA 2018; State of Hawaiʻi 2018; NOAA 2015

Note: Hurricane documentation for the State of Hawaiʻi is extensive and not all sources have been identified or researched. Additionally, loss and impact information for many events could vary depending on the source. Therefore, Table 4.10-3 may not include all events that have occurred in the state and the accuracy of monetary figures discussed is based only on the available information identified during research for this 2018 HMP Update.

DR Major Disaster Declaration (FEMA)
EOC Emergency Operations Center
FEMA Federal Emergency Management Agency
NCEI National Centers for Environmental Information
NOAA National Oceanic and Atmospheric Administration

Figure E-10. Historical Storm Tracks in the Vicinity of Hawai'i

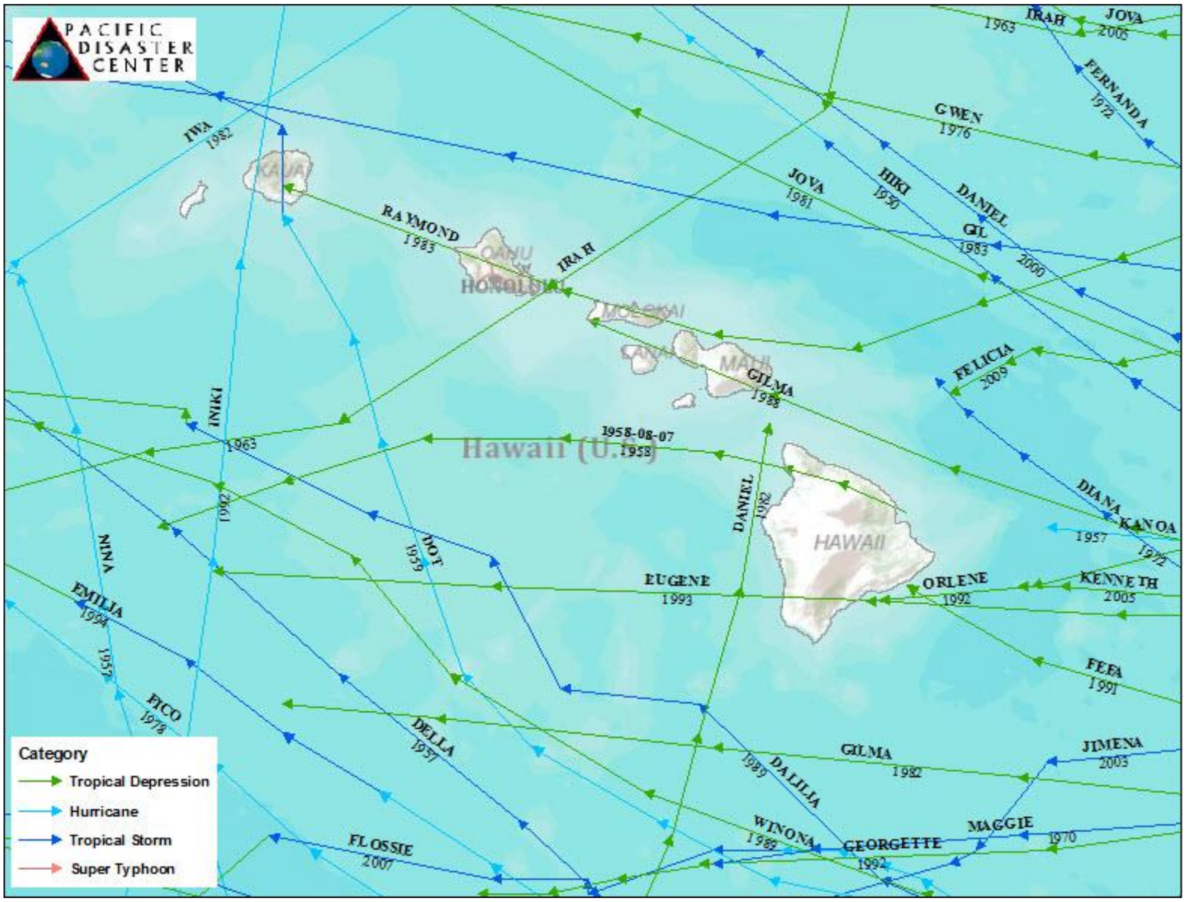
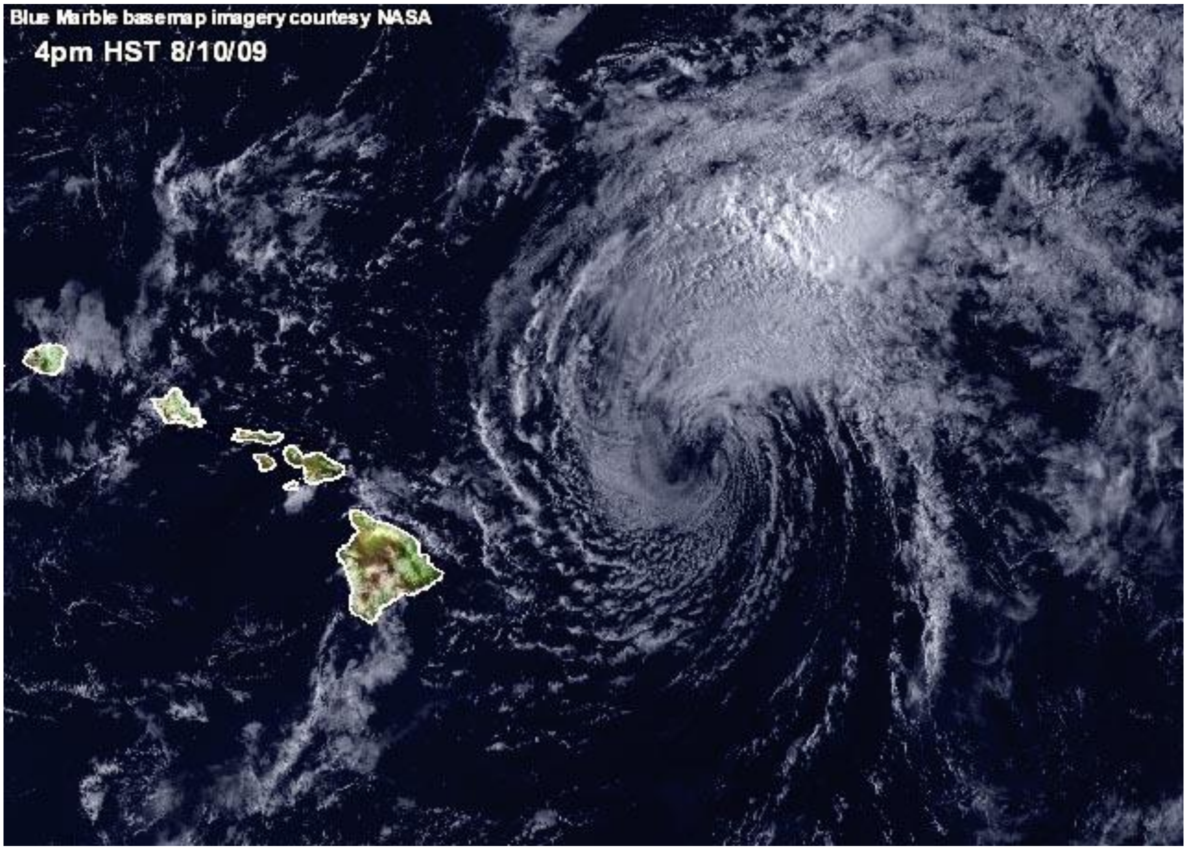


Figure E-11. Tropical Storm Felicia Approaching Hawaiʻi on August 10, 2009



E.11 Landslide and Rockfall

The following presents landslide and rockfall events that occurred in the State of Hawaiʻi between 1871 and 2017, as presented in the 2013 and 2018 HMPs. The information is reproduced as documented in the 2013 and 2018 plans.

Many sources from FEMA, USGS, and DLNR provided information regarding previous occurrences and losses associated with landslide and rockfall events throughout the State of Hawaiʻi. The 2018 HMP discussed specific landslide and rockfall events that occurred in the state between January 1, 2012 and December 31, 2017. However, due to the heavy rains, flooding, and mud/rockslides that caused damages and losses to areas in the City and County of Honolulu and the County of Kauaʻi during the time of the 2018 HMP Update, the April 2018 event was included. Table E-18 lists major landslide and rockfall events that occurred in the state between 2012 and 2017, with the addition of the April 2018 event

Table E-18. Landslide Events in the State of Hawaiʻi, 2012–April 2018

Date(s) of Event	Event Type and Federal Disaster Declaration (if applicable)	Counties Affected	Description
2012 Mar 3-11	Severe Storms, Flooding, and Landslides (FEMA-DR-4062)	Kauaʻi, Honolulu, and Maui	On March 3 and 4, an upper trough in the vicinity of the Hawaiian Islands brought heavy rain, landslides, and flash flooding to the County of Kauaʻi and the City and County of Honolulu. Numerous roads and bridges were closed throughout the impacted counties due to flooding. The City and County of Honolulu EOC was activated. This event resulted in a FEMA declaration for the counties of Kauaʻi and Maui. A total of $3.6 million in public assistance was approved for the impacted counties.
2012 Apr 4	Rockfall	Honolulu	Boulders fell from loose soil and damaged homes and roadways along Kula Kōlea Place in Kāhili Valley. Three homes were damaged, two severely. There were no injuries, but nine homes were evacuated. Several other boulders on the hillside needed to be stabilized or removed to prevent further damage, at a cost of $150,000.
2016 May 16	Flash Flood, Landslide	Honolulu	Rocks fell on a portion of the Pali Highway. The Honolulu Emergency Operations Center was activated.
2016 Sept 11-14	Severe Storms, Flooding, Landslides, and Mudslides (FEMA-DR-4282)	Maui and Hawaiʻi	As a weak tropical disturbance with abundant low-level moisture moved through the Hawaiian Islands, an upper low moved in from the northwest. This combination generated heavy showers and thunderstorms, which then resulted in landslides, mudslides, and flash flooding over the County of Maui. In the County of Hawaiʻi, flash flooding was reported closing roadways in the Mountain View area of the county. Other parts of the state received heavy rainfall as well. Overall damages were estimated at $15 million and created approximately 9,000 truckloads of debris. On September 27, 2016, Governor Ige requested a major disaster declaration due to this event. On October 6, 2016, President Obama declared that a major disaster existed in the State of Hawaiʻi. The County of Maui was included in the declaration. Public assistance for the event reached over $7.4 million.

Date(s) of Event	Event Type and Federal Disaster Declaration (if applicable)	Counties Affected	Description
2018 Apr	Heavy Rains, Flooding, and Mud & Rock Slides (FEMA-DR-4365)	Honolulu and Kauaʻi	Heavy rains and flooding caused damages and losses to areas in Honolulu and Kauaʻi. According to NOAA, a rain gauge on Kauai's North Shore recorded 49.69 inches of rain in 24 hours. In Kauaʻi County, heavy rain caused extensive damage to the slopes adjacent to Kūhiō Highway and impacted the communities of Wainiha and Haena. Multiple landslides led to the closure of the road. Numerous road closures reported in the impacted areas. Many homes were damaged or destroyed. American Red Cross conducted damage assessments and distributed clean up kits to residents in Aina Haina, Niu Valley, Kuliouou, Waimanalo, and Kailua. In Kauaʻi County, the American Red Cross opened five shelters. Ten residents from Wainiha were airlifted to be taken to a shelter. Between April 13th and 19th, the Red Cross provided shelter to 110 individuals on Kauaʻi. Governor Ige declared the District of Hanalei in Kauaʻi County a disaster area. This declaration provided relief for damage caused by the event. Details regarding monetized impacts are not available at the time of this plan update

E.11.1 COUNTY OF KAUAʻI

Soil avalanches or landslides taking place on the western side or even northern side of the island of Kauaʻi. Soil avalanches may leave bright scars on the hillside for months. A good example is a slide that occurred in Olokele Canyon in October 1981. The slide face was about 300 meters wide and about 800 meters high (about a thousand feet wide by 2,400 feet high) – a slide of tremendous proportions. This particular slide was caused by a combination of high rainfall and underground water seepage. Features and processes like this are responsible for much of the valley development, cliff faces, and other geologic features in the Hawaiian archipelago.

E.11.2 CITY AND COUNTY OF HONOLULU

The hazards of debris flows in the Honolulu District were exhibited during the New Year's Eve storm of 1987-1988. Most of the damage occurred in the eastern part of the Honolulu District. Debris flows directly impacted several homes in Kuliʻouʻou and Hahaʻione valleys. Debris from a number of landslides clogged a drainage structure, and caused severe flooding in Hahaʻione Valley. The storm also triggered a large landslide high in the Kūpaua valley that sent tons of mud, rock, and other debris downstream into lower Niu Valley, obstructing drainage channels and flooding a number of homes and a shopping center. Fortunately, no lives were lost, and the damage to private property was light, in view of the severity of the storm and the hundreds of debris flows it produced. Total damage from the storm nevertheless, sufficient to warrant a federal disaster declaration.

- May 9, 1999 - a landslide killed seven hikers and injured many more at Sacred Falls State Park, near Hauʻula on the north shore of the island. One of the injured hikers later died of injuries received in the landslide. The governor of Hawaiʻi at the time, Ben Cayetano, closed the park due to concern about continuing landslide hazard near the falls.

- March 2000 - notable rockfalls include a Waimea Bay rockslide which hit two cars and resulted in total closure of highway 83 affecting 6,000 vehicles a day for more than two weeks. Emergency design and construction of a realigned roadway cost $10 million.
- August 9, 2002 – Dara Rei Onishi, 26 was killed when a 5-ton boulder hit her family's Nuʻuanu home as she slept. This was the worst of two incidents on Henry Street.
- October 15, 2002 - rockslide at Makapuʻu Point closed a lane of highway 72, affecting 10,200 vehicles a day for several months.
- November 28, 2002 - on Thanksgiving Day, a rockslide brought down two boulders from a hillside above the Lalea condominium in Hawaiʻi Kai that slammed into parked cars, prompting the evacuation of 26 families for 11 months.
- February 14, 2003 - a 4-by-3-foot boulder rumbled down a hillside in Waiʻalae Nui and came to rest 20 feet from a house.
- May 11, 2004 – Thi Vo Hamakado of Henry Street was saved when she jumped out of the path of a 1-1/2-ton boulder that barreled out of the tree line behind her Nuʻuanu Valley home.
- April 17, 2006 – The state shut down Kamehameha Highway near Waimea Bay after a slide of rocks and debris, chain-link fencing and netting the state installed after the 2000 slide was in place, but the new slide occurred at an unprotected area.
- August 24, 2007 – A U.S. Army Corps of Engineers project removed five large boulders perched above homes on Ala Mahina Street in Moanalua Valley, at a cost of $309,000.
- November 4, 2007 – A fall rainstorm led to two separate incidents of 4-foot boulders striking homes, one in Pālolo Valley and one in Hao Street in upper ʻĀina Haina.
- January 7, 2009 – A rock 28 inches across slammed into the back of a Kahawalu Drive home in Nuʻuanu.
- January 22, 2010 – Tow large boulders rumbled down a hillside in Kalihi Valley and crashed through a chain-link fence above an apartment complex, hit a wall and came to rest on a patio. Nine families were temporarily displaced.
- April 11, 2012 – Five boulders fell from a steep hillside and caused substantial damage of two homes on Kula Kolea Place, Kalihi Valley. The state appropriated funds to remove remaining boulders from private property above the homes.

Debris flows triggered by the New Year's Eve storm were not a unique occurrence in the history of Honolulu. The most recent disaster involving debris flow on the island of Oʻahu occurred in 2006 when a sustained period of heavy rain from February through April caused a number of instances of flooding and mudslides on Oʻahu and Kauaʻi. On Oʻahu this included debris flow and mudslides onto Highway 61 (Kailua road) causing closures of the road. In another incident, a mudslide buried cars and other property on Maunaloa road in Makiki. There were further reports of mudslides on Puʻuhonua Street and flooding in Mānoa. Kahala Mall was also flooded causing closure of many of the stores and theaters for up to 9 months.

E.11.3 COUNTY OF MAUI

ISLAND OF MAUI

On September 14, 2004, a female ranger at Haleakalā National Park was fatally injured while trying to clear a rockslide on Piʻilani Highway (State Highway 31) near Kīpahulu. The ranger was on duty when she was hit by a falling rock from the nearby hillside while removing rocks on the narrow road.

On the first week of December of 2007, a strong Kona storm hit the Island of Maui causing runoff induced debris flows across several roads and highways. In the Kīhei area, runoff from gathering from the slopes of Haleakalā volcano pushed boulders and debris onto Piʻilani Highway (State Highway 31) forcing temporary closure of the road. Similarly, the storm's runoff carried debris across portions of Honoapiʻilani Highway (State Highway 30) near Nāpili in East Maui. The storm also generated debris flows in the Kula region of upcountry Maui. For instance, mud, rocks, and loosen vegetation were carried across Lower Kula Road. More noteworthy is the case of a debris flow across Polipoli Road also in the Kula region. In this case, debris including remains of a private residence, forced the closure of the road for several days until county crews removed all the leftovers from the debris flow.

On March 21, 2009, a mudslide on northeast Maui forced the closure of the Hāna Highway (State Highway 360). The incident occurred at 9:30 a.m. near mile-post 21, approximately two miles on the Keʻanae side of Puaʻa Kaʻa State Wayside Park. State and county public works crew cleared the mud and debris using heavy equipment. The highway reopened five hours after the mudslide. The County said the area had not been identified as a potential slide-problem area, but that wet weather in the few weeks before the incident may have saturated the soil resulting in the slide.

On April 23, 2009, another landslide occurred at the same location of the Hāna Highway following an episode of intense rainfall. The landslide occurred at 10:00 p.m. and forced the closure of the highway in both directions between mile-post 19 near the Wailua lookout and mile-post 21. The cleanup work on both lanes had to be postponed until the morning of the 24th due to unsafe conditions resulting from nighttime wet weather. After the partial removal of rocks and debris on the morning of the 24th, the highway reopened intermittently for a few days until cleanup work was completed.

Also on April 23, 2009, a rockfall occurred on Kahekili Highway (State Highway 340) at around 5:00 p.m. The rockfall resulted in large boulders blocking the highway near Waihale Gulch resulting in the closure of the road near mile-post 15. Debris removal began the morning of the 24th and extended well into the afternoon.

ISLANDS OF MOLOKAʻI AND LĀNAʻI

In 1871, the Lānaʻi Earthquake had a magnitude of 7 or greater. Massive rockfalls and cliff collapse occurred on Lānaʻi as a result of the event. Houses and churches were flattened on the island of Maui and Molokaʻi and land slippage was reported in Waianae and Lahaina. The 1938 Maui Earthquake was assigned a magnitude of 6.7-6.9 with an epicenter located only 6 miles north of the island of Maui. Landslides forced the closure of the road to Hāna, and long sections of the highway collapsed into the sea.

On November 5, 2007, heavy rains resulted in rockfalls and debris flows along different portions of Kamehameha V Highway (State Highway 450) on the east side of the island of Molokaʻi. In the case of the island of Lānaʻi, there are no available records of any historic landslides, debris flows, or rockfalls.

E.11.4 COUNTY OF HAWAIʻI

The largest Hawaiian earthquake in recorded history occurred in 1868 beneath the Kaʻū district on the southeast flank of Mauna Loa. The earthquake caused a mudflow that killed 31 people. The second most destructive earthquake in Hawaiʻi occurred on Kīlauea's south flank in Kalapana, November 29, 1975. The earthquake caused 11 feet of the Kalapana coast to subside, triggering a tsunami. Damage can be reduced by land-use zoning that restricts building on or near steep slopes that can fail during an earthquake and in areas underlain by materials that are likely to amplify the ground motion of a strong earthquake.

E.12 Terrorism

Specific events involving terrorism were not discussed in the 2013 and 2018 SHMPs.

E.13 Tsunami

The following presents tsunami events that occurred in the State of Hawaiʻi between 1812 and 2017, as presented in the 2013 and 2018 HMPs. The information is reproduced as documented in the 2013 and 2018 plans.

The recorded history of tsunamis in Hawaiʻi encompasses several phases according to the availability of recorded data. During the 19th century, numerous tsunamis were reported in newspapers, weeklies, and books written by residents at the time. The cause of tsunamis was not generally known, nor was the origin in terms of whether the tsunami was the result of a seismic event in a distant source such as the Aleutian Islands of Alaska or a local submarine landslide in the Hawaiian Islands. Toward the end of the 19th century, seismological stations became available to record and locate earthquakes. Through the instruments in these stations, it became easier to associate distant earthquakes with tsunamis in Hawaiʻi. The establishment of the Hawaiʻi Volcano Observatory in 1912 brought the expertise needed to accurately determine the origin and causes of local earthquakes and tsunamis in the islands. After the 1946 tsunami, the Tsunami Warning System was established and a group of experts was constituted to track and document origin, wave heights, and other data pertinent to tsunamis.

Up to May of 2013, twenty-eight tsunamis with run-up heights greater than 3.3 feet (1 meter) have made landfall in the Hawaiian Islands during recorded history and 4 have had significant damaging effects. In fact, tsunamis in the Hawaiian Archipelago have cumulatively killed the largest number of people of all natural hazards affecting the islands. Tsunamis reaching the Hawaiian Islands have exhibited tremendous variability in terms of their run-up heights, inundation distances, and the damage they have inflicted. Table E-19 and Table E-20 list tsunamis affecting the state of Hawaiʻi with run-up heights greater than 3.3 feet (1 meter). To complement the aforementioned table, Table E-21 lists tsunami destruction in the state of Hawaiʻi.

Table E-19. Tsunamis Affecting Hawai'i, 1812–2012

TSUNAMIS AFFECTING HAWAI'I, 1812-2002 (> 1 M RUNUP)

Yr		Mo	Day	Ms	MM	Runup (m)	Runup (ft)	Runup Station Location	Source	Notes (H=Hawai'i, M=Maui, Mo=Molokai, O=O'ahu, K=Kaua'i)
1812	12/21/1812	12	21			3	10	Ho'okena, Hawai'i	S.California?	1 (H)
1819	4/12/1819	4	12			2	7	W. Hawai'I, Hawai'i	North Coast Chile	1 (H)
1837	11/7/1837	11	7			6	20	Hilo, Hawai'i	South Coast Chile	3 (H,M,O)
1841	5/17/1841	5	17			4.6	15	Hilo, Hawai'i	Kamchatka	3 (H,M,O)
1860	12/1/1860	12	1			3.6	12	Maliko, Maui	N. Pacific?	2 (M)
1868	8/13/1868	8	13			4.5	15	Hilo, Hawai'i	North Chile	6 (H.M.O,K)
1868	10/2/1868	10	2			6.1	20	Kahaualea, Hawai'i	S. Pacific?	1 (H)
1869	7/24/1869	7	24			8.2	27	Puna Coast, Hawai'i	S. Pacific?	2 (H,M)
1871	2/20/1871	2	20	7					Off Lanai?	
1872	8/23/1872	8	23			1.3	4	Hilo, Hawai'i	Aleutians	1 (H)
1877	5/10/1877	5	10			4.8	16	Wai'akea, Hawai'i	N. Chile	8 (H,M,O)
1896	6/15/1896	6	15			5.5	18	Keauhou Landing, Hawai'i	Japan	15 (H,M,K)
1868	4/2/1868	4	2	7.9	XII	13.7	45	Keauhou Landing	Ka'u	many observations
1908	9/21/1908	9	21	6.8	VI	1.2	4	Hilo, Hawai'i	Mauna Loa NE Rift	1 (H)
1919	10/2/1919	10	2	6.1		4.3	14	Ho'opuloa, Hawai'i	South Kona (landslide possibly)	3 (H), Hoopuloa submarine landslide
1926	3/20/1926	3	20			1.5			Off Wailupe, Oahu	
1951	8/21/1951	8	21	6.9	VIII	1.2	4	Ho'okena, Hawai'i	South Kona	
1952	3/17/1952	3	17	4.5	V	3	10	Kalapana, Hawai'i	Kilauea South Flank	1 (H)
1975	11/29/1975	11	29	7.2	VIII	14.3	47	Keauhou Landing, Hawai'i	Kilauea South Flank	many observations (H), 2 deaths/19 injured, **$4.1 million**;
										32 campers at foot of Pu'u Kapukapu - rocks fell pushing
										them to beach where waves started 1) 1.5 m wave,
										2) 7.9 m (26-ft)wave carried campers into crevice/ditch saving
										them from being carried to sea; subsidence 3-3.5 m (11.5ft)Halape
1901	8/9/1901	8	9	7.8		1.2	4	Ho'opuloa, Kailua-Kona, Hawai'i	Vanuatu	
1906	1/31/1906	1	31	8.1		1.8	6	Hilo, Hawai'i	Ecuador	
1906	8/17/1906	8	17	8		3.6	12	Ma'alea, Maui	Chile	
1918	9/7/1918	9	7	8		1.5	5	Hilo, Hawai'i	Kurils	
1922	11/11/1922	11	11	8.1		2.1	7	Hilo, Hawai'i	Chile	
1923	2/3/1923	2	3	8.1		6.1	20	Hilo, Hawai'i	Kamchatka	
1933	3/2/1933	3	2	8.3		3.3	11	Ka'alualu, Hawai'i	Japan	
1946	4/1/1946	4	1	7.1		16.4	54	Waikolu Valley, Moloka'i	Aleutians	159 deaths, **$26 million**, in Hilo (3800 km), 8-m waves,
										every house facing bay washed across st/smashed
1952	11/4/1952	11	4	8.2		9.1	30	Ka'ena Point, O'ahu	Kamchatka	**$0.8-1.0 million**
1957	3/9/1957	3	9	8.1		16.1	53	Kaua'i, Kaua'i	Aleutians	**$5 million**, arr Laie, Oahu (3600 km away) 12ft wave
1960	5/22/1960	5	22	8.5		10.7	35	Hilo, Hawai'i	Chile	61 deaths, **$26.5 million**
1964	3/28/1964	3	28	8.4		4.9	16	Waimea Bay, O'ahu	Alaska	
1965	2/4/1965	2	4	8.2		1.1	4	North Kaua'i, Kaua'i	Aleutians	2 observations on Kaua'I
EQ - NO TSUNAMI										
1983	11/16/1983	11	16	6.6					Kao'iki	Ext damage SE Hawai'i, **>$6 million**
1989	6/25/1989	6	25	6.1					Kalapana	SE Hawai'i, **Almost $1 million**
2011	3/11/2011	3	11	9.0					Honshu, Japan	
						covert m-ft	3.286713			

Table E-20. Tsunami Events in Hawai'i, 2012–2017

Date(s) of Event	Event Type	Counties Affected	Description
2012 Oct 28	Tsunami Runup	Honolulu, Maui, Kaua'i, and Hawai'i	The source of the tsunami was in British Columbia, Canada. The maximum runup of this tsunami near the source was 13 meters. The Pacific Tsunami Warning Center issued a tsunami warning for Hawai'i. There were no reports of damage; however, one person died in a car crash on O'ahu's north shore during the evacuation. From photographs, runup was inferred to have been about one meter at Honouliwai, Moloka'i and at Kapalua, Maui. Runup was measured in all counties: • Waianea (Honolulu) had a maximum water height of 0.41 meters (tide-gauge measurement) • Barbers Point (Honolulu) had a maximum water height of 0.09 meters (tide-gauge measurement) • Lahaina (Maui) had a maximum water height of 0.28 meters (tide-gauge measurement) • Kahului (Maui) had a maximum water height of 0.79 meters (tide-gauge measurement) • Hanalei (Kaua'i) had a maximum water height of 0.19 meters (tide-gauge measurement)

Date(s) of Event	Event Type	Counties Affected	Description
			• Nāwiliwili (Kauaʻi) had a maximum water height of 0.03 meters (tide-gauge measurement) • Haleʻiwa (Honolulu) had a maximum water height of 0.43 meters (tide-gauge measurement) • Mokuoloʻe-Coconut Island (Honolulu) had a maximum water height of 0.09 meters (tide-gauge measurement) • Makapuʻu Point (Honolulu) had a maximum water height of 0.27 meters and 0.41 meters (tide-gauge measurement) • Honolulu (Honolulu) had a maximum water height of 0.2 meters (tide-gauge measurement) • Kaumalapau (Maui) had a maximum water height of 0.18 meters (tide-gauge measurement) • Kawaihae (Hawaiʻi) had a maximum water height of 0.56 meters (tide-gauge measurement) • Honokōhau (Hawaiʻi) had a maximum water height of 0.09 meters (tide-gauge measurement) • Honuʻapo (Hawaiʻi) had a maximum water height of 0.04 meters (tide-gauge measurement) • Kapoho (Hawaiʻi) had a maximum water height of 0.19 meters (tide-gauge measurement) • Hilo (Hawaiʻi) had a maximum water height of 0.29 meters (tide-gauge measurement)
2012 Nov 7	Tsunami Runup	Maui and Hawaiʻi	The source of the tsunami was in Guatemala. The maximum near-source runup of this tsunami was 0.35 meters. Runup was measured in the Counties of Maui and Hawaiʻi: • Kahului (Maui) had a maximum water height of 0.07 meters (tide-gauge measurement) • Hilo (Hawaiʻi) had a maximum water height of 0.06 meters (tide-gauge measurement)
2013 Feb 6	Tsunami Runup	Honolulu, Maui, Kauaʻi and Hawaiʻi	The source of the tsunami was in the Santa Cruz Islands, where runup reached 11 meters and there were numerous deaths. The tsunami was measured in all counties: • Waianea (Honolulu) had a maximum water height of 0.06 meters (tide-gauge measurement) • Barbers Point (Honolulu) had a maximum water height of 0.05 meters (tide-gauge measurement) • Lahaina (Maui) had a maximum water height of 0.12 meters (tide-gauge measurement) • Nāwiliwili (Kauaʻi) had a maximum water height of 0.01 meters (tide-gauge measurement) • Haleʻiwa (Honolulu) had a maximum water height of 0.19 meters (tide-gauge measurement) • Makapuʻu Point (Honolulu) had a maximum water height of 0.08 meters (tide-gauge measurement) • Honolulu (Honolulu) had a maximum water height of 0.06 meters (tide-gauge measurement) • Kaumalapau (Maui) had a maximum water height of 0.03 meters (tide-gauge measurement)

Date(s) of Event	Event Type	Counties Affected	Description
			• Kahului (Maui) had a maximum water height of 0.12 meters (tide-gauge measurement) • Kawaihae (Hawaiʻi) had a maximum water height of 0.09 meters (tide-gauge measurement) • Honokōhau (Hawaiʻi) had a maximum water height of 0.07 meters (tide-gauge measurement)
2014 Apr 1	Tsunami Runup	Honolulu, Kauaʻi, Hawaiʻi	The source of the tsunami was in Northern Chile, where runup reached 4.4 meters. Runup was measured in the Counties of Honolulu, Kauaʻi, and Hawaiʻi: • Waianea (Honolulu) had a maximum water height of 0.09 meters (tide-gauge measurement) • Barbers Point (Honolulu) had a maximum water height of 0.08 meters (tide-gauge measurement) • Nāwiliwili (Kauaʻi) had a maximum water height of 0.04 meters (tide-gauge measurement) • Haleʻiwa (Honolulu) had a maximum water height of 0.15 meters (tide-gauge measurement) • Makapuʻu Point (Honolulu) had a maximum water height of 0.08 meters (tide-gauge measurement) • Waimānalo (Honolulu) had a maximum water height of 0.11 meters (tide-gauge measurement) • Honolulu (Honolulu) had a maximum water height of 0.06 meters (tide-gauge measurement) • Kaumalapau (Maui) had a maximum water height of 0.02 meters (tide-gauge measurement) • Kahului (Maui) had a maximum water height of 0.53 meters (tide-gauge measurement) • Kawaihae (Hawaiʻi) had a maximum water height of 0.22 meters (tide-gauge measurement) • Honokōhau (Hawaiʻi) had a maximum water height of 0.09 meters (tide-gauge measurement) • Honuʻapo (Hawaiʻi) had a maximum water height of 0.04 meters (tide-gauge measurement) • Kapoho (Hawaiʻi) had a maximum water height of 0.12 meters (tide-gauge measurement) • Hilo (Hawaiʻi) had a maximum water height of 0.57 meters (tide-gauge measurement)
2014 June 23	Tsunami Runup	Kauaʻi, Honolulu, and Maui	The source of the tsunami was in the Aleutian Islands in Alaska. The maximum measured runup in the Aleutians (though some distance from the source) was 0.17 meters. Runup was measured in the Counties of Kauaʻi, Honolulu, and Maui: • Hanalei (Kauaʻi) had a maximum water height of 0.05 meters (tide-gauge measurement) • Haleʻiwa (Honolulu) had a maximum water height of 0.04 meters (tide-gauge measurement) • Makapuʻu Point (Honolulu) had a maximum water height of 0.03 meters (tide-gauge measurement) • Kahului (Maui) had a maximum water height of 0.1 meters (tide-gauge measurement)

Date(s) of Event	Event Type	Counties Affected	Description
2015 Sept 16	Tsunami Runup	Honolulu, Kauaʻi, Hawaiʻi, and Maui	The source of the tsunami was in Central Chile, where runup reached 13.6 meters. A tsunami watch was issued for the state of Hawaiʻi but was cancelled before the tsunami arrived. The tsunami was measured in all counties: • Waianea (Honolulu) had a maximum water height of 0.23 meters (tide-gauge measurement) • Barbers Point (Honolulu) had a maximum water height of 0.1 meters (tide-gauge measurement) • Nāwiliwili (Kauaʻi) had a maximum water height of 0.14 meters (tide-gauge measurement) • Hanalei (Kauaʻi) had a maximum water height of 0.03 meters (tide-gauge measurement) • Waimānalo (Hawaiʻi) had a maximum water height of 0.21 meters (tide-gauge measurement) • Mokuoloʻe-Coconut Island (Honolulu) had a maximum water height of 0.04 meters (tide-gauge measurement) • Makapuʻu Point (Honolulu) had a maximum water height of 0.01 meters (tide-gauge measurement) • Waimānalo (Honolulu) had a maximum water height of 0.21 meters (tide-gauge measurement) • Honolulu (Honolulu) had a maximum water height of 0.11 meters (tide-gauge measurement) • Kalaupapa (Maui) had a maximum water height of 0.08 meters (tide-gauge measurement) • Kahului (Maui) had a maximum water height of 0.65 meters (tide-gauge measurement) • Kawaihae (Hawaiʻi) had a maximum water height of 0.27 meters (tide-gauge measurement) • Hilo (Hawaiʻi) had a maximum water height of 0.91 meters (tide-gauge measurement)
2016 Nov 21	Tsunami Runup	Hawaiʻi	The source of the tsunami was in Japan off the east coast of Honshu Island. The maximum water height from this tsunami is unknown. A runup from this event was observed at the Midway Islands in Hawaiʻi, with a maximum water height of 0.09 meters (tide-gauge measurement).
2017 Sept 8	Tsunami Runup	Honolulu, Maui, and Hawaiʻi	The source of the tsunami was in Mexico, where runup reached 2.7 meters. The tsunami was measured in the Counties of Honolulu, Maui, and Hawaiʻi: • Mokuoloʻe-Coconut Island(Honolulu) had a maximum water height of 0.03 meters (tide-gauge measurement) • Kahului (Maui) had a maximum water height of 0.18 meters (tide-gauge measurement) • Kawaihae (Hawaiʻi) had a maximum water height of an unknown height (tide-gauge measurement) • Hilo (Hawaiʻi) had a maximum water height of 0.17 meters (tide-gauge measurement)

Table E-21. Tsunami Destruction in Hawai'i

DATE	SOURCE	DEATHS*	WHERE	Run-up**	REMARKS
1837	Earthquake in Chile	16	Hawaiian islands	6 m / 19.6 ft	14 deaths on the Big Island and 2 on Maui.
1868	Earthquake off the Big Island	47	Big Island	13.7 m / 45 ft	The earthquake also caused a landslide in Pahala that killed 37 bringing total deaths to 79.
1877	Earthquake in Chile	5	Hilo	4.8 m / 16 ft	Also 17 injured in Hilo.
1923	Kamchatka earthquake	1	Hilo	6.1 m / 20 ft	Others may have been killed (up to 12 others) and extensive damage occurred in Hilo and Kahului.
1933	Earthquake in Japan	1,600	Japan	3.3 m / 10.8 ft	No deaths in Hawaii but 17 feet waves were reported at Napoopoo.
1946	Earthquake in Aleutian islands	159	Mostly in Hilo (96) but also Kauai (15), Maui (14), & Oahu (9)	16.4 m / 53.8 ft	The largest natural disaster recorded to have occurred in Hawaii.
1952	Kamchatka earthquake	0	Hawaiian islands	9.1 m / 29.9 ft	Damage occurred on Kauai, Maui, Oahu, and in Hilo.
1957	Earthquake in the Aleutian islands	0	Hawaiian islands	16.12 m / 52.8 ft	Caused extensive damage on Kauai.
1960	Earthquake in Chile	61	Hawaiian islands	10.7 m / 35.1 ft	Over 1,000 people died in Chile, Japan, The Philippines, and Hawaii.
1964	Earthquake in Alaska	0	Hawaiian islands	4.9 m / 16.1 ft	106 people died in Alaska and 16 died on the North American coast. Damage occurred in Hilo and Kahului.
1975	Earthquake off the Big Island	2	Halape	14.3 m / 47 ft	19 others were injured.

* For more details see Doak C. Cox, "Tsunami Casualties and Mortality in Hawaii", University of Hawaii, Environmental Center, June 1987.
**Maximum run-up is the greatest height the tsunami was found to reach above the normal shore. The measurements listed are for the highest run-up recorded anywhere in Hawaii for that event (listed in meters and feet).

The tsunamis of 1868 and 1975 were locally generated by earthquakes beneath the southern coast of the island of Hawaiʻi. The waves produced by the 1868 tsunami destroyed several coastal villages in the Kaʻū and Puna districts of the Island of Hawaiʻi (most of which were never rebuilt). The 1975 tsunami claimed two lives and caused widespread damage along the Kalapana coast on the East side of the island of Hawaiʻi.

The most devastating tsunamis to hit the state of Hawaiʻi in the last century occurred in 1946 and 1960. The tsunami of 1946 originated in the Aleutian Islands, and struck the Hawaiian Islands without warning. Over 170 people were killed in the Island of Hawaiʻi, mainly at Laupāhoehoe and Hilo where the wave heights averaged 30 feet. The maximum wave height reported on the island of Hawaiʻi was 55 feet at Pololū Valley on the northern tip of the island.

The May 1960 tsunami (generated by the magnitude 9.5 Great Valdivia Earthquake in Chile) was one of the most destructive to hit the Hawaiian Islands. In the town of Kahului in the island of Maui, damage estimate was about $763,000 in the low coastal areas of the town. The waves washed inland for a distance of about 3,000 feet to ground elevations of about 6 feet. The Kahului Shopping Center and immediate vicinity received most of the damage. This tsunami also had significant effect on the town of Hilo, on the east shore of the Island of Hawaiʻi. Although the arrival time of this tsunami was correctly predicted, many people failed to heed the warnings and evacuations mandated by the authorities were insufficient. As a result, 61 lives were lost as waves up to 35 feet high crashed through homes in Hilo. Whole city blocks were swept clean of all buildings, and 580 acres were flooded. $23 Million in damages were reported in Hilo.

A much less destructive tsunami hit the island of Maui in March 1964 (generated by the magnitude 9.2 Great Alaskan Earthquake) with a recorded maximum run-up at Kahului of 12 feet and doing estimated $53,000 (1964 dollars) damage.

In 2010, a tsunami generated by a magnitude 8.8 earthquake offshore of the Region of Maule in Chile, arrived to the Hawaiian Islands approximately at noon on February 27. Although very similar in nature to the May 22 tsunami generated by the Valdivia Earthquake also in Chile, the 2010 tsunami did not cause any damage to property, injury, or loss of life because its run-ups were much lower than those of the 1960 tsunami. The tsunami generally generated run-ups between 3 and 4 feet across all shores of all Hawaiian Islands with the higher run-ups occurring on the south and east facing shores.

Although not destructive, the latest tsunami to hit the Hawaiian Islands occurred in 2011. This tsunami was generated by a magnitude 9.0 earthquake off the coast of Tōhoku, Japan. Likewise, the 2010 tsunami created by the Chile earthquake, this tsunami did not cause any damage to property, injury, or loss of life in any of the Hawaiian Islands.

E.14 Volcanic Hazards

The following presents volcanic hazard events that occurred in the state of Hawaiʻi between 1790 and 2018, as presented in the 2013 and 2018 SHMPs. The information is reproduced as documented in the 2018 plan.

The recorded history of volcanic activity in Hawaiʻi begins with the arrival of the Christian missionaries in the early 1800's and those that are known from oral traditions of the Hawaiians. Additional information on prehistoric eruptions is based on geologic mapping and dating of old lava flows.

For the 2018 HMP Update, volcanic events were summarized between January 1, 2012, and December 31, 2017. Major events include those that resulted in losses or fatalities, events that resulted in the activation of the state and/or county emergency operations center (EOC), and/or events that led to a FEMA disaster declaration. It should be noted that it is recognized that the Kīlauea Volcano entered a new and very damaging phase of its long-running eruption at the end of April of 2018 and this activity continues as this plan is updated. Data regarding those impacts are in the development stage.

Table E-22. Volcanic Hazard Events in Hawaiʻi, 2012–2017

Date(s) of Event	Event Type	Counties Affected	Description
2014 Sept 4 – 2015 June 27	Puʻu ʻŌʻō Volcanic Eruption and Lava Flow	Hawaiʻi	Lava erupted from the northeast flank of Kīlauea's Puʻu ʻŌʻō cone. Hawaiʻi Electric Light Company staff worked to insulate utility poles from encroaching lava flows. Staff were deployed to monitor the lava flow. Crews worked to build new roads around Pahoa in case the lava cut off access to Highway 130. One residence was destroyed, and a solid waste transfer station was temporarily out of commission.
2017 June 8	South Flank Kīlauea Volcanic Eruption and Earthquake	Hawaiʻi	A 5.3 magnitude earthquake occurred on the south flank of Kīlauea, due to southward spreading of the volcano. The earthquake was reported felt by about 800 people within an hour. The County of Hawaiʻi EOC was fully activated.
2018 May – June *	Kīlauea Volcanic Eruption and Earthquakes (DR-4366)	Hawaiʻi	▪ On May 1, the USGS HVO issued a report that a migration of seismicity and deformation downrift (east) of Puʻu ʻŌʻō indicated that a large area along the East Rift Zone was potentially at risk of new outbreak, possibly in the Lower Puna area. ▪ On May 11, FEMA issued a major disaster declaration for the State of Hawaiʻi due to the eruption of Kīlauea. The County of Hawaiʻi was included in this declaration. ▪ On May 16, heavy de-gassing was occurring at each vent within the Leilani Estates neighborhood and the lower East Rift. The Hawaiʻi Fire Department reported air quality condition RED (immediate danger to health) in areas around Lanipuna Gardens and surrounding farm lots on Pohoiki Road. ▪ On May 17, HVO indicated an explosive eruption at Kīlauea summit occurred at 4:17am. By the afternoon, HVO reported a new fissure 21 down rift of Makamae Street in Leilani Estates neighborhood. Several fissures reactivated, and flows have been generated. The HVO reported lava was Pāhoehoe. Residents were issued masks for ash protection and shelters were open for residents. Eruptions continued to occur, and fissures reactivated. Lava destroyed homes, led to road closures, caused brush fires, and residents were evacuated. ▪ On May 20, white plumes of acid and extremely fine shards of glass billowed over the Island of Hawaiʻi as molten rock from Kīlauea poured into the ocean. The rate of sulfur dioxide gas shooting from the ground fissures tripled, leading County of Hawaiʻi to repeat warnings about air quality. At the volcano's summit, two explosive eruptions unleashed clouds of ash. Winds carried much of it toward the southwest. Since May 3, Kīlauea burned some 40 structures, including two dozen homes, since it began erupting in the Leilani Estates neighborhood. About 2,000 people were evacuated from their homes, including 300 who were staying in shelters. ▪ May 31, 2018, Mandatory Evacuation Order in Effect for Leilani Estates ▪ Hawaiian Volcano Observatory reports that vigorous lava eruptions continue from the lower east rift zone fissure system in the area of Leilani Estates and Lanipuna Gardens.

E.14.1 MAUNA LOA, ISLAND OF HAWAIʻI

Mauna Loa has had 33 historically recorded eruptions, most of which have occurred at the summit. Approximately 25% of the eruptions have started on the east-northeast rift zone and another 25% began in the southwest rift zone. During the period from 1832 to 1950, Mauna Loa averaged one eruption every 3.6 years. Since 1950, eruption activity on Mauna Loa has slowed considerably. The two eruptions since 1950 include a 1-day summit eruption in 1975 and a 3-week eruption on the northeast rift zone which advanced to within 4 miles of Hilo.

Six eruptions from Mauna Loa have reached the ocean since 1859. The 1859 eruption on the northwest flank of Mauna Loa lasted approximately 300 days and reached the ocean north of Kīholo Bay in the North Kona district. Between 1868 and 1950, 5 lava flows have reached the ocean from eruptions on the southwest rift zone of Mauna Loa. These flows traveled quickly with 4 out of the 5 reaching the ocean in 3 to 48 hours. These flows entered the ocean in the South Kona and Kaʻu districts. The eruption of 1950 destroyed the Hoʻokena-Mauka village in South Kona with the swiftly flowing lava traveling 14 miles in only 3 hours. Although the lava flow also crossed the area's only highway in two places, the residents escaped unharmed.

E.14.2 KĪLAUEA, ISLAND OF HAWAIʻI

Kīlauea was almost continuously erupting at its summit caldera from the beginning of historic records up until 1924. Since 1955, most of the activity has occurred along the east rift zone. In January 1960, the volcano erupted; destroying villages of Koaʻe and Kapoho (see Figure E-12). The latest eruption of the east rift zone began in 1983 and is still ongoing as of the date of this report. The southwest rift zone has been less active with only 5 eruptions in the past 200 years; the latest was in 1974.

The recorded eruption history of Kīlauea (see Table E-23) demonstrates the degree of variability in eruption type, duration, and other aspects of volcanoes. Although voluminous records covering various facets of volcano activity obviously exist, it is important to note that they do not necessarily inform our mitigation strategies, as most directly impacted areas are uninhabited federal lands under the jurisdiction of the National Park Service. In turn, the brunt of the mitigation focus is on indirect impacts that have implications for population settlements.

Figure E-12. Photograph of the Kīlauea eruption taken 10:00 am January 14, 1960

Table E-23. Summary of Historical Eruptions at Kīlauea from 1790–2017

Year	Start (mo-day)	Duration (days)	Eruptive Subdivision	Area Covered (km2)	Volume (km3)
1983	3-Jan	>6,200 (s)(v)	ER (u)	102	1.9
1982	25-Sep	<1	C	0.8	0.003
1982	30-Apr	<1	C	0.3	0.0005
1979	16-Nov	1	ER	0.3	0.00058
1977	13-Sep	18	ER	7.8	0.0329
1975	Nov-29 (bb)	<1	C	0.3	0.00022
1974	31-Dec	<1	SWR	7.5	0.0143 (w)
1974	19-Sep	<1	C	1	0.0102 (aa)
1974	19-July	3	C, ER	3.1	0.0066
1973	10-Nov	30	ER (z)	1	0.0027
1973	5-May	<1	ER (x)	0.3	0.0012 (y)
1972	3-Feb	900 (s)	ER (t)	46	0.162
1971	24-Sep	5	C, SWR	3.9	0.0077 (w)
1971	14-Aug	<1	C	3.1	0.0091
1969	24-May	874 (s)	ER (t)	50	0.185
1969	22-Feb	6	ER (r)	6	0.0161
1968	7-Oct	15	ER (q)	2.1	0.0066
1968	22-Aug	5	ER (o)	0.1	0.00013 (p)
1967	5-Nov	251	H	0.7	0.0803
1965	24-Dec	<1	ER (n)	0.6	0.00085
1965	5-Mar	10	ER (m)	7.8	0.0168
1963	5-Oct	1	ER (l)	3.4	0.0066
1963	21-Aug	2	ER (k)	0.2	0.0008

Year	Start (mo-day)	Duration (days)	Eruptive Subdivision	Area Covered (km2)	Volume (km3)
1962	7-Dec	2	ER (j)	0.1	0.00031
1961	22-Sep	3	ER (i)	0.8	0.0022
1961	10-July	7	H	1	0.0126
1961	3-Mar	2	H	0.3	0.00026
1961	24-Feb	1	H	0.1	0.000022 (h)
1960	13-Jan	36	ER	10.7	0.1132
1959	14-Nov	36	KI	0.6	0.0372
1955	28-Feb	88	ER	15.9	0.0876
1954	31-May	3	H, C	1.1	0.0062
1952	27-June	136	H	0.6	0.0467
1934	6-Sep	33	H	0.4	0.0069
1931	23-Dec	14	H	0.3	0.007
1930	19-Nov	19	H	0.2	0.0062
1929	25-July	4	H	0.2	0.0026
1929	20-Feb	2	H	0.2	0.0014
1927	7-July	13	H	0.1	0.0023 (g)
1924	19-July	11	H	0.1	0.000234
1924 (g)	10-May	17	C	No lava	No lava
1923	25-Aug	1	ER	0.5	0.000073
1922	28-May	2	MC, NC	0.1	NA
1921	18-Mar	7	C	2	0.0064
1919	21-Dec	221	SWR	13	0.0453
1919	7-Feb	294 (f)	C	4.2	0.0252 ?
1918	23-Feb	14	C	0.1	0.000183
1894	7-July	4 ?	C	NA	NA
1894	21-Mar	6+	C	NA	NA
1885	Mar	80	C	NA	NA
1884	Jan-22 (e)	1	ER	0.1	NA
1877	21-May	-	K	0.1	NA
1877	4-May	1	CW	NA	NA
1868	2-Apr	Short	SWR	0.1	0.000183
1868	2-Apr	Short	KI	0.2	NA
1840	30-May	26	ER	17.2 (d)	0.205
1832	14-Jan	Short	east rim of C	NA	NA
1823	Feb-July	Short	SWR	10.0 (d)	0.0110 (d)
Nearly continuous lava-lake activity on the caldera floor characterized the period from before 1823 until 1924. (a)					
1790 (c)	Nov	-	C	No lava flow	No lava flow
1790 ?	-	-	ER	7.9	0.0275
1750 ?	-	-	ER	4.1	0.0142

- C = summit caldera
- CW = caldera wall
- SWR = southwest rift zone
- ER = east rift zone
- ER = east rift zone
- H = Halema`uma`u
- K = Keanakako`i

Written records begin in July-August 1823, when the first European visited the summit of Kīlauea. Thereafter until 1924, lava-lake eruptive activity was almost continuous in the caldera. Before the mid-1800s, however, records of the many overflows from the lava lake are sparse. The table lists the periods of major overflows only.

E.15 Wildfire

The following presents wildfire events that occurred in the State of Hawaiʻi between 1953 and 2017, as presented in the 2013 and 2018 HMPs. The information is reproduced as documented in the 2013 and 2018 plans.

Due to the fact that the bulk of analysis for this plan relies on the history of past wildfires and spatial extent, clear patterns emerged particularly in the County of Hawaiʻi with approximately 48 fires burning a total of 90,159.19 acres from which to draw the following inferences.

Twenty-nine out of the 48 total fires were on the western end of the island, in the proximity of the Waikoloa Village "Community at Risk." Vulnerability of "Communities at Risk" locations in this analysis is primarily a function of proximity to historical wildfire incidents.

When combining the past burn areas layer and the rainfall tercile layer, it is apparent that "low rainfall" zones increase the odds of wildfire occurrence. A total of 40 of the 48 fires in the County of Hawaiʻi from 1953 to 2001 occurred in "low rainfall" zones. Table E-24 illustrates the range of potential wildfire triggers, as well as substantiates the general assertion that human negligence is the main trigger.

Table E-24. Wildland Fire Incidence, Causes, and Extent of Damage in the State of Hawaiʻi from 2003–2016

	Lightning		Campfire		Smoking		Debris burning		Arson		Equipment		Children		Miscellaneous	
Year	#	Acres	#	Acres	#	Acres	#	Acres	#	Acres	#	Acres	#	Acres	#	Acres
2003	0	0.0	5	12.2	5	2.4	9	372.5	15	2.6	8	302.5	1	0.1	64.0	15,893.1
2004	2	2.0	7	8.4	5	70.4	4	12.7	16	48.6	9	16.5	1	0.1	39.0	1,910.6
2005	3	4.1	8	801.7	0	0.0	5	1.6	12	218.2	6	135.9	0	0.0	75.0	25,331.1
2006	7	3,596.3	4	783.1	0	0.0	12	37.9	27	3,104.3	15	679.9	0	0.0	140.0	6,383.3
2007	1	0.1	5	40.1	1	2,291.0	11	53.9	21	6,728.5	9	255.6	0	0.0	99.0	20,222.3
2008	0	0.0	1	5.0	0	0.0	1	50.0	2	50.0	3	1,500.0	0	0.0	1.0	2,236.0
2009	0	0.0	2	23.0	0	0.0	0	0.0	0	0.0	3	199.0	0	0.0	2.0	7,852.0
2010	1	900.0	2	2.0	0	0.0	0	0.0	2	1,487.0	0	0.0	0	0.0	5.0	7,140.0
2011	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	1,153.0	0	0.0	2.0	1,566.0
2012	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	11.0	13,065.0
2013	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2.0	700.0
2014	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2.0	554.0
2015	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	9.0	5,691.0
2016	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	13.0	25,514.0
Total	**13**	**3,602.5**	**32**	**1,673.5**	**11**	**2,363.8**	**42**	**528.6**	**93**	**10,152.2**	**54**	**4,242.4**	**2**	**0.2**	**464.0**	**115,858.4**

E.15.1 COUNTY OF KAUAʻI

The County of Kauaʻi has had the smallest wildfire incidence despite intermittent drought conditions. Although Kauaʻi is known for its relatively wet weather most of the "high rainfall" locations are situated high in the central mountains on conservation land. Much of the "medium rainfall" zones are likewise located in the central area of the island, in remote mountainous areas. As such, a greater portion of the island falls within the "low rainfall" category. The wildfires that have been mapped have actually occurred in conservation or agriculture land, with the distances to "community at risk" ranging from 1.3 miles away to distances of 16.2 miles away. Hence, from this analysis, wildland fires may not appear to be much of a problem on Kauaʻi, but as stated previously, wildland fire vulnerability is not predictive of wildfire occurrence.

E.15.2 CITY AND COUNTY OF HONOLULU

The City and County of Honolulu, from 1998 to 2002, according to the map data had 9 fires, 5 of which were located in the Waipiʻo "Community at Risk". Four of the fires occurred in 2002 alone, and were fires that were between communities, hence endangering more than one community. The City and County of Honolulu, has the largest number of "Communities at Risk," primarily due to the fact that 72 percent of the state's population lives in the City and County of Honolulu, and there is a larger mix of urban/rural land to open land, with approximately 35 percent urban/rural, as compared to Maui County (5%), Kauaʻi County (5%), and Hawaiʻi County (2%). This can be interpreted as a density factor or a built-up area to open land ratio, which can be very dangerous during a wildland fire. Most of the wildland fires in the City and County of Honolulu have taken place on the central to western end of the island, either in "low rainfall" locations or between zones of low to medium rainfall within agriculture lands. Some areas, like the Waipiʻo location mentioned previously, abut communities along major road corridors. Unlike other counties, there was a higher incidence of what appeared to be "natural" wildfires, such as Waiʻanae Valley and Kaʻena Point.

E.15.3 COUNTY OF MAUI

Island of Maui

In the island of Maui, wildfires in the last ten years have been consistent with the concept of "communities at risk" developed during the preparation NFP. As will be discussed in this section, most of the fires in the last decade have occurred near or within populated centers.

On September 16, 2003, a controlled burn by the Hawaiian Commercial & Sugar Company got out of hand near the locality of Waikapū on the central valley of the island of Maui when the wind carried some of the flames into nearby mountainous terrain. The fire ended up blackening about 1000 acres of parched grassland, to as high as 2000 feet in elevation in the West Maui Mountains. The blaze forced the evacuation of the Sandalwood and Grand Waikapū golf courses for a few hours during the afternoon of the 16th and all day on the 17th. State and federal firefighters, with the help of four water-carrying helicopters (including a large Chinook from the Hawaiʻi Army National Guard on the island of Oʻahu), battled the fire over several days. No serious injuries or property damage were reported during this uncontrolled sugar can burn.

The first large fires of the last ten years occurred in 2005. This year was a particularly active year for wildfires in the Island of Maui. The first fire, which occurred in early July, burned 120 acres in the Launiupoko area causing the closure of Honoapiʻilani Highway (State Highway 30) for three and a half hours. Another July brush fire, this time on the 12th, scorched 200 acres between Māʻalaea and McGregor Point halted traffic for several hours along Honoapiʻlani Highway (State Highway 30). Smoke from the fire caused much of the problem. Four separate fires along the route merged into one large blaze that took fire fighters many hours to contain and control. County officials believed that the initial fires were intentionally set. There were no reports of serious property damage or injuries.

Also on July 12 of 2005, a wildfire upslope from Lahainaluna High School in leeward West Maui was of unknown origin and burned over two and a half days. The fire scorched 120 acres of brush and grass land, but for a time threatened native plants and bird habitats. However, no serious injuries or property damage were reported after the blaze was extinguished.

Just a few weeks later, on July 37 of 2005, a grass and brush fire with a suspicious origin scorched 80 acres near Lahaina in leeward West Maui. The blaze came within 50 yards of homes in the Wahikuli residential area, above Kahoma Street on the slopes of the West Maui Mountains. However, no serious injuries or property damage were reported.

The last two fires of 2005 happened simultaneously in the Lahaina area during the month of October. The blazes, which are suspected to have been arson incidents, burned near Lahainaluna High school. One of the two October 2005 fires charred 200 acres of former sugar cane land.

On September 1, 2006, a large wildfire in the Māʻalaea area charred approximately 2,000 acres of land. The fire threatened residences and businesses in the town of Māʻalaea. This Māʻalaea blaze also posed a significant risk to the Kaheawa Wind Power farm perched in the slopes of the West Maui Mountains above Māʻalaea. A fire Management Assistance Grant (FMAG) was approved by the Federal Emergency Management Agency (FEMA) to assist the County of Maui and the State of Hawaiʻi in suppressing this fire.

During 2007, a myriad of wildfires affected the island of Maui. On January 27, 2007, the Upper Waiohuli Wildfire burned approximately 2,300 acres of forested public lands within the Lula Forest Reserve on the western slopes of the Haleakalā volcano on the island's east side. The wildfire, which burned for approximately two weeks, is believed to have been started by a discarded cigarette, most likely from a hiker. According to a report by the State of Hawaiʻi Department of Land and Natural Resources (DLNR) Division of Forestry and Wildlife, in terms of size and intensity, the Upper Waiohuli Wildfire was one of the most devastating to have occurred for many decades in the Hawaiian Islands. Per the same document, approximately 500 acres within the burn unit were subject to relatively lighter fire intensities, and the forest areas therein are anticipated to recover. On the other hand, approximately 1,800 acres within the burn unit were severely burned with little remaining live vegetation.

A couple of weeks after the Upper Waiohuli Wildfire, a wildfire struck the Kauaʻula Valley in the Lahaina area on February 19, 2007. The conflagration, which started above the Puamana subdivision, burned more than 1,000 acres of former sugar cane fields. According to the Honolulu Star Bulletin, the Kauaʻula Valley Wildfire also entered the fringe of the Panaewa section of the West Maui Natural Area Reserve system. This reserve area is home to endangered species of plants.

On June 27, 2007, two brushfires on the island's west side forced evacuations in the Lahaina and Olowalu areas. The smaller Lahaina brushfire came within 20 feet of homes at the Wahikulu subdivision forcing evacuations of some homes. The much larger Olowalu fire burned approximately 2,600 acres and destroyed one residence. The fire, which started on the mountain side of Honoapiʻilani Highway (State Highway 30), spread across the road to the ocean side of the highway severely disrupting traffic along a two-mile portion of this main arterial road.

Just a few days after the late June 2007 high winds flared up another wildfire in the Lahaina area. The fire, which started on July 3, consumed approximately 180 acres and prompted the evacuation of at least 150 people from a homeless shelter and rental project in the town of Lahaina. The fire also threatened the Lahaina Aquatic Center. The fire is believed to have been sparked by fireworks.

Lastly, in 2009, several brushfires affected the Māʻalaea area. On June 21st, a brush fire that started near Māʻalaea Harbor forced the closing of Honoapiʻilani Highway (State Highway 30) from the town of Māʻalaea to the Ukumehame gulch area. The brush fire charred approximately 80 acres, damaged one residence, and fully destroyed another residence. Similarly, on November 2nd another blaze resulted in the closure of Honoapiʻilani Highway.

ISLAND OF MOLOKAʻI

Of the islands that conform the County of Maui, the island of Molokaʻi seems to be the most susceptible to wildfire. There were nine years on record where 1,000 plus acres were burned. The top years for fires in the island of Molokaʻi have been 1981, 1988, 1991, 1998, 2007 and 2009. On July 6, 2005, afire about 2.5 miles south of Hoʻolehua Airport burned 200 acres of brush. The cause of the fire was unknown. There were no reports of serious injuries or property damage.

In 2007, the Kalua Koi wildfire charred 3,000 acres of bush on the far west end of Molokaʻi. The blaze was first reported on June 7 near mile marker 11 along Maunaloa Highway (State Highway 460). The Kalua Koi wildfire spread quickly on the ocean side of the highway and reached well pass Kalua Koi road. Luckily, the blaze did not pose a threat to any residences.

More recently, during the last days of August and first days of September of 2009, a wildfire consumed approximately 7,800 acres near the town of Kaunakakai on central Molokaʻi. The Kaunakakai fire was first reported on August 29th and burned for 7 days until it was fully contained on September 5th by the combined effort of more than 30 firefighters from the Division of Forestry and Wildlife Management (DOFAW) and the Maui Fire Department (MFD). The fire forced the evacuation of residents from Kalamaula Mauka and threatened 400 primary structures and 80 communication structures.

ISLAND OF LĀNAʻI

Of The island of Lānaʻi has been the safest island in terms of wildfires with only a few consequential fires in the past two decades. In January 1995, one fire burned 1,204 acres and in December 1999, a fire in the Kaluanui Flats area, approximately 2 miles southeast of Lānaʻi City, burned over 2,000 acres. On November 18, 2008, the Pālāwai Basin wildfire consumed approximately 1,000 acres south of Lānaʻi City. According to County of Maui officials, the Pālāwai Basing conflagration forced the evacuation of 600 visitors and residents from Mānele Bay Hotel and nearby residences.

COUNTY OF HAWAIʻI

A fire in July 2007 burned 25 acres adjacent to the entrance road into Puakō. On October 28, 2007, nine fires were set in the Puakō/Kawaihae/Waikoloa area. The community was evacuated as the largest of these fires, more than 1,000 acres, approached within a ¼ -mile of Puakō Beach Drive. Only a fortuitous shift in wind prevented a huge loss of property (estimated value more than $500 million). Those people who refused to evacuate were also at risk.

South Kona was recently reminded that upland wildfire is a significant threat. It took weeks for firefighters to extinguish the 1800-acre wildfire which began at Kealakekua Ranch on December 27, 2009. Grasses ignited by lightning were fueled by mature ʻohiʻa and koa trees, hard woods which can burn for weeks. These long burning fuels and rhizomous grasses that can smolder and carry fire underground made the fire extremely challenging to put out. The rugged terrain at the 4,400-foot elevation where the fire broke out, along with lack of access to water, abundant fuel sources, dry conditions, and warm weather causing smoldering to reignite all combined to create difficult and hazardous conditions for the dozens of firefighters who worked 24-hour shifts to battle the blaze and protect the community. Smoke from the fire, trapped by Kona's temperature inversion layer, created health hazards for fire fighters and the entire South Kona community.

In July 2013, a brush fire in the Kailua-Kona area forced the evacuation of a condominium multifamily building. The fire, which occurred on Hulikoa drive, scorched about 100-acres of land.

E.15.4 SUMMARY FOR ALL COUNTIES

Table E-25 summarizes all wildfire events statewide and the spatial relationship between wildfire events and relevant CDPs. To complement Table E-25, summary reports that analyze annual wildfires for the years 2004 through 2008 are included in Table E-26 through Table E-35. The information provided on this last table is available and regularly updated on the State of Hawaiʻi Department of Land and Natural Resources Division of Forestry and Wildlife (DOFAW) Fire Management Program website.

Table E-36 and Table E-37 detail the number of fires and acres burned by County for the period between 2003 and 2012. Although there are annual dry seasons, the wildfires are more frequent during severe drought. Lastly, Table E-38 summarizes fire occurrences across the State of Hawaiʻi that were declared to Federal Emergency Management Agency for Fire Management Assistance from 2007 through 2017. A summary of each fire is also provided subsequently to the table.

Table E-25. Historic Wildfire Events by County and Impacted CDPs

County	Year	No.	Total Acreage	Closest CDP	Distance	CDP Pop (Year 2000)
Hawaiʻi	1953	1	3,681.34	Waimea	10.4 Miles	7,208
Hawaiʻi	1969	1	2,616.55	Waikoloa Village	3.02 Miles	4,806
Hawaiʻi	1972	1	8.966	Waimea	5.76 Miles	7,208
Hawaiʻi	1973	8	7,223.44	Waikoloa Village	4.46 Miles	4,806
Hawaiʻi	1975	2	342.209	Waimea	11.19 Miles	7,208
Hawaiʻi	1976	2	5.047	Honalo	12.82 Miles	1,987
Hawaiʻi	1977	2	1,065.11	Waimea	11.05 Miles	7,208
Hawaiʻi	1978	1	35.42	Waikoloa Village	11.67 Miles	4,806
Hawaiʻi	1983	1	5.82	Waikoloa Village	5.10 Miles	4,806
Hawaiʻi	1985	1	24,270.08	Waikoloa Village	3.28 Miles	4,806
Hawaiʻi	1987	3	11,701.20	Waikoloa Village	0 Miles	4,806
Hawaiʻi	1988	1	575.452	Kalaoa	6.15 Miles	6,794
Hawaiʻi	1989	1	3,318.15	Puakō	2.14 Miles	429

County	Year	No.	Total Acreage	Closest CDP	Distance	CDP Pop (Year 2000)
Hawaiʻi	1991	2	215.831	Kalaoa	6.28 Miles	6,794
Hawaiʻi	1993	4	1,451.91	Waikoloa Village	6.14 Miles	4,806
Hawaiʻi	1994	2	714.632	Honalo	12.42 Miles	1,987
Hawaiʻi	1995	3	1,408.47	Kailua-Kona	2.88 Miles	9,870
Hawaiʻi	1996	1	72.988	Waikoloa Village	6.23 Miles	4,806
Hawaiʻi	1998	5	12,666.38	Waikoloa Village	0.84 Miles	4,806
Hawaiʻi	1999	4	18,709.09	Waikoloa Village	0.38 Miles	4,806
Hawaiʻi	2001	2	71.106	Kailua-Kona	14.22 Miles	9,870
Hawaiʻi	1980	4	4,829.06	Kualapuʻu	0 Miles	1,936
Maui	1984	5	2,003.21	Kīhei	0.85 Miles	16,749
Maui	1985	1	0.269	Wailea-Mākena	4.11 Miles	5,761
Maui	1987	4	970.061	Kaunakakai	2.33 Miles	2,726
Maui	1988	2	83.581	Waikapu	0.48 Miles	1,115
Maui	1989	2	31.264	Waikapu	0.39 Miles	1,115
Maui	1990	4	207.659	Lānaʻi City	1.34 Miles	3,164
Maui	1991	6	8,320.79	Waikapu	2.55 Miles	1,115
Maui	1992	3	315.761	Kaunakakai	1.45 Miles	2,726
Maui	1993	3	217.51	Kaunakakai	2.00 Miles	2,726
Maui	1995	1	48.217	Waikapu	1.87 Miles	1,115
Maui	1998	5	12,145.19	Kaunakakai	0 Miles	2,726
Maui	2001	1	547.524	Lahaina	2.27 Miles	9,118
Maui	2002	1	296.384	Lahaina	3.45 Miles	9,118
Kauaʻi	1998	1	1.328	Waimea	5.00 Miles	1,787
Kauaʻi	1999	2	16.167	Waimea	6.85 Miles	1,787
Kauaʻi	2000	2	12.001	Hanalei	10.44 Miles	478
Honolulu	1998	4	864.808	Mokulēʻia	1.08 Miles	1,839
Honolulu	2000	1	272.969	Waipiʻo	0 Miles	11,672
Honolulu	2002	4	2,765.25	Pearl City, Waipiʻo	0 Miles	30,976/11,672

Table E-26. Annual Wildfire Summary Report, 2008—Total Fires, by Cause

Cause	No.	Acres
Lightning	0	0
Campfire	1	5
Smoking	0	0
Debris burning	1	50
Arson	2	50
Equipment	3	1,500
Railroads	0	0
Children	0	0
Miscellaneous	1	2,236
TOTAL:	**8**	**3,841**

Table E-27. Annual Wildfire Summary Report, 2008— Total Fires, by Site Class

Size Class	No.	Acres
Class A - 0.25 acres or less	0	0
Class B - 0.26 to 9 acres	1	9
Class C - 10 to 99 acres	3	325
Class D - 100 to 299 acres	2	525
Class E - 300 to 999 acres	0	0
Class F - 1000 to 4999 acres	2	2,982
Class G - 5000 acres or more:	0	0
TOTAL:	8	3,841

Table E-28. Annual Wildfire Summary Report, 2009— Total Fires, by Cause

Cause	No.	Acres
Lightning	0	0
Campfire	2	23
Smoking	0	0
Debris burning	0	0
Arson	0	0
Equipment	3	199
Railroads	0	0
Children	0	0
Miscellaneous	2	7,852
TOTAL:	**7**	**8,074**

Table E-29. Annual Wildfire Summary Report, 2009— Total Fires, by Site Class

Size Class	No.	Acres
Class A - 0.25 acres or less	1	1
Class B - 0.26 to 9 acres	2	18
Class C - 10 to 99 acres	2	143
Class D - 100 to 299 acres	1	110
Class E - 300 to 999 acres	0	0
Class F - 1000 to 4999 acres	0	0
Class G - 5000 acres or more	1	7,802
TOTAL:	**7**	**8,074**

Table E-30. Annual Wildfire Summary Report, 2010— Total Fires, by Cause

Cause	No.	Acres
Lightning	1	900
Campfire	2	2
Smoking	0	0
Debris burning	0	0
Arson	2	1,487
Equipment	0	0
Railroads	0	0

Cause	No.	Acres
Children	0	0
Miscellaneous	5	7,140
TOTAL:	**10**	**9,529**

Table E-31. Annual Wildfire Summary Report, 2010— Total Fires, by Site Class

Size Class	No.	Acres
Class A - 0.25 acres or less	1	1
Class B - 0.26 to 9 acres	2	28
Class C - 10 to 99 acres	2	175
Class D - 100 to 299 acres	1	100
Class E - 300 to 999 acres	3	3,025
Class F - 1000 to 4999 acres	0	0
Class G - 5000 acres or more	1	6,200
TOTAL:	**10**	**9,529**

Table E-32. Annual Wildfire Summary Report, 2011— Total Fires, by Cause

Cause	No.	Acres
Lightning	0	0
Campfire	0	0
Smoking	0	0
Debris burning	0	0
Arson	0	0
Equipment	1	1,153
Railroads	0	0
Children	0	0
Miscellaneous	2	413
TOTAL:	**3**	**1,566**

Table E-33. Annual Wildfire Summary Report, 2011— Total Fires, by Site Class

Size Class	No.	Acres
Class A - 0.25 acres or less	0	0
Class B - 0.26 to 9 acres	0	0
Class C - 10 to 99 acres	1	75
Class D - 100 to 299 acres	0	0
Class E - 300 to 999 acres	1	338
Class F - 1000 to 4999 acres	1	1,153
Class G - 5000 acres or more	0	0
TOTAL:	**3**	**1,566**

Table E-34. Annual Wildfire Summary Report, 2012— Total Fires, by Cause

Cause	No.	Acres
Lightning	0	0
Campfire	0	0
Smoking	0	0
Debris burning	0	0
Arson	0	0
Equipment	0	0
Railroads	0	0
Children	0	0
Miscellaneous	17	5,837
TOTAL:	**17**	**5,837**

Table E-35. Annual Wildfire Summary Report, 2012— Total Fires, by Site Class

Size Class	No.	Acres
Class A - 0.25 acres or less	0	0
Class B - 0.26 to 9 acres	6	13
Class C - 10 to 99 acres	5	122
Class D - 100 to 299 acres	1	220
Class E - 300 to 999 acres	2	1,152
Class F - 1000 to 4999 acres	3	4,330
Class G - 5000 acres or more	0	0
TOTAL:	**17**	**5,837**

Table E-36. Number of Wildfires by County from 2003 to 2012

Year	Number of Fires				
	Kauaʻi	Honolulu	Maui	Hawaiʻi	Total
2003	6	11	1	2	21
2004	3	2	1	1	7
2005	4	0	0	1	5
2006	1	4	1	5	11
2007	2	3	10	10	25
2008	2	1	3	2	8
2009	1	4	2	0	7
2010	1	2	3	4	10
2011	0	0	1	2	3
2012	3	7	2	5	17

Table E-37. Acres Burned by County from 2003 to 2012

Year	Acres Burned				
	Kauaʻi	Honolulu	Maui	Hawaiʻi	Total
2003	9	1,809	60	2,1242	4,002
2004	6	1,790	60	30	1,886
2005	40	0	0	1	41
2006	135	3,270	110	16,000	19,515
2007	292	1,076	16,177	5,980	23,525
2008	55	5	396	3,385	3,841
2009	23	249	7,802	0	8,074
2010	1	506	6,925	2,097	9,529
2011	0	0	75	1,491	1,566
2012	3,002	1,770	30	1,035	5,837

Table E-38. Federal Emergency Management Agency, Declared Fires from 2007 to 2013

Fire	Acreage	Nearest Town	Distance to Population	Population	Cost	Cause
OLAWALU FEMA-2701 6/27– 7/4/07	1938	Olawalu, Launiopoko	0.1 mile	Lahaina 9118	$359,081, (2 homes destroyed)	Human, accidental
WAIALUA FEMA-2720 8/12 – 8/21/07	8000	Waialua, Haleiwa, North Shore	0.1 mile	Waialua 3761 Mokulēʻia 1839 Haleʻiwa 2225	$642,229	Human, intentional
KOHALA MTN. FEMA- 2722 8/16 – 8/22/07	200+	Waimea, Kamuela View Estates	3 miles Waimea ¼ mi. – one house	WaikoloaVlg. 4806	$111,504	Unknown
PUAKŌ FEMA-2740 10/28 – 11/7/07	1005	Puakō, Spenser Park, Mauna Kea Beach	¼ mile	Puakō 429	$320,321	Unknown
KAUNAKAKAI FEMA-2834 8/29 – 9/7/09	10,000	Kaunakakai, Kualapuʻu	0.1 mile	Kaunakakai 2726	$880,944 (estimate)	Unknown
MĀʻALAEA FEMA-2844 6/7/10 - 6/13/10	6200	Māʻalaea, Harbor area	0.5 mile	Māʻalaea 454	No estimates available yet.	Unknown

Olowalu fire (06/27/2007 through 07/04/2007): The Olowalu fire in Olowalu, Maui started on July 27, 2007, was a particularly destructive fire, ultimately destroying two homes and sending over 330 persons to shelters. The fire was thought to be started accidentally by a backhoe digging behind the Olowalu General Store, hitting something, possibly just a rock, and throwing a spark. One of the homes destroyed was close behind the Store, and the other was just east of the Launiupoko subdivision of Olowalu village. Of those entering the shelters, at Maui High School, over 320 were tourists who had missed flights or had checked out of their hotels. Ten were local residents. Three people were sent to Maui Memorial Hospital Emergency Room and released. Strong winds up to 52 mph hindered firefighters initially and caused the fire to grow and expand its territory. The combination of the high wind and dry grass in the area caused the fire to spread rapidly and race upwards towards the mountain.

Waialua Fire (08/12/2007 through 08/21/2007): The fire consumed about 8000 acres of brush land and farm land along the North shore of Hawaiʻi, threatening the town of Waialua and the area between the mountains and the ocean. In addition, Dillingham airfield, several camps are in the area and were threatened by the fire. There were also concerns that the Mt. Kaʻala Observatory could be affected. The fire started before noon on the 12th and several homes were quickly evacuated. The mountains above the farms were particularly difficult to work within as access to burning areas was often difficult. The fire was burning uphill in areas of dry brush. The Otake Camp housing area and the Pamoho agricultural area were affected, as well as the local high school and elementary school, 100 homes and about 15 businesses in the Waialua area. As the fire grew, shelters were opened at the Waialua District Park and Liliʻokalani Protestant Church. Ultimately approximately 8000 acres were burned.

Kohala Mountain Road Fire (08/16/ 2007 through 08/22/ 2007): The fire was along Highway 250, or the Kohala Mountain Road near the 4-mile marker, on the ocean side of the highway, in the South Kohala district of Hawaiʻi County. Residents along Mahua Street of Kamuela View Estates were evacuated, with approximately 50 homes being involved, as the fire reached within a quarter-mile of the homes. On the 16th windblown debris caused a short circuit in a 34,000-volt transmission line. There was speculation that the sparking caused by this actually started the fire. This fire also occurred during a period when Hurricane Flossie threatened the Big Island by passing within 100 miles. An earthquake of 5.4 also rattled the island Monday night the 20th, but it resulted in no injuries or major damage.

Puakō fire (10/ 28/2007 through 11/ 7/ 2007): The Puakō fire on the Leeward coast of Big Island occurred when nine runaway fires of varying sizes were burning at the same time, straining county and state resources to their maximum abilities. Puakō along Puakō Beach Drive and Spencer Beach Park in Kawaihae were evacuated and evacuation centers set up at Waiakoloa Elementary School in Waikoloa and the Waimea Community Center. A mandatory evacuation of Puakō was announced on the October 28th. Three hundred homes were directly threatened by the fire, a factor which contributed in the quick declaration by FEMA. By the end of the fire, about 1000 acres were consumed.

Kaunakakai Fire (08/29/2009 through 09/07/2009): The Kaunakakai fire destroyed approximately 10,000 acres of land North of Kaunakakai Town, Island of Molokaʻi, Maui and extended west to the boundaries of the airport. The amount of resources expended for this single fire makes it the largest fire in the state within the last several years. The fire began on the 29th of August and was not declared controlled until September 7.

Kealakekua Ranch on December 27, 2009: Grasses ignited by lightning were fueled by mature ’ohi’a and koa trees, hard woods which can burn for weeks. These long burning fuels and rhizomous grasses that can smolder and carry fire underground made the fire extremely challenging to put out. The rugged terrain at the 4,400-foot elevation where the fire broke out, along with lack of access to water, abundant fuel sources, dry conditions, and warm weather causing smoldering to reignite all combined to create difficult and hazardous conditions for the dozens of firefighters who worked 24-hour shifts to battle the blaze and protect the community. Smoke from the fire, trapped by Kona’s temperature inversion layer, created health hazards for fire fighters and the entire South Kona community.

Māʻalaea Fire (06/07/2010 through 06/14/2010): The fire encompassed an area of approximately 6200 acres in Wailuku, Maui, becoming the first declared fire of the 2010 year. The area affected was around the town of Māʻalaea up into surrounding hillsides, similar to the Māʻalaea Fire of 2006. It threatened homes in the direction of Wailuku, near the local King Kamehameha Golf Club. The fire also burned up into the hills toward the Wind electric generating 'farm' at the top of the first range of hills, actually causing reported burn damage to at least two of the 'windmills'.

Table E-39. Wildfire Events in the State of Hawaiʻi – 2012 to 2017

Date(s) of Event	Event Type	Counties Affected	Description
2012 Feb 18	Wildfire	Hawaiʻi	Approximately 80 acres burned near the Waikoloa Elementary School. No structures were threatened, and no roads were closed. A nearby car show was evacuated as a precaution. Waikoloa Emergency Operations Center (EOC) was activated.
2012 May 28-June 5	Wildfire (Miloliʻi Hikimoe Fire)	Kauaʻi	Approximately 220 acres burned
2012 June 4-11	Wildfire (Kukahi Fire)	Honolulu	Fire burned approximately 1,200 acres, starting in the Lualualei Naval Magazine and burning through the Lualualei Valley into the Waiʻanae Kai Valley Forest Reserve. By June 5, nearly half of the Honolulu Fire Department's assets were dedicated to battling the fire. Many farms were evacuated, and roads were closed.
2012 June 6-7	Wildfire	Honolulu	Approximately 1,000 acres burned in the Waiʻanae Valley, unrelated to the fire burning from June 4 to 11, 2012. Sixty firefighters responded and prevented the fire from threatening structures. The County of Oʻahu EOC was partially activated.
2012 June 18	Brush Fires	Hawaiʻi	The Hawaiʻi EOC was partially activated in response to two wildfires burning in the Pāhala area. One wildfire burned approximately 5,200 acres, the other burned 400 acres.
2012 June 25-July 4	Wildfire (Hikimoe Ridge)	Kauaʻi	The Hikimoe Ridge Fire burned 765 acres of a eucalyptus tree plantation. A voluntary evacuation order was put in place as a precaution. The fire cost the state $375,000, mostly for the cost of hiring fire suppression helicopters.
2012 July 4	Wildfire	Honolulu	A fire flared along the north side of the Kaloko New Industrial Area road. Smoke was visible in Kailua Village.
2012 July 14-15	Wildfire (Yokahama Cecily fire)	Honolulu	Approximately 500 acres burned
2012 Aug 17-22	Wildfire (Pōkiʻi Ridge Fire)	Kauaʻi	Approximately 3,000 acres above Kekaha burned. It started on the Pōkiʻi Ridge and spread to the Paua and Waiaka Ridges. The fire approached a high voltage power line, which was shut down. The fire damaged power, radio, and fiber optic lines. Residents and businesses in Kekaha and Waimea were asked to limit water consumption to essential uses only. The fire chief issued a voluntary evacuation order of Kōkeʻe. The County of Kauaʻi EOC was activated.
2012 Nov 10	Wildfire (Iroquois Point Fire)	Honolulu	ʻEwa Beach experienced its largest wildfire between 2001 and 2012 on November 10, 2012. The fire started near the intersection of Hoʻomaka Street and Iroquois Road in an area of dry grass and brush. One hundred

Date(s) of Event	Event Type	Counties Affected	Description
			acres of brush and grasses burned along Iroquois Point Road in western Oʻahu.
2012 Nov 15	Wildfire (PTA Training Area 22 Fire)	Hawaiʻi	Approximately 1,000 acres burned
2013 Aug 18	Wildfire (Makua Keaʻau Keolu Fire)	Honolulu	Approximately 100 acres burned
2013 Nov 25-26	Wildfire (Puʻu Anahulu Fire Complex)	Hawaiʻi	Nearly 600 acres on the Island of Hawaiʻi burned. Three fires made up this incident. No structures were damaged. The Hawaiʻi County EOC was activated.
2014 Apr 24	Wildfire	Hawaiʻi	Four acres burned near Mile Marker 29 of Highway 190 in Kona. Traffic was limited to one lane on the highway. No injuries or structure damage were reported. The County of Hawaiʻi EOC was partially activated.
2014 Aug 22	Wildfire (Makakilo First Goal Fire)	Honolulu	Approximately 550 acres burned.
2015 Jan 20 – Feb 17	Wildfire (Lau Strike Kīpapa Fire)	Honolulu	Approximately 460 acres burned.
2015 Mar 23	Wildfire (Waimea Canyon Drive Fire)	Kauaʻi	Approximately 130 acres burned.
2015 May 4	Brush Fire	Hawaiʻi	Over 20 acres within the Nīnole Loop on the southeast side of Highway 11 burned. Highway 11 was closed for several hours due to low visibility. The fire burned through vacant pasture land. The County of Hawaiʻi EOC was partially activated.
2015 May 11	Brush Fire	Hawaiʻi	A runaway brush fire consumed 20 acres and one home in the Green Sands and Mark Twain Estates subdivision in Kaʻū. No injuries were reported. The County of Hawaiʻi EOC was partially activated.
2015 July 5-9	Wildfire (Pōkiʻi Ridge 2015 Fire)	Kauaʻi	Approximately 365 acres burned.
2015 Aug 1-11	Wildfire (Malevolence Poamoho Fire)	Honolulu	Approximately 500 acres burned.
2015 Aug 8	Wildfire (Kawaihae Fire)	Hawaiʻi	Approximately 3,300 acres burned.
2015 Aug 14	Wildfire (Puʻukoliʻi Fire 2015)	Maui	Approximately 356 acres burned.
2015 Aug 22	Wildfire	Honolulu	The Makakilo Fire was human-caused and one of the largest wildfires in Makakilo's history. The fire burned 1,000 acres near homes along ʻUmena Street and up toward Honouliuli Forest Reserve. Dozens of homes and cabins were evacuated, including Camp Timberline visitors and occupants. Red Cross established an emergency shelter at Makakilo Community Park, where they hosted approximately residents.

Date(s) of Event	Event Type	Counties Affected	Description
2016 Jan 16	Wildfire	Hawaiʻi	Palamanui Campus fire burned 200 acres near Queen Kaʻahumanu Highway.
2016 Feb 10-11	Wildfire	Hawaiʻi	A string of Puʻu Anahulu fires burned 1,150 acres in total in North Kona. These included a fire mauka of intersection of Daniel K. Inouye Hwy (Mile Marker 50) and Highway 190; a fire at Highway 190 at Mile Marker 16; and a fire at Highway 190 near Mile Marker 17 on the mauka side of the highway.
2016 Feb 15-24	Brush Fire	Maui	Approximately 5,300 acres of the southern slopes of Haleakalā burned between February 15 and 24, 2016. The Kahikinui Homesteads area was evacuated. Shelters for displaced residents were opened at Kēōkea Park in Kula. The County of Maui EOC was activated.
2016 Mar 5	Wildfire	Maui	The Kahikinui Fire, caused by arson, burned 5,800 acres and threatened 15 residences and 3 other structures. No structures were destroyed.
2016 Mar 17	Wildfire	Honolulu	The Nānākuli Valley Fire was one of the largest wildfires in Western Oʻahu's history, burning 2,500 acres. The wildfire began atop a steep cliff on the southeastern edge of the valley and moved downslope toward homes along Pikaiolena Street, Waiea Place, and Huikala Place. The fire burned right to the edge of homes, prompting voluntary evacuations. Westbound lanes of Farrington Highway at Ko ʻOlina were shut down by police.
2016 Mar 23-24	Wildfire	Hawaiʻi	A wildfire burned 2,500 acres of brush and grass mixture along Highway 190 between Mākālei and Daniel K. Inouye Highway.
2016 Mar 28	Brush Fire	Hawaiʻi	A runaway brush fire that started in a residential area burned 125 acres on the mauka side of Waimea. The fire destroyed a ranch shed, but no homes or businesses. The County of Hawaiʻi EOC was activated.
2016 Mar 29	Brush Fire	Honolulu	Due to drought conditions, the slopes of Diamond Head on Oʻahu were impacted by a brush fire. The fire was moving quickly upslope and spreading due to strong winds. Roads were closed and 12 fire companies responded. The brush fire burned approximately two acres.
2016 July 2	Wildfire (Māʻalaea Nui Fire)	Maui	Approximately 4,700 acres burned after equipment caused the Māʻalaea Nui wildfire.
2016 July 8-10	Wildfire (Ukumehame Fire)	Maui	Approximately 1,242 acres burned
2016 Nov 18-22	Wildfire	Honolulu	Approximately 1,235 acres burned
2017 Mar 22-23	Bush Fire	Hawaiʻi	Approximately 10 acres of brush makai of the Queen Kaʻahumanu Highway shut down southbound lanes of the highway and other roads. The County of Hawaiʻi EOC was partially activated.
2017 May 4-18	Wildfire	Kauaʻi	The Kapalawai Wildfire resulted in the County of Kauaʻi EOC being partially activated. Approximately 750 acres burned. Total costs in equipment and personnel to suppress the fire reached over $80,000.
2017 July 7	Brush Fire	Hawaiʻi	Approximately 2,176 acres burned near the Puukapu Farm Lots and Parker ranch area over two days. No injuries were reported. The County of Hawaiʻi EOC was partially activated.

Appendix F. State Profile and Risk Assessment Supplement

CONTENTS

TABLES

[1] *Section Cover Photo: Aerial view of Molokaʻi and the town of Kaunakakai. Photo by Megan Brotherton*

APPENDIX F. STATE PROFILE AND RISK ASSESSMENT SUPPLEMENT

The 2023 State Hazard Mitigation Plan (SHMP) Update was organized into a practical and readable document for the public and an implementable document for the State to support future risk reduction. This appendix contains supporting information for the State Profile (Section 3) and Risk Assessment (Section 4) sections, as available.

F.1 State Profile

The list of facilities deemed critical by HI-EMA contained spatial coordinates for the majority of the facilities. For the facilities that did not have spatial coordinates or the original coordinates were invalid, other location attributes were used to geocode the facilities. Not all facilities had sufficient location attributes for geocoding. Of the total 1,542 facilities, 1,475 had sufficient data to be geocoded and are included in the spatial analyses reported in Sections 4.2 through 4.16.

An estimated 400 community lifelines and critical facilities are State buildings that appear in both inventories used for the risk assessment. The duplication of these assets is acknowledged, and the datasets are reported separately.

The original facility list only contained two attributes: facility name and facility type. Therefore, assumptions were made to populate the required fields needed to estimate potential losses using Hazus. The average values already populated in Hazus for each facility type (known as default values) for square footage were utilized; however, it is recognized that the actual square footage could differ significantly. The replacement cost, or amount it will cost to replace the structure at the time of the loss, was calculated using the default square footage values and 2022 RS Means costs per square foot for each facility. RS Means is the industry-standard cost-estimate model for replacement cost. Therefore, replacement costs could vary significantly from actual values; however, this is a suitable methodology for planning purposes. The Hazus default attribute data for community lifelines was used to replace the default attribute values where the facilities could not be matched to the community lifeline or critical facility using the facility name.

Table F-1 summarizes the facility types included in each community lifeline and critical facility category used in the risk assessment.

Table F-1. Facility Type Included in Each Community Lifeline and Critical Facility Category

Facility Lifeline Category	Facility Type	
Communications	• 911 Call Center • Banking and Credit • Communications Distribution Hub • Communications Site • Emergency Services Communication Facility (Dispatch Center)	• Information Technology Center • Office • Other Communication Facility • Radio/TV
Energy	• Line Booster • Liquefied Natural Gas (LNG) Satellite Storage • Liquid Petroleum Gas (LPG) • Motor Vehicle Fueling Station • Natural Gas • Operations Yard • Petroleum Product Bulk Plant	• Petroleum Product Land-based Bulk • Terminal Petroleum Product pipeline • Power Plant • Propane Air Injection/Regulator Station • Propane Plant • Resource Recovery Facility
Food, Water, Shelter	• Agriculture and Food Product Storage and Distribution Warehouse • Animal Shelter • Food and Beverage Store • Food Bank • Food Processing Facility • Grocery Store/Supermarket • Hotel/Motel • Ice Distributor	• Lift/Pump Station • Pump Station - Potable • Religious Facility (Shelter) • Wastewater Collection System • Wastewater Pump Station • Wastewater Treatment Facility • Wastewater Treatment Plant • Water Treatment Facility • Water Well
Hazardous Material	• Landfill/Solid Waste	• Solid Waste Transfer Station
Health & Medical	• Ambulatory Healthcare Facility • Community Healthcare Center • Extended Care Facility • Facility/Mortuary Facility • Hospice • Hospital/Medical Facility • Kidney Dialysis Center	• Mental Health Treatment Facility • Nursing Care Facility • Public Health Agency • Public Health Laboratory • Residential Care Facility • Urgent Care Center
Safety & Security	• Armory • Baseyard • Collee • Correctional Facility/Jail/Prison • Department Operations Center (DOC) • Emergency Operations Center (EOC) • Fire & Emergency Services Administrative Office/Headquarters • Fire & Emergency Services Operational Facility	• Government Building (designated as essential) • Law Enforcement Administrative Office/Headquarters • Law Enforcement Operational Facility • Maintenance/Repair Facility • Museum • Office • Other Emergency Services Facility • School
Transportation	• Air Traffic Control or Navigation Facility • Airport • Airport Terminal • Cargo Terminal • Maritime Supporting Facility	• Operations Support Facility • Pier • Transit Bus Garage • Transit Bus Terminal • Transit Operations

Facility Lifeline Category	Facility Type	
Other Critical Facilities	• Civic Center • Community Center • Gym • Home Improvement Store	• Office • Park • Warehouse

Source: HI-EMA 2022

F.2 Risk Assessment Methodology

F.2.1 HAZUS

In 1997, FEMA developed the standardized Hazards U.S. (Hazus) model to estimate losses caused by earthquakes and identify areas that face the highest risk and potential for loss. Hazus was later expanded into a multi-hazard methodology with new models for estimating potential losses from hurricanes, floods, and tsunamis.

Hazus is a GIS-based software program used to support risk assessments, mitigation planning, and emergency planning and response. It provides a wide range of inventory data, such as demographics, building stock, community lifeline, critical facility, transportation and utility lifeline, and multiple models to estimate potential losses from natural disasters. The program maps and displays hazard data and the results of damage and economic loss estimates for buildings and infrastructure. Its advantages include the following:

- Provides a consistent methodology for assessing risk across geographic and political entities.
- Provides a way to save data so that they can readily be updated as population, inventory, and other factors change and as mitigation planning efforts evolve.
- Facilitates review of mitigation plans because it helps to ensure that FEMA methodologies are incorporated.
- Supports grant applications by calculating benefits using FEMA definitions and terminology.
- Produces hazard data and loss estimates that can be used in communication with local stakeholders.
- Administered by the local government and can be used to manage and update a hazard mitigation plan throughout its implementation.

Levels of Detail for Evaluation

Hazus provides default data for inventory, vulnerability, and hazards; these default data can be supplemented with local data to provide a more refined analysis. The model can carry out three levels of analysis, depending on the format and level of detail of information about the planning area:

- **Level 1**—All of the information needed to produce an estimate of losses is included in the software's default data. These data are derived from national databases and describe in general terms the characteristic parameters of the planning area.
- **Level 2**—More accurate estimates of losses require more detailed information about the planning area. To produce Level 2 estimates of losses, detailed information is required about local geology, hydrology,

hydraulics, and building inventory, as well as data about community lifelines. This information is needed in a GIS format.

- **Level 3**—This level of analysis generates the most accurate estimate of losses. It requires detailed engineering and geotechnical information to customize it for the planning area.

For the 2023 SHMP Update, a user-defined analysis was conducted. The State buildings, community lifelines, and critical facilities were added to Hazus in the user-defined inventory to estimate potential losses for each individual structure. All community lifelines and critical facilities were updated using RS Means 2022 data.

The dasymetric building data provided in Hazus v5.1 was used to evaluate the event-based flood hazard. Development of the dasymetric dataset involved removing homogeneous undeveloped areas (such as areas covered by bodies of water, parks, or forests) from the Census blocks. Cumulative building exposure is distributed only in developed sub-Census Block areas. As a result, more accurate flood loss determinations are produced using this dataset.

The State building dataset included various structural attributes used for the analyses, including replacement cost, agency that owns or leases the building, use description, year built, number of stories, and square footage. For State buildings, community lifelines, and critical facilities that have missing values for these attributes and for additional attributes required for the FEMA Hazus analyses, default values were used. The following table summarizes the default data used if the information was missing from the dataset provided. Note that all analyses in the SHMP for the County of Maui include the County of Kalawao.

Table F-2. Default Building Values in Hazus v5.1

Attribute	Default Value
Year Built	2020 Census median year built at the tract or state level
Number of Stories	1 story
Square Footage	Typical size for the occupancy class as shown in the Table 14.1 of the Hazus-MH Flood Model Technical Manual.
Building Replacement Cost	Per square foot cost for the occupancy class from RS Means multiplied by the square footage.
Content Replacement Cost	Building replacement cost multiplied by the default Hazus contents value percent of structure value for the occupancy class as shown in Table 14.6 of the Hazus-MH Flood Model Technical Manual.
Earthquake Building Type	Most common building type for the occupancy class based on year built and number of stories as shown in Tables 3A.2 through 3A.10 of the Hazus-MH Flood Model Technical Manual.
Earthquake Design Code	Design code based on year built and UBC seismic zone (zone 1 for Kauaʻi and City and County of Honolulu, zone 2B for Maui, zone 4 for County of Hawaiʻi) as shown in Table 5.20 of the Hazus Earthquake Technical Manual.
Flood Building Type	Based on the earthquake building type.
Flood Foundation Type	Most common foundation type for the occupancy class as shown in the Flood Specific Occupancy Mapping tables viewable through the inventory menu in Hazus.
First Floor Elevation	1 foot for slab on grade foundations and 2 feet for crawl space foundations.

When analyzing hazard areas, the total area was calculated from the State of Hawaiʻi State Land Use District GIS layer. Hazard areas downloaded from the State of Hawaiʻi GIS Program Geospatial Data Portal were clipped to the coastline. Total area may differ slightly between this and other calculations due to slight differences in the shoreline geography.

Socially Vulnerable Population

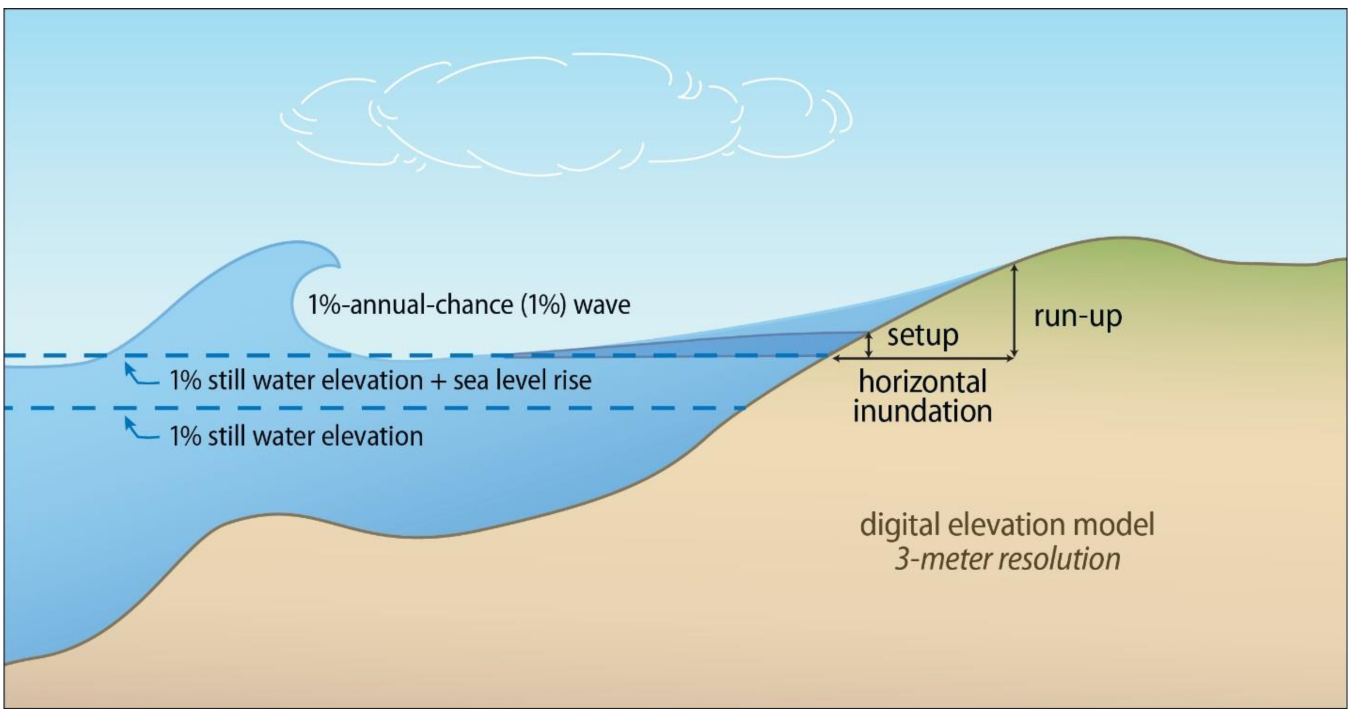
The vulnerability of the Census tracts in the Social Vulnerability Index data was based on the Centers for Disease Control and Prevention (CDC) Social Vulnerability Index (SVI) and was categorized as "high" if the overall tract summary ranking aligned with the current FEMA BRIC evaluation score greater than 0.80 (80%).

F.3 Climate Change and Sea Level Rise

F.3.1 1%CFZ-3.2 DATA GENERATION METHODOLOGY

Under the DLNR Contract 64064, a coastal flood zone was modeled that includes flood extents and wave heights for wave-generating events with sea level rise by Tetra Tech Inc. and Sobis Inc. This area is referred to as the 1%-annual-chance coastal flood zone or 1%CFZ. Key inputs and outputs of modeling the 1%CFZ are shown in Figure F-1.

Figure F-1. Schematic diagram Showing Key Inputs and Outputs of Modeling the 1%-Annual-Chance Coastal Flood Zone (1%CFZ)



Data Inputs

Hazard modeling for the 1%CFZ used the 3-meter DEM, which captured the same horizontal extent of passive flooding but with lower resolution of the land closest to the shoreline. The current 1%-annual-chance stillwater elevation was generated based on the most current flood insurance studies (FIS) for each island conducted by

FEMA. The FIS calculates the 1%-annual-chance stillwater elevation, wave setup, and wave run-up (called maximum wave crest) at regularly spaced transects around the islands based on historical data. In some parts of the islands, large gaps exist between transects. In order to address these gaps in the data coverage, Hazus was run at 0.5-foot stillwater level intervals, and the results were compared to the existing floodplain (FIRM). The interval of 0.5 feet was chosen as a small enough step to result in a near approximation of the FIRM while not being too impractically narrow to require the testing of dozens of input elevations. The elevation which matched up best was used as the current base flood elevation.

Modeling Approach

Key steps in modeling the projected 1%CFZ with sea level rise include: (1) generating a contiguous (no gaps along the shoreline) and present-day 1%-annual-chance stillwater elevation based on the most recent FIS, (2) elevating the present-day 1%-annual-chance stillwater elevation by adding projected sea level rise heights, and (3) modeling the projected 1%-annual-chance coastal flood with sea level rise in Hazus using the 1%-annual-chance wave setup and run-up from the FIS. The 1%CFZ extent and depth was generated using the Hazus v5.1 coastal flood model, 3-meter DEM, the FIS for each island, and the Intergovernmental Panel on Climate Change Fifth Assessment Report upper sea level projection for Representative Concentration Pathway (RCP) 8.5 scenario for 0.6 feet, 1.0 feet, 2.0 feet, and 3.2 feet of sea level rise above Mean Higher High Water. The Hazus output includes the estimated spatial extent of coastal flooding as well as an estimated flood depth map grid for the sea level rise projections.

Using the current floodplain generated with Hazus, the projected 1%-annual-chance stillwater elevation was generated using the sea level rise projections. This stillwater elevation with sea level rise was used as a basis for modeling. The projected 1%-annual coastal flood with sea level rise was modeled in Hazus using the current 1%-annual-chance wave setup and run-up from the FIS and the projected 1%-annual-chance stillwater elevation with sea level rise.

Assumptions and Limitations

Historical records of severe wave events used to model the 1%CFZ do not consider potential changes in tropical cyclone activity related to climate change. Historical data used to model the 1%CFZ were based on the current FIS for each island conducted by the NFIP. The FIS use historic severe wave events from hurricanes, tsunamis, and other significant events to develop the FIRMs.

The 1%CFZ is modeled as a static rise of the base flood elevation using a fixed shoreline. As such, it does not consider changes in the location of the shoreline resulting from coastal erosion. While the current FIS for each island was used for modeling; these studies are based on historical records of hurricanes, tsunamis, and other coastal wave events and do not include projected changes in waves due to changes in storm frequency or intensity as a result of climate change. Also, riverine flooding is not included in the modeling.

Additional Results

Table F-3 summarizes the number of miles of State roads located in the SLR-XA-3.2 and 1%CFZ-3.2, organized by county.

Table F-3. State Road Exposure to Sea-Level Rise Hazard Areas by County

State Route	Length (in miles)				
	Total Length (miles)	Miles of State Road in the SLR-XA-3.2	Percent (%) of Total Length	Miles of State Road in the 1%CFZ-3.2	Percent (%) of Total Length
County of Kauaʻi					
State Route 50	32.89242	3.193582	9.71%	11.88131	36.12%
State Route 51	3.457222	0.029893	0.86%	0.531002	15.36%
State Route 56	28.316299	1.448715	5.12%	6.505937	22.98%
State Route 58	2.052085	0	0.00%	0.161423	7.87%
State Route 540	3.884869	0	0.00%	0	0.00%
State Route 541	0.37465	0	0.00%	0.064994	17.35%
State Route 550	14.03193	0	0.00%	0.125556	0.89%
State Route 560	9.98938	2.643944	26.47%	6.792348	68.00%
State Route 570	1.125605	0	0.00%	0	0.00%
State Route 580	6.668581	0.040679	0.61%	0.878158	13.17%
State Route 583	0.921237	0	0.00%	0	0.00%
Total	**103.714278**	**7.356813**	**7.09%**	**26.940728**	**25.98%**
City and County of Honolulu					
State Route 61	21.173569	0.021857	0.10%	0.028452	0.13%
State Route 63	16.618809	0	0.00%	0	0.00%
State Route 64	2.624714	0.124464	4.74%	2.138496	81.48%
State Route 65	6.584201	0	0.00%	0.251109	3.81%
State Route 72	22.766927	1.479001	6.50%	8.252005	36.25%
State Route 76	11.059837	1.01059	9.14%	1.339601	12.11%
State Route 78	1.346173	0.014683	1.09%	0.097597	7.25%
State Route 80	1.893686	0	0.00%	0	0.00%
State Route 83	47.821595	8.352385	17.47%	17.854149	37.33%
State Route 92	18.685552	1.987624	10.64%	10.79711	57.78%
State Route 93	19.522013	4.703742	24.09%	2.855635	14.63%
State Route 98	3.470599	0.031178	0.90%	0.032308	0.93%
State Route 99	41.120805	0.108576	0.26%	0.353361	0.86%
State Route 750	8.056213	0	0.00%	0	0.00%
State Route 901	1.403364	0	0.00%	0	0.00%
State Route 930	10.054945	0.554215	5.51%	3.065938	30.49%
State Route 7012	1.862959	0	0.00%	0	0.00%
State Route 7101	5.865258	0.035746	0.61%	0.422072	7.20%
State Route 7110	0.609843	0	0.00%	0	0.00%
State Route 7141	1.50208	0	0.00%	0	0.00%
State Route 7210	0.115075	0	0.00%	0	0.00%
State Route 7239	0.338737	0	0.00%	0	0.00%

State Route	Length (in miles)				
	Total Length (miles)	Miles of State Road in the SLR-XA-3.2	Percent (%) of Total Length	Miles of State Road in the 1%CFZ-3.2	Percent (%) of Total Length
State Route 7241	2.331816	0.008449	0.36%	0.010742	0.46%
State Route 7310	1.041137	0	0.00%	0.2275	21.85%
State Route 7345	0.554715	0	0.00%	0	0.00%
State Route 7350	0.597196	0	0.00%	0	0.00%
State Route 7351	0.243914	0	0.00%	0	0.00%
State Route 7401	0.214056	0.044232	20.66%	0.214056	100.00%
State Route 7413	0.352495	0	0.00%	0	0.00%
State Route 7415	0.536255	0	0.00%	0.16786	31.30%
State Route 7526	0.397834	0	0.00%	0	0.00%
State Route 7601	0.432591	0	0.00%	0	0.00%
State Route 7801	1.151651	0	0.00%	0	0.00%
State Route 8300	0.501274	0.020791	4.15%	0.098285	19.61%
State Route 8918	0.13352	0	0.00%	0	0.00%
State Route 8930	4.941677	0	0.00%	0	0.00%
State Route 8940	3.321223	0	0.00%	0	0.00%
State Route 8945	0.984948	0	0.00%	0	0.00%
State Route 8955	2.697864	0.260486	9.66%	0.85498	31.69%
State Route H-1	54.2852	0.61322	1.13%	1.43314	2.64%
State Route H-2	16.631646	0	0.00%	0	0.00%
State Route H-201	8.479473	0.024632	0.29%	0.031691	0.37%
State Route H-3	30.593733	0.01579	0.05%	0.372911	1.22%
Total	**374.921172**	**19.411661**	**5.18%**	**50.898998**	**13.58%**
County of Maui					
State Route 30	41.599628	6.819562	16.39%	0.921403	2.21%
State Route 31	7.147053	0	0.00%	0	0.00%
State Route 32	2.855291	0	0.00%	0.927283	32.48%
State Route 36	16.225414	0.282187	1.74%	0.971622	5.99%
State Route 37	21.33757	0	0.00%	0	0.00%
State Route 310	3.609294	1.646439	45.62%	2.395813	66.38%
State Route 311	6.415815	0	0.00%	0	0.00%
State Route 340	4.265623	0	0.00%	0	0.00%
State Route 360	34.838612	0	0.00%	0.059796	0.17%
State Route 377	9.136002	0	0.00%	0	0.00%
State Route 378	10.082808	0	0.00%	0	0.00%
State Route 380	6.197863	0	0.00%	0.323681	5.22%
State Route 440	13.153636	0	0.00%	0	0.00%
State Route 441	0.476716	0	0.00%	0	0.00%
State Route 442	0.022862	0	0.00%	0	0.00%
State Route 450	27.477007	2.248936	8.18%	11.150368	40.58%
State Route 460	16.534641	0.030871	0.19%	1.66084	10.04%
State Route 470	10.74695	0	0.00%	0	0.00%
State Route 480	5.898639	0	0.00%	0	0.00%

State Route	Length (in miles)				
	Total Length (miles)	Miles of State Road in the SLR-XA-3.2	Percent (%) of Total Length	Miles of State Road in the 1%CFZ-3.2	Percent (%) of Total Length
State Route 3000	2.346263	0	0.00%	0	0.00%
State Route 3400	2.635502	0.737817	28.00%	0.304754	11.56%
State Route 3500	1.125483	0	0.00%	0.562062	49.94%
State Route 3800	0.625243	0	0.00%	0	0.00%
State Route 32A	0.400435	0.035054	8.75%	0.400435	100.00%
State Route 32B	0.172196	0	0.00%	0.172196	100.00%
State Route 36A	0.526104	0	0.00%	0.43995	83.62%
Total	**245.85265**	**11.800866**	**4.80%**	**20.290203**	**8.25%**
County of Hawaiʻi					
State Route 11	117.608086	0	0.00%	0.100353	0.09%
State Route 19	93.300605	0.204494	0.22%	1.957262	2.10%
State Route 130	21.68728	0	0.00%	0	0.00%
State Route 139	1.197816	0	0.00%	0	0.00%
State Route 160	3.821277	0	0.00%	0	0.00%
State Route 163	0.133863	0	0.00%	0	0.00%
State Route 190	34.085758	0	0.00%	0	0.00%
State Route 197	1.17843	0	0.00%	0	0.00%
State Route 200	43.219679	0	0.00%	0	0.00%
State Route 220	3.754068	0	0.00%	0	0.00%
State Route 240	9.601941	0	0.00%	0	0.00%
State Route 250	19.266672	0	0.00%	0	0.00%
State Route 270	27.020618	0	0.00%	0.422338	1.56%
State Route 1370	0.191175	0	0.00%	0.191175	100.00%
State Route 1970	0.923307	0	0.00%	0.080659	8.74%
State Route 2000	2.184464	0	0.00%	0	0.00%
Total	379.175039	0.204494	0.05%	2.751787	0.73%

Source: *State of Hawaii Department of Transportation 2022; Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017; Tetra Tech Inc. and Sobis Inc. 2017*

Table F-4 shows the square miles of SLR-XA-3.2 and 1%CFZ-3.2 for each State Land Use District in each county.

Table F-4. State Land Use Districts in the Sea Level Rise Hazard Areas

Land Use District	Area (in Square Miles)						
	Total Square Miles	Square Miles in SLR-XA-3.2	SLR-XA-3.2 as Percent (%) of Total Area	SLR-XA-3.2 as Percent (%) of Total Hazard Exposure	Square Miles in 1%CFZ-3.2	1%CFZ-3.2 as Percent (%) of Total Area	1%CFZ-3.2 as Percent (%) of Total Hazard Exposure
County of Kauaʻi							
Agricultural	297.078539	4.847083	1.63%	54.30%	19.072984	6.42%	59.01%
Conservation	304.260357	2.552858	0.84%	28.60%	7.411515	2.44%	22.93%
Rural	2.146976	0.03049	1.42%	0.34%	0.368211	17.15%	1.14%
Urban	23.643203	1.496503	6.33%	16.76%	5.46669	23.12%	16.91%
Total	**627.129075**	**8.926934**	**1.42%**	**100.00%**	**32.3194**	**5.15%**	**100.00%**

Land Use District	Area (in Square Miles)						
	Total Square Miles	Square Miles in SLR-XA-3.2	SLR-XA-3.2 as Percent (%) of Total Area	SLR-XA-3.2 as Percent (%) of Total Hazard Exposure	Square Miles in 1%CFZ-3.2	1%CFZ-3.2 as Percent (%) of Total Area	1%CFZ-3.2 as Percent (%) of Total Hazard Exposure
City and County of Honolulu							
Agricultural	188.479146	1.902749	1.01%	15.63%	8.440963	4.48%	20.84%
Conservation	247.601978	3.150159	1.27%	25.88%	4.684754	1.89%	11.57%
Rural	-	-	-	-	-	-	-
Urban	162.455059	7.117581	4.38%	58.48%	27.371817	16.85%	67.59%
Total	**598.536183**	**12.170489**	**2.03%**	**100.00%**	**40.497534**	**6.77%**	**100.00%**
County of Maui							
Agricultural	637.731138	2.040536	0.32%	21.58%	4.580218	0.72%	25.55%
Conservation	552.35574	4.621992	0.84%	48.87%	7.264157	1.32%	40.52%
Rural	12.824585	0.564782	4.40%	5.97%	1.791795	13.97%	10.00%
Urban	45.187433	2.229674	4.93%	23.58%	4.289195	9.49%	23.93%
Total	**1,248**	**9.456984**	**0.76%**	**100.00%**	**17.925365**	**1.44%**	**100.00%**
County of Hawai'i							
Agricultural	1,850.31	0.146216	0.01%	3.29%	3.660674	0.20%	19.49%
Conservation	2,098.66	3.42501	0.16%	77.09%	10.731767	0.51%	57.13%
Rural	1.36344	0.004256	0.31%	0.10%	0.005582	0.41%	0.03%
Urban	87.847736	0.867486	0.99%	19.52%	4.385858	4.99%	23.35%
Total	**4,038**	**4.442968**	**0.11%**	**100.00%**	**18.783881**	**0.47%**	**100.00%**

Source: *State Land Use Commission, Hawaii Statewide GIS Program 2021; Honolulu County GIS 2022; Hawai'i Climate Change Mitigation and Adaptation Commission 2017; Tetra Tech Inc. and Sobis Inc. 2017*

Notes: *(-) Denotes no rural district in the City and County of Honolulu*

F.4 Cyber Threat

There are no additional tables to support Section 4.3 (Cyber Threat).

F.5 Drought

There are no additional tables to support Section 4.4 (Drought).

F.6 Earthquake

Table F-5 summarizes the estimated potential damages to State buildings by agency as a result of the 100-year probabilistic earthquake event in Hazus v5.1.

Table F-5. Estimated Potential Loss to State Buildings by Agency (100-year Probabilistic Earthquake Event)

Agency	Total Number of State Buildings	Total Replacement Cost Value	Total Number of State Buildings in Hazard Area	Estimated Potential Loss	Percent (%) of Total Value
Dept. of Accounting & General Services	66	$953,963,738	66	$3,191,403	0.33%

Agency	Total Number of State Buildings	Total Replacement Cost Value	Total Number of State Buildings in Hazard Area	Estimated Potential Loss	Percent (%) of Total Value
Dept. of Agriculture	70	$147,607,399	70	$1,728,845	1.17%
Dept. of Attorney General	15	$108,425,480	15	$301,576	0.28%
Dept. of Budget & Finance	16	$28,968,679	16	$137,221	0.47%
Dept. of Business, Economic Development and Tourism	25	$645,480,379	25	$1,452,562	0.23%
Dept. of Commerce & Consumer Affairs	2	$40,197,360	2	$61,939	0.15%
Dept. of Defense	69	$267,352,836	69	$2,158,817	0.81%
Dept. of Education	4,090	$10,598,205,739	4003	$268,584,100	2.53%
Dept. of Hawaiian Home Lands	12	$110,427,352	12	$431,959	0.39%
Dept. of Health	44	$387,068,440	43	$1,025,948	0.27%
Dept. of Human Resources Development	1	$5,973,872	1	$8,018	0.13%
Dept. of Human Services	130	$480,212,294	130	$2,235,397	0.47%
Dept. of Labor and Industrial Relations	22	$90,076,209	22	$1,114,879	1.24%
Dept. of Land and Natural Resources	90	$101,441,821	89	$268,403	0.26%
Dept. of Public Safety	154	$440,774,415	154	$8,803,098	2.00%
Dept. of Taxation	1	$7,174,162	1	$11,809	0.16%
Dept. of Transportation	68	$2,935,208,214	68	$5,949,192	0.20%
Hawaiʻi State Ethics Commission	1	$984,533	1	$1,422	0.14%
Hawaiʻi Health Systems Corporation	106	$1,230,852,871	97	$27,166,906	2.21%
Hawaiʻi Housing Finance & Development Corporation	86	$360,851,671	86	$3,206,470	0.89%
Hawaiʻi Public Housing Authority	273	$982,981,701	209	$6,052,550	0.62%
Hawaiʻi State Legislature	2	$48,555,381	2	$75,061	0.15%
Hawaiʻi State Public Library System	53	$525,584,082	51	$3,292,268	0.63%
Judiciary	41	$534,877,354	41	$3,267,028	0.61%
Legislative Reference Bureau	1	$2,996,162	1	4082.9213	0.14%
Office of Hawaiian Affairs	11	$54,125,645	11	$87,800	0.16%
Office of the Auditor	2	$1,921,180	2	$2,569	0.13%
Office of the Governor	1	$2,996,162	1	$4,083	0.14%
Office of the Lieutenant Governor	2	$4,588,849	2	$9,945	0.22%
Office of the Ombudsman	1	$1,818,060	1	$2,484	0.14%
Research Corporation of the University of Hawaiʻi	3	$4,189,026	3	$6,583	0.16%
University of Hawaiʻi	637	$5,014,974,503	637	$18,138,256	0.36%
Total	**6,095**	**$26,120,855,568**	**5,931**	**$358,782,672**	**1.37%**

Source: *State of Hawaiʻi Risk Management Office 2017; FEMA Hazus v5.1*

Table F-6 summarizes the estimated potential damages to State buildings by county as a result of the Kalapana earthquake event in Hazus v5.1.

Table F-6. Estimated Potential Loss to State Buildings by County (Kalapana 1975 M7.7 Scenario)

County	Total Replacement Cost Value	Estimated Potential Loss	
		Value	Percent (%) of Total
County of Kauaʻi	$990,850,824	$0	0.00%
City and County of Honolulu	$17,393,945,915	$2,607,370	0.01%

County	Total Replacement Cost Value	Estimated Potential Loss	
		Value	Percent (%) of Total
County of Maui	$3,097,491,689	$361,115	0.01%
County of Hawai'i	$4,638,567,141	$112,266,079	2.42%
Total	**$26,120,855,568**	**$115,234,564**	**0.44%**

Source: State of Hawaii Risk Management Office 2017; United States Geological Survey 2013; FEMA Hazus v5.1

Table F-7 summarizes the estimated potential damages to State buildings by agency as a result of the Kalapana earthquake event in Hazus v5.1.

Table F-7. Estimated Potential Loss to State Buildings by Agency (Kalapana 1975 M7.7 Scenario)

Agency	Total Replacement Cost Value	Estimated Potential Loss	
		Value	Percent (%) of Total
Dept. of Accounting & General Services	$953,963,738	$810,273	0.08%
Dept. of Agriculture	$147,607,399	$694,619	0.47%
Dept. of Attorney General	$108,425,480	$44,044	0.04%
Dept. of Budget & Finance	$28,968,679	$77,881	0.27%
Dept. of Business, Economic Development & Tourism	$645,480,379	$122,544	0.02%
Dept. of Commerce & Consumer Affairs	$40,197,360	$5,179	0.01%
Dept. of Defense	$267,352,836	$1,531,755	0.57%
Dept. of Education	$10,598,205,739	$80,394,007	0.76%
Dept. of Hawaiian Home Lands	$110,427,352	$40,340	0.04%
Dept. of Health	$387,068,440	$235,300	0.06%
Dept. of Human Resources Development	$5,973,872	$1,468	0.02%
Dept. of Human Services	$480,212,294	$526,885	0.11%
Dept. of Labor & Industrial Relations	$90,076,209	$726,303	0.81%
Dept. of Land & Natural Resources	$101,441,821	$24,805	0.02%
Dept. of Public Safety	$440,774,415	$5,126,088	1.16%
Dept. of Taxation	$7,174,162	$1,271	0.02%
Dept. of Transportation	$2,935,208,214	$1,222,041	0.04%
Hawai'i State Ethics Commission	$984,533	$100	0.01%
Hawai'i Health Systems Corporation	$1,230,852,871	$13,674,956	1.11%
Hawai'i Housing Finance & Development Corporation	$360,851,671	$134,509	0.04%
Hawai'i Public Housing Authority	$982,981,701	$669,034	0.07%
Hawai'i State Legislature	$48,555,381	$11,758	0.02%
Hawai'i State Public Library System	$525,584,082	$1,778,824	0.34%
Judiciary	$534,877,354	$1,185,061	0.22%
Legislative Reference Bureau	$2,996,162	$742	0.02%
Office of Hawaiian Affairs	$54,125,645	$8,860	0.02%
Office of the Auditor	$1,921,180	$261	0.01%
Office of the Governor	$2,996,162	$742	0.02%

Agency	Total Replacement Cost Value	Estimated Potential Loss	
		Value	Percent (%) of Total
Office of the Lieutenant Governor	$4,588,849	$870	0.02%
Office of the Ombudsman	$1,818,060	$248	0.01%
Research Corporation of the University of Hawai'i	$4,189,026	$783	0.02%
University of Hawai'i	$5,014,974,503	$6,183,013	0.12%
Total	**$26,120,855,568**	**$115,234,564**	**0.44%**

Source: Source: State of Hawaii Risk Management Office 2017; United States Geological Survey 2013; FEMA Hazus v5.1

Table F-8 summarizes the estimated potential damages to community lifelines and critical facilities by category as a result of the Kalapana earthquake event in Hazus v5.1.

Table F-8. Estimated Potential Loss to Community Lifelines and Critical Facilities by Category (Kalapana 1975 M7.7 Scenario)

Category	Total Replacement Cost Value	Estimated Potential Loss	
		Value	Percent (%) of Total
Communications	$776,797,683	$2,958,202	0.38%
Energy	$3,093,949,530	$1,948,153	0.06%
Food, Water, Shelter	$11,847,189,588	$40,547,006	0.34%
Hazardous Material	$436,474,800	$7,962,395	1.82%
Health and Medical	$4,606,713,364	$23,308,914	0.51%
Safety and Security	$38,164,188,232	$54,391,923	0.14%
Transportation Services	$2,039,091,600	$2,661,950	0.13%
Additional Critical Facilities	$447,698,794	$3,357,342	0.75%
Total	**$61,412,103,591**	**$137,135,884**	**0.22%**

Source: Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020; United States Geological Survey 2013, Hazus v5.1

Table F-9 summarizes the estimated potential damages to State buildings by county as a result of the Kaʻū earthquake event in Hazus v5.1.

Table F-9. Estimated Potential Loss to State Buildings by County (Kaʻū M8.0 Scenario)

County	Total Replacement Cost Value	Estimated Potential Loss	
		Value	Percent (%) of Total
County of Kauaʻi	$990,850,824	$0	0.00%
City and County of Honolulu	$17,393,945,915	$3,892,689	0.02%
County of Maui	$3,097,491,689	$772,179	0.02%
County of Hawaiʻi	$4,638,567,141	$143,537,454	3.09%
Total	**$26,120,855,568**	**$148,202,322**	**0.57%**

Source: State of Hawaii Risk Management Office 2017; United States Geological Survey 2013; FEMA Hazus v5.1

Table F-10 summarizes the estimated potential damages to State buildings by agency as a result of the Kaʻū earthquake event in Hazus v5.1.

Table F-10. Estimated Potential Loss to State Buildings by Agency (Kaʻū M8.0 Scenario)

Agency	Total Replacement Cost	Estimated Potential Loss	
	Value	Value	Percent (%) of Total
Dept. of Accounting & General Services	$953,963,738	$1,106,170	0.12%
Dept. of Agriculture	$147,607,399	$911,336	0.62%
Dept. of Attorney General	$108,425,480	$58,606	0.05%
Dept. of Budget & Finance	$28,968,679	$82,770	0.29%
Dept. of Business, Economic Development & Tourism	$645,480,379	$178,734	0.03%
Dept. of Commerce & Consumer Affairs	$40,197,360	$9,762	0.02%
Dept. of Defense	$267,352,836	$1,579,360	0.59%
Dept. of Education	$10,598,205,739	$100,407,448	0.95%
Dept. of Hawaiian Home Lands	$110,427,352	$243,190	0.22%
Dept. of Health	$387,068,440	$326,827	0.08%
Dept. of Human Resources Development	$5,973,872	$1,468	0.02%
Dept. of Human Services	$480,212,294	$720,727	0.15%
Dept. of Labor & Industrial Relations	$90,076,209	$764,268	0.85%
Dept. of Land & Natural Resources	$101,441,821	$36,741	0.04%
Dept. of Public Safety	$440,774,415	$7,351,391	1.67%
Dept. of Taxation	$7,174,162	$2,379	0.03%
Dept. of Transportation	$2,935,208,214	$1,698,065	0.06%
Hawaiʻi State Ethics Commission	$984,533	$224	0.02%
Hawaiʻi Health Systems Corporation	$1,230,852,871	$18,865,437	1.53%
Hawaiʻi Housing Finance & Development Corporation	$360,851,671	$214,980	0.06%
Hawaiʻi Public Housing Authority	$982,981,701	$1,264,044	0.13%
Hawaiʻi State Legislature	$48,555,381	$11,758	0.02%
Hawaiʻi State Public Library System	$525,584,082	$1,902,838	0.36%
Judiciary	$534,877,354	$1,474,413	0.28%
Legislative Reference Bureau	$2,996,162	$742	0.02%
Office of Hawaiian Affairs	$54,125,645	$15,806	0.03%
Office of the Auditor	$1,921,180	$471	0.02%
Office of the Governor	$2,996,162	$742	0.02%
Office of the Lieutenant Governor	$4,588,849	$1,403	0.03%
Office of the Ombudsman	$1,818,060	$451	0.02%
Research Corporation of the University of Hawaiʻi	$4,189,026	$1,234	0.03%
University of Hawaiʻi	$5,014,974,503	$8,968,535	0.18%
Total	**$24,780,556,017**	**$148,202,322**	**0.60%**

Source: State of Hawaii Risk Management Office 2017; United States Geological Survey 2013; FEMA Hazus v5.1

Table F-11 summarizes the estimated potential damages to community lifelines and critical facilities by category as a result of the Kaʻū earthquake event in Hazus v5.1.

Table F-11. Estimated Potential Loss to Community Lifelines and Critical Facilities by Category (Kaʻū M8.0 Scenario)

Category	Total Replacement Cost Value	Estimated Potential Loss	
		Value	Percent (%) of Total
Communications	$776,797,683	$3,906,389	0.50%
Energy	$3,093,949,530	$1,614,276	0.05%
Food, Water, Shelter	$11,847,189,588	$54,302,551	0.46%
Hazardous Material	$436,474,800	$8,124,554	1.86%
Health and Medical	$4,606,713,364	$46,855,655	1.02%
Safety and Security	$38,164,188,232	$102,405,944	0.27%
Transportation Services	$2,039,091,600	$3,095,431	0.15%
Additional Critical Facilities	$447,698,794	$4,581,006	1.02%
Total	**$61,412,103,591**	**$224,885,808**	**0.37%**

Source: Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020; United States Geological Survey 2013, Hazus v5.1

Table F-12 summarizes the estimated potential damages to State buildings by county as a result of the Lānaʻi earthquake event in Hazus v5.1.

Table F-12. Estimated Potential Loss to State Buildings by County (Lānaʻi M7.0 Scenario)

County	Total Replacement Cost Value	Estimated Potential Loss	
		Value	Percent (%) of Total
County of Kauaʻi	$990,850,824	$0	0.00%
City and County of Honolulu	$17,393,945,915	$2,067,123	0.01%
County of Maui	$3,097,491,689	$37,395,087	1.21%
County of Hawaiʻi	$4,638,567,141	$23,550	0.00%
Total	**$26,120,855,568**	**$39,485,760**	**0.15%**

Source: State of Hawaii Risk Management Office 2017; United States Geological Survey 2013; FEMA Hazus v5.1

Table F-13 summarizes the estimated potential damages to State buildings by agency as a result of the Lānaʻi earthquake event in Hazus v5.1.

Table F-13. Estimated Potential Loss to State Buildings by Agency (Lānaʻi M7.0 Scenario)

Agency	Total Replacement Cost Value	Estimated Potential Loss	
		Value	Percent (%) of Total
Dept. of Accounting & General Services	$953,963,738	$295,115	0.03%
Dept. of Agriculture	$147,607,399	$30,168	0.02%

Agency	Total Replacement Cost Value	Estimated Potential Loss	
		Value	Percent (%) of Total
Dept. of Attorney General	$108,425,480	$15,792	0.01%
Dept. of Budget & Finance	$28,968,679	$4,378	0.02%
Dept. of Business, Economic Development & Tourism	$645,480,379	$72,572	0.01%
Dept. of Commerce & Consumer Affairs	$40,197,360	$5,716	0.01%
Dept. of Defense	$267,352,836	$51,913	0.02%
Dept. of Education	$10,598,205,739	$31,769,046	0.30%
Dept. of Hawaiian Home Lands	$110,427,352	$13,763	0.01%
Dept. of Health	$387,068,440	$53,414	0.01%
Dept. of Human Resources Development	$5,973,872	$658	0.01%
Dept. of Human Services	$480,212,294	$348,243	0.07%
Dept. of Labor & Industrial Relations	$90,076,209	$159,811	0.18%
Dept. of Land & Natural Resources	$101,441,821	$28,470	0.03%
Dept. of Public Safety	$440,774,415	$105,381	0.02%
Dept. of Taxation	$7,174,162	$1,161	0.02%
Dept. of Transportation	$2,935,208,214	$2,224,415	0.08%
Hawaiʻi State Ethics Commission	$984,533	$134	0.01%
Hawaiʻi Health Systems Corporation	$1,230,852,871	$2,324,765	0.19%
Hawaiʻi Housing Finance & Development Corporation	$360,851,671	$244,966	0.07%
Hawaiʻi Public Housing Authority	$982,981,701	$98,323	0.01%
Hawaiʻi State Legislature	$48,555,381	$6,908	0.01%
Hawaiʻi State Public Library System	$525,584,082	$346,432	0.07%
Judiciary	$534,877,354	$450,962	0.08%
Legislative Reference Bureau	$2,996,162	$335	0.01%
Office of Hawaiian Affairs	$54,125,645	$12,137	0.02%
Office of the Auditor	$1,921,180	$211	0.01%
Office of the Governor	$2,996,162	$335	0.01%
Office of the Lieutenant Governor	$4,588,849	$2,783	0.06%
Office of the Ombudsman	$1,818,060	$204	0.01%
Research Corporation of the University of Hawaiʻi	$4,189,026	$631	0.02%
University of Hawaiʻi	$5,014,974,503	$816,617	0.02%
Total	**$26,120,855,568**	**$39,485,760**	**0.15%**

Source: State of Hawaii Risk Management Office 2017; United States Geological Survey 2013; FEMA Hazus v5.1

Table F-14 summarizes the estimated potential damages to community lifelines and critical facilities by category as a result of the Lānaʻi earthquake event in Hazus v5.1.

Table F-14. Estimated Potential Loss to Community Lifelines and Critical Facilities by Category (Lānaʻi M7.0 Scenario)

Category	Total Replacement Cost Value	Estimated Potential Loss	
		Value	Percent (%) of Total
Communications	$776,797,683	$991,928	0.13%
Energy	$3,093,949,530	$375,321	0.01%
Food, Water, Shelter	$11,847,189,588	$8,312,963	0.07%
Hazardous Material	$436,474,800	$17,462	0.00%
Health and Medical	$4,606,713,364	$6,936,985	0.15%
Safety and Security	$38,164,188,232	$380,048,621	1.00%
Transportation Services	$2,039,091,600	$7,302,517	0.36%
Additional Critical Facilities	$447,698,794	$833,761	0.19%
Total	**$61,412,103,591**	**$404,819,558**	**0.66%**

Source: Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020; United States Geological Survey 2013, Hazus v5.1

Table F-15 summarizes the estimated potential damages to State buildings by county as a result of the NE Maui earthquake event in Hazus v5.1.

Table F-15. Estimated Potential Loss to State Buildings by County (NE Maui M7.0 Scenario)

County	Total Replacement Cost Value	Estimated Potential Loss	
		Value	Percent (%) of Total
County of Kauaʻi	$990,850,824	$0	0.00%
City and County of Honolulu	$17,393,945,915	$743,785	0.00%
County of Maui	$3,097,491,689	$3,897,232	0.13%
County of Hawaiʻi	$4,638,567,141	$47,651	0.00%
Total	**$26,120,855,568**	**$4,688,669**	**0.02%**

Source: State of Hawaii Risk Management Office 2017; United States Geological Survey 2013; FEMA Hazus v5.1

Table F-16 summarizes the estimated potential damages to State buildings by agency as a result of the NE Maui earthquake event in Hazus v5.1.

Table F-16. Estimated Potential Loss to State Buildings by Agency (NE Maui M7.0 Scenario)

Agency	Total Replacement Cost Value	Estimated Potential Loss	
		Value	Percent (%) of Total
Dept. of Accounting & General Services	$953,963,738	$62,546	0.01%
Dept. of Agriculture	$147,607,399	$60,801	0.04%
Dept. of Attorney General	$108,425,480	$12,614	0.01%
Dept. of Budget & Finance	$28,968,679	$2,609	0.01%
Dept. of Business, Economic Development & Tourism	$645,480,379	$44,114	0.01%

Agency	Total Replacement Cost Value	Estimated Potential Loss	
		Value	Percent (%) of Total
Dept. of Commerce & Consumer Affairs	$40,197,360	$2,027	0.01%
Dept. of Defense	$267,352,836	$60,720	0.02%
Dept. of Education	$10,598,205,739	$1,479,239	0.01%
Dept. of Hawaiian Home Lands	$110,427,352	$6,514	0.01%
Dept. of Health	$387,068,440	$31,071	0.01%
Dept. of Human Resources Development	$5,973,872	$276	0.00%
Dept. of Human Services	$480,212,294	$83,068	0.02%
Dept. of Labor & Industrial Relations	$90,076,209	$13,217	0.01%
Dept. of Land & Natural Resources	$101,441,821	$23,348	0.02%
Dept. of Public Safety	$440,774,415	$102,707	0.02%
Dept. of Taxation	$7,174,162	$511	0.01%
Dept. of Transportation	$2,935,208,214	$896,094	0.03%
Hawai'i State Ethics Commission	$984,533	$46	0.00%
Hawai'i Health Systems Corporation	$1,230,852,871	$940,641	0.08%
Hawai'i Housing Finance & Development Corporation	$360,851,671	$62,662	0.02%
Hawai'i Public Housing Authority	$982,981,701	$53,329	0.01%
Hawai'i State Legislature	$48,555,381	$2,440	0.01%
Hawai'i State Public Library System	$525,584,082	$72,368	0.01%
Judiciary	$534,877,354	$70,278	0.01%
Legislative Reference Bureau	$2,996,162	$139	0.00%
Office of Hawaiian Affairs	$54,125,645	$3,187	0.01%
Office of the Auditor	$1,921,180	$88	0.00%
Office of the Governor	$2,996,162	$139	0.00%
Office of the Lieutenant Governor	$4,588,849	$4,421	0.10%
Office of the Ombudsman	$1,818,060	$85	0.00%
Research Corporation of the University of Hawai'i	$4,189,026	$259	0.01%
University of Hawai'i	$5,014,974,503	$597,110	0.01%
Total	**$26,120,855,568**	**$4,688,669**	**0.02%**

Source: State of Hawaii Risk Management Office 2017; United States Geological Survey 2013; FEMA Hazus v5.1

Table F-17 summarizes the estimated potential damages to community lifelines and critical facilities by category as a result of the NE Maui earthquake event in Hazus v5.1.

Table F-17. Estimated Potential Loss to Community Lifelines and Critical Facilities by Category (NE Maui M7.0 Scenario)

Category	Total Replacement Cost Value	Estimated Potential Loss	
		Value	Percent (%) of Total
Communications	$776,797,683	$196,892	0.03%
Energy	$3,093,949,530	$425,985	0.01%
Food, Water, Shelter	$11,847,189,588	$3,313,261	0.03%
Hazardous Material	$436,474,800	$4,212	0.00%
Health and Medical	$4,606,713,364	$1,334,965	0.03%
Safety and Security	$38,164,188,232	$51,399,655	0.13%
Transportation Services	$2,039,091,600	$1,483,104	0.07%
Additional Critical Facilities	$447,698,794	$323,458	0.07%
Total	**$61,412,103,591**	**$58,481,531**	**0.10%**

Source: Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020; United States Geological Survey 2013, Hazus v5.1

Table F-18 summarizes the number of miles of State roads located on NEHRP soil types D and E, organized by county.

Table F-18. State Road Exposure to NEHRP Soil Types D and E by County

State Route	Length (in miles)						
	Total Length	Length in NEHRP Type D Soil	Exposed Length as % of Total Length	Length in NEHRP Type E Soil	Exposed Length as % of Total Length	NEHRP Type D & E Soil Hazard Area	Exposed Length as % of Total Length
County of Kaua'i							
State Route 50	32.89242	0	0.00%	0.0	0.0%	0	0.00%
State Route 51	3.457222	0	0.00%	0.0	0.0%	0	0.00%
State Route 56	28.316299	0	0.00%	0.0	0.0%	0	0.00%
State Route 58	2.052085	0	0.00%	0.0	0.0%	0	0.00%
State Route 540	3.884869	0	0.00%	0.0	0.0%	0	0.00%
State Route 541	0.37465	0	0.00%	0.0	0.0%	0	0.00%
State Route 550	14.03193	0	0.00%	0.0	0.0%	0	0.00%
State Route 560	9.98938	0	0.00%	0.0	0.0%	0	0.00%
State Route 570	1.125605	0	0.00%	0.0	0.0%	0	0.00%
State Route 580	6.668581	0	0.00%	0.0	0.0%	0	0.00%
State Route 583	0.921237	0	0.00%	0.0	0.0%	0	0.00%
Total	**103.714278**	**0**	**0.00%**	**0.0**	**0.0%**	**0**	**0.00%**
City and County of Honolulu							
State Route 61	21.173569	0	0.00%	0.0	0.0%	0	0.00%
State Route 63	16.618809	0	0.00%	0.0	0.0%	0	0.00%
State Route 64	2.624714	0	0.00%	0.0	0.0%	0	0.00%
State Route 65	6.584201	0	0.00%	0.0	0.0%	0	0.00%

State Route	Length (in miles)						
	Total Length	Length in NEHRP Type D Soil	Exposed Length as % of Total Length	Length in NEHRP Type E Soil	Exposed Length as % of Total Length	NEHRP Type D & E Soil Hazard Area	Exposed Length as % of Total Length
State Route 72	22.766927	0	0.00%	0.0	0.0%	0	0.00%
State Route 76	11.059837	0	0.00%	0.0	0.0%	0	0.00%
State Route 78	1.346173	0	0.00%	0.0	0.0%	0	0.00%
State Route 80	1.893686	0	0.00%	0.0	0.0%	0	0.00%
State Route 83	47.821595	0	0.00%	0.0	0.0%	0	0.00%
State Route 92	18.685552	0	0.00%	0.0	0.0%	0	0.00%
State Route 93	19.522013	0	0.00%	0.0	0.0%	0	0.00%
State Route 98	3.470599	0	0.00%	0.0	0.0%	0	0.00%
State Route 99	41.120805	0	0.00%	0.0	0.0%	0	0.00%
State Route 750	8.056213	0	0.00%	0.0	0.0%	0	0.00%
State Route 901	1.403364	0	0.00%	0.0	0.0%	0	0.00%
State Route 930	10.054945	0	0.00%	0.0	0.0%	0	0.00%
State Route 7012	1.862959	0	0.00%	0.0	0.0%	0	0.00%
State Route 7101	5.865258	0	0.00%	0.0	0.0%	0	0.00%
State Route 7110	0.609843	0	0.00%	0.0	0.0%	0	0.00%
State Route 7141	1.50208	0	0.00%	0.0	0.0%	0	0.00%
State Route 7210	0.115075	0	0.00%	0.0	0.0%	0	0.00%
State Route 7239	0.338737	0	0.00%	0.0	0.0%	0	0.00%
State Route 7241	2.331816	0	0.00%	0.0	0.0%	0	0.00%
State Route 7310	1.041137	0	0.00%	0.0	0.0%	0	0.00%
State Route 7345	0.554715	0	0.00%	0.0	0.0%	0	0.00%
State Route 7350	0.597196	0	0.00%	0.0	0.0%	0	0.00%
State Route 7351	0.243914	0	0.00%	0.0	0.0%	0	0.00%
State Route 7401	0.214056	0	0.00%	0.0	0.0%	0	0.00%
State Route 7413	0.352495	0	0.00%	0.0	0.0%	0	0.00%
State Route 7415	0.536255	0	0.00%	0.0	0.0%	0	0.00%
State Route 7526	0.397834	0	0.00%	0.0	0.0%	0	0.00%
State Route 7601	0.432591	0	0.00%	0.0	0.0%	0	0.00%
State Route 7801	1.151651	0	0.00%	0.0	0.0%	0	0.00%
State Route 8300	0.501274	0	0.00%	0.0	0.0%	0	0.00%
State Route 8918	0.13352	0	0.00%	0.0	0.0%	0	0.00%
State Route 8930	4.941677	0	0.00%	0.0	0.0%	0	0.00%
State Route 8940	3.321223	0	0.00%	0.0	0.0%	0	0.00%
State Route 8945	0.984948	0	0.00%	0.0	0.0%	0	0.00%
State Route 8955	2.697864	0	0.00%	0.0	0.0%	0	0.00%
State Route H-1	54.2852	0	0.00%	0.0	0.0%	0	0.00%
State Route H-2	16.631646	0	0.00%	0.0	0.0%	0	0.00%
State Route H-201	8.479473	0	0.00%	0.0	0.0%	0	0.00%

State Route	Length (in miles)						
	Total Length	Length in NEHRP Type D Soil	Exposed Length as % of Total Length	Length in NEHRP Type E Soil	Exposed Length as % of Total Length	NEHRP Type D & E Soil Hazard Area	Exposed Length as % of Total Length
State Route H-3	30.593733	0	0.00%	0.0	0.0%	0	0.00%
Total	**374.921172**	**0**	**0.00%**	**0.0**	**0.0%**	**0**	**0.00%**
County of Maui							
State Route 30	41.599628	20.88681	50.21%	0.0	0.0%	20.88681	50.21%
State Route 31	7.147053	1.835538	25.68%	0.0	0.0%	1.835538	25.68%
State Route 32	2.855291	2.855291	100.00%	0.0	0.0%	2.855291	100.00%
State Route 36	16.225414	2.32542	14.33%	0.0	0.0%	2.32542	14.33%
State Route 37	21.33757	0.065403	0.31%	0.0	0.0%	0.065403	0.31%
State Route 310	3.609294	3.609294	100.00%	0.0	0.0%	3.609294	100.00%
State Route 311	6.415815	5.203529	81.10%	0.0	0.0%	5.203529	81.10%
State Route 340	4.265623	2.51029	58.85%	0.0	0.0%	2.51029	58.85%
State Route 360	34.838612	1.145617	3.29%	0.0	0.0%	1.145617	3.29%
State Route 377	9.136002	0.06717	0.74%	0.0	0.0%	0.06717	0.74%
State Route 378	10.082808	0.148269	1.47%	0.0	0.0%	0.148269	1.47%
State Route 380	6.197863	6.197863	100.00%	0.0	0.0%	6.197863	100.00%
State Route 440	13.153636	2.966894	22.56%	0.0	0.0%	2.966894	22.56%
State Route 441	0.476716	0	0.00%	0.0	0.0%	0	0.00%
State Route 442	0.022862	0	0.00%	0.0	0.0%	0	0.00%
State Route 450	27.477007	20.375919	74.16%	0.0	0.0%	20.375919	74.16%
State Route 460	16.534641	3.971464	24.02%	0.0	0.0%	3.971464	24.02%
State Route 470	10.74695	0	0.00%	0.0	0.0%	0	0.00%
State Route 480	5.898639	0	0.00%	0.0	0.0%	0	0.00%
State Route 3000	2.346263	0.846656	36.09%	0.0	0.0%	0.846656	36.09%
State Route 3400	2.635502	2.635502	100.00%	0.0	0.0%	2.635502	100.00%
State Route 3500	1.125483	1.125483	100.00%	0.0	0.0%	1.125483	100.00%
State Route 3800	0.625243	0.554144	88.63%	0.0	0.0%	0.554144	88.63%
State Route 32A	0.400435	0.400435	100.00%	0.0	0.0%	0.400435	100.00%
State Route 32B	0.172196	0.172186	99.99%	0.0	0.0%	0.172186	99.99%
State Route 36A	0.526104	0.526104	100.00%	0.0	0.0%	0.526104	100.00%
Total	**245.85265**	**80.425281**	**32.71%**	0.0	0.0%	**80.425281**	**32.71%**
County of Hawaiʻi							
State Route 11	117.608086	1.909226	1.62%	0.0	0.0%	1.909226	1.62%
State Route 19	93.300605	1.879939	2.01%	0.0	0.0%	1.879939	2.01%
State Route 130	21.68728	0	0.00%	0.0	0.0%	0	0.00%
State Route 139	1.197816	0	0.00%	0.0	0.0%	0	0.00%
State Route 160	3.821277	0	0.00%	0.0	0.0%	0	0.00%
State Route 163	0.133863	0	0.00%	0.0	0.0%	0	0.00%
State Route 190	34.085758	0	0.00%	0.0	0.0%	0	0.00%

State Route	Length (in miles)						
	Total Length	Length in NEHRP Type D Soil	Exposed Length as % of Total Length	Length in NEHRP Type E Soil	Exposed Length as % of Total Length	NEHRP Type D & E Soil Hazard Area	Exposed Length as % of Total Length
State Route 197	1.17843	0	0.00%	0.0	0.0%	0	0.00%
State Route 200	43.219679	8.119068	18.79%	0.0	0.0%	8.119068	18.79%
State Route 220	3.754068	0	0.00%	0.0	0.0%	0	0.00%
State Route 240	9.601941	0	0.00%	0.0	0.0%	0	0.00%
State Route 250	19.266672	0	0.00%	0.174809	0.91%	0.174809	0.91%
State Route 270	27.020618	0.650338	2.41%	0.0	0.0%	0.650338	2.41%
State Route 1370	0.191175	0	0.00%	0.0	0.0%	0	0.00%
State Route 1970	0.923307	0	0.00%	0.0	0.0%	0	0.00%
State Route 2000	2.184464	0	0.00%	0.0	0.0%	0	0.00%
Total	379.175039	12.558571	3.31%	0.2	0.0%	12.73338	3.36%

Source: *State of Hawaii Department of Transportation 2022; AECOM 2008; United States Geological Survey*
Notes: *The County of Kaua'i and the City and County of Honolulu do not have spatially delineated NEHRP soils available for this analysis.*

Table F-19 shows the square miles of NEHRP Soil Types D and E in each State Land Use District in each county.

Table F-19. Area of State Land Use Districts on NEHRP Class D and E Soils

Land Use District	Area (in square miles)			
	Total Square Miles	Square Miles on NEHRP Type D & E Soils	Square Miles on NEHRP Type D & E Soils as Percent (%) of Total Area	Square Miles on NEHRP Type D & E Soils as Percent (%) of Total Hazard Exposure
City and County of Honolulu				
Agricultural	637.731138	64.679352	10.14%	56.68%
Conservation	552.35574	26.32655	4.77%	23.07%
Rural	12.824585	3.342811	26.07%	2.93%
Urban	45.187433	19.756157	43.72%	17.31%
Total	**1,248**	**114.10487**	**9.14%**	**100.00%**
County of Hawai'i				
Agricultural	1,850.31	53.777899	2.91%	41.33%
Conservation	2,098.66	74.143346	3.53%	56.99%
Rural	1.36344	0.00594	0.44%	0.00%
Urban	87.847736	2.180574	2.48%	1.68%
Total	4,038	130.107759	3.22%	100.00%

Source: *State Land Use Commission, Hawaii Statewide GIS Program 2021; Honolulu County GIS 2022; AECOM 2008; United States Geological Survey*

F.7 Flood

F.7.1 CHRONIC COASTAL FLOOD

Table F-20 summarizes the number of miles of State roads located in the SFHA, organized by county.

Table F-20. State Road Exposure to the Chronic Coastal Flood Hazard Area by County

State Route	Length (in miles)		
	Total Length	Chronic Coastal Flooding Hazard Area Length	Exposed Length as % of Total Length
County of Kauaʻi			
State Route 50	32.89242	1.991849	6.06%
State Route 51	3.457222	0.019938	0.58%
State Route 56	28.316299	0.289864	1.02%
State Route 58	2.052085	0	0.00%
State Route 540	3.884869	0	0.00%
State Route 541	0.37465	0	0.00%
State Route 550	14.03193	0	0.00%
State Route 560	9.98938	1.431079	14.33%
State Route 570	1.125605	0	0.00%
State Route 580	6.668581	0.008347	0.13%
State Route 583	0.921237	0	0.00%
Total	103.714278	3.741077	3.61%
City and County of Honolulu			
State Route 61	21.173569	0.019234	0.09%
State Route 63	16.618809	0	0.00%
State Route 64	2.624714	0.116064	4.42%
State Route 65	6.584201	0	0.00%
State Route 72	22.766927	0.552122	2.43%
State Route 76	11.059837	0.003199	0.03%
State Route 78	1.346173	0	0.00%
State Route 80	1.893686	0	0.00%
State Route 83	47.821595	3.72413	7.79%
State Route 92	18.685552	0.374774	2.01%
State Route 93	19.522013	0.988107	5.06%
State Route 98	3.470599	0.031178	0.90%
State Route 99	41.120805	0.09529	0.23%
State Route 750	8.056213	0	0.00%
State Route 901	1.403364	0	0.00%
State Route 930	10.054945	0.12444	1.24%
State Route 7012	1.862959	0	0.00%
State Route 7101	5.865258	0.029919	0.51%

State Route	Length (in miles)		
	Total Length	Chronic Coastal Flooding Hazard Area Length	Exposed Length as % of Total Length
State Route 7110	0.609843	0	0.00%
State Route 7141	1.50208	0	0.00%
State Route 7210	0.115075	0	0.00%
State Route 7239	0.338737	0	0.00%
State Route 7241	2.331816	0.007428	0.32%
State Route 7310	1.041137	0	0.00%
State Route 7345	0.554715	0	0.00%
State Route 7350	0.597196	0	0.00%
State Route 7351	0.243914	0	0.00%
State Route 7401	0.214056	0.044232	20.66%
State Route 7413	0.352495	0	0.00%
State Route 7415	0.536255	0	0.00%
State Route 7526	0.397834	0	0.00%
State Route 7601	0.432591	0	0.00%
State Route 7801	1.151651	0	0.00%
State Route 8300	0.501274	0.013861	2.77%
State Route 8918	0.13352	0	0.00%
State Route 8930	4.941677	0	0.00%
State Route 8940	3.321223	0	0.00%
State Route 8945	0.984948	0	0.00%
State Route 8955	2.697864	0	0.00%
State Route H-1	54.2852	0.218541	0.40%
State Route H-2	16.631646	0	0.00%
State Route H-201	8.479473	0.021757	0.26%
State Route H-3	30.593733	0.01579	0.05%
Total	374.921172	6.380066	1.70%
County of Maui			
State Route 30	41.599628	3.468854	8.34%
State Route 31	7.147053	0	0.00%
State Route 32	2.855291	0	0.00%
State Route 36	16.225414	0.026017	0.16%
State Route 37	21.33757	0	0.00%
State Route 310	3.609294	0.801981	22.22%
State Route 311	6.415815	0	0.00%
State Route 340	4.265623	0	0.00%
State Route 360	34.838612	0	0.00%
State Route 377	9.136002	0	0.00%
State Route 378	10.082808	0	0.00%
State Route 380	6.197863	0	0.00%

State Route	Length (in miles)		
	Total Length	Chronic Coastal Flooding Hazard Area Length	Exposed Length as % of Total Length
State Route 440	13.153636	0	0.00%
State Route 441	0.476716	0	0.00%
State Route 442	0.022862	0	0.00%
State Route 450	27.477007	0.006653	0.02%
State Route 460	16.534641	0.008827	0.05%
State Route 470	10.74695	0	0.00%
State Route 480	5.898639	0	0.00%
State Route 3000	2.346263	0	0.00%
State Route 3400	2.635502	0.376556	14.29%
State Route 3500	1.125483	0	0.00%
State Route 3800	0.625243	0	0.00%
State Route 32A	0.400435	0	0.00%
State Route 32B	0.172196	0	0.00%
State Route 36A	0.526104	0	0.00%
Total	245.85265	4.688888	1.91%
County of Hawaiʻi			
State Route 11	117.608086	0	0.00%
State Route 19	93.300605	0.194483	0.21%
State Route 130	21.68728	0	0.00%
State Route 139	1.197816	0	0.00%
State Route 160	3.821277	0	0.00%
State Route 163	0.133863	0	0.00%
State Route 190	34.085758	0	0.00%
State Route 197	1.17843	0	0.00%
State Route 200	43.219679	0	0.00%
State Route 220	3.754068	0	0.00%
State Route 240	9.601941	0	0.00%
State Route 250	19.266672	0	0.00%
State Route 270	27.020618	0	0.00%
State Route 1370	0.191175	0	0.00%
State Route 1970	0.923307	0	0.00%
State Route 2000	2.184464	0	0.00%
Total	379.175039	0.194483	0.05%

Source: State of Hawaii Department of Transportation 2022; Hawai'i Climate Change Mitigation and Adaptation Commission 2017

Table F-21 shows the square miles of the chronic coastal flood hazard area (SLR-XA-1.1) in each State Land Use District in each county.

Table F-21. State Land Use Districts in the Chronic Coastal Flood Hazard Area by County

Land Use District	Area (in square miles)			
	Total Square Miles	Square Miles in Chronic Coastal Flood Hazard Area	Hazard Area as Percent (%) of Total Area	Hazard Area as Percent (%) of Total Hazard Exposure
County of Kauaʻi				
Agricultural	297.078539	1.955746	0.66%	43.39%
Conservation	304.260357	1.805303	0.59%	40.05%
Rural	2.146976	0.008052	0.38%	0.18%
Urban	23.643203	0.738555	3.12%	16.38%
Total	627.129075	4.507656	0.72%	100.00%
City and County of Honolulu				
Agricultural	188.479146	0.63963	0.34%	10.67%
Conservation	247.601978	2.551735	1.03%	42.57%
Rural	0	0	0.00%	0
Urban	162.455059	2.802986	1.73%	46.76%
Total	598.536183	5.994351	1.00%	100.00%
County of Maui				
Agricultural	637.731138	0.313962	0.05%	6.40%
Conservation	552.35574	3.116214	0.56%	63.54%
Rural	12.824585	0.22841	1.78%	4.66%
Urban	45.187433	1.245985	2.76%	25.40%
Total	1,248	4.904571	0.39%	100.00%
County of Hawaiʻi				
Agricultural	1,850.31	0.078357	0.00%	2.32%
Conservation	2,098.66	2.811525	0.13%	83.25%
Rural	1.36344	0.003763	0.28%	0.11%
Urban	87.847736	0.483611	0.55%	14.32%
Total	4,038	3.377256	0.08%	100.00%

Source: State Land Use Commission, Hawaii Statewide GIS Program 2021; Hawai'i Climate Change Mitigation and Adaptation Commission 2017

F.7.2 EVENT-BASED FLOOD

Table F-22 summarizes the State buildings located in the 1% annual chance flood A-Zone and estimated potential losses by county.

Table F-22. State Buildings Exposure and Potential Losses to 1% Annual Chance Flood A-Zone Hazard Areas

County	Number of State Buildings in the A-Zone	Total Value of State Buildings in the A-Zone	Estimated Potential Loss	
			Value	Percent (%) of Total
County of Kauaʻi	80	$126,182,385	$8,495,647	6.73%
City and County of Honolulu	251	$602,961,198	$70,169,830	11.64%
County of Maui	32	$125,192,806	0	0.00%
County of Hawaiʻi	29	$39,912,701	$998,700	2.50%
Total	**392**	**$894,249,090**	**$79,664,176**	**8.91%**

Source: FEMA Map Service Center 2021; State of Hawaii Risk Management Office 2017; FEMA Hazus v5.1

Table F-23 summarizes the total length of State roads exposure to the A-Zone and V-Zones by county.

Table F-23. State Road Exposure to the 1% Annual Chance Flood Event by County

County	Length (in miles)				
	Total Length	A-Zone Flood Hazard Area Length	Hazard Length as % of Total Length	V-Zone Flood Hazard Area Length	Hazard Length as % of Total Length
County of Kauaʻi	103.7	11.6779	11.26%	3.86866	3.73%
City and County of Honolulu	374.9	36.669053	9.78%	8.320804	2.22%
County of Maui	245.9	15.841237	6.44%	4.851483	1.97%
County of Hawaiʻi	379.2	3.315361	0.87%	1.088591	0.29%
Total	**1,103.70**	**67.503551**	**6.12%**	**18.129538**	**1.64%**

Source: State of Hawaii Department of Transportation 2022; FEMA Map Service Center 2021

Table F-24 summarizes the number of miles of State roads by state route located in the A-Zones, V-Zones, and SFHA, organized by county.

Table F-24. State Road Exposure to the 1% Annual Chance Flood Event by State Route

State Route	Length (in miles)						
	Total Length	Length in the A-Zone	Exposed Length as % of Total Length	Length in the V-Zone	Exposed Length as % of Total Length	Length in the SFHA	Exposed Length as % of Total Length
County of Kauaʻi							
State Route 50	32.89242	5.803111	17.64%	0.639131	1.94%	6.442242	19.59%
State Route 51	3.457222	0.252486	7.30%	0	0.00%	0.252486	7.30%
State Route 56	28.316299	2.040602	7.21%	0.066556	0.24%	2.107158	7.44%
State Route 58	2.052085	0	0.00%	0	0.00%	0	0.00%
State Route 540	3.884869	0	0.00%	0	0.00%	0	0.00%
State Route 541	0.37465	0	0.00%	0	0.00%	0	0.00%
State Route 550	14.03193	0	0.00%	0	0.00%	0	0.00%
State Route 560	9.98938	2.938389	29.42%	3.162972	31.66%	6.101361	61.08%
State Route 570	1.125605	0	0.00%	0	0.00%	0	0.00%
State Route 580	6.668581	0.622327	9.33%	0	0.00%	0.622327	9.33%
State Route 583	0.921237	0.020985	2.28%	0	0.00%	0.020985	2.28%
Total	**103.714278**	**11.6779**	**11.26%**	**3.868659**	**3.73%**	**15.546559**	**14.99%**
City and County of Honolulu							
State Route 61	21.173569	0.046397	0.22%	0	0.00%	0.046397	0.22%
State Route 63	16.618809	0.05199	0.31%	0	0.00%	0.05199	0.31%
State Route 64	2.624714	0.68192	25.98%	0.133898	5.10%	0.815817	31.08%
State Route 65	6.584201	0.028755	0.44%	0	0.00%	0.028755	0.44%
State Route 72	22.766927	5.659284	24.86%	0.078003	0.34%	5.737287	25.20%
State Route 76	11.059837	0.577192	5.22%	0	0.00%	0.577192	5.22%
State Route 78	1.346173	0	0.00%	0	0.00%	0	0.00%
State Route 80	1.893686	0	0.00%	0	0.00%	0	0.00%
State Route 83	47.821595	11.039649	23.09%	6.458983	13.51%	17.498634	36.59%

State Route	Length (in miles)						
	Total Length	Length in the A-Zone	Exposed Length as % of Total Length	Length in the V-Zone	Exposed Length as % of Total Length	Length in the SFHA	Exposed Length as % of Total Length
State Route 92	18.685552	6.154198	32.94%	0	0.00%	6.154198	32.94%
State Route 93	19.522013	3.427372	17.56%	1.64992	8.45%	5.077291	26.01%
State Route 98	3.470599	0	0.00%	0	0.00%	0	0.00%
State Route 99	41.120805	0.528811	1.29%	0	0.00%	0.528811	1.29%
State Route 750	8.056213	0	0.00%	0	0.00%	0	0.00%
State Route 901	1.403364	0	0.00%	0	0.00%	0	0.00%
State Route 930	10.054945	3.475214	34.56%	0	0.00%	3.475214	34.56%
State Route 7012	1.862959	0	0.00%	0	0.00%	0	0.00%
State Route 7101	5.865258	1.418178	24.18%	0	0.00%	1.418178	24.18%
State Route 7110	0.609843	0.017205	2.82%	0	0.00%	0.017205	2.82%
State Route 7141	1.50208	0	0.00%	0	0.00%	0	0.00%
State Route 7210	0.115075	0	0.00%	0	0.00%	0	0.00%
State Route 7239	0.338737	0	0.00%	0	0.00%	0	0.00%
State Route 7241	2.331816	0	0.00%	0	0.00%	0	0.00%
State Route 7310	1.041137	0	0.00%	0	0.00%	0	0.00%
State Route 7345	0.554715	0.131555	23.72%	0	0.00%	0.131555	23.72%
State Route 7350	0.597196	0	0.00%	0	0.00%	0	0.00%
State Route 7351	0.243914	0	0.00%	0	0.00%	0	0.00%
State Route 7401	0.214056	0.214056	100.00%	0	0.00%	0.214056	100.00%
State Route 7413	0.352495	0	0.00%	0	0.00%	0	0.00%
State Route 7415	0.536255	0.147137	27.44%	0	0.00%	0.147137	27.44%
State Route 7526	0.397834	0	0.00%	0	0.00%	0	0.00%
State Route 7601	0.432591	0.112353	25.97%	0	0.00%	0.112353	25.97%
State Route 7801	1.151651	0	0.00%	0	0.00%	0	0.00%
State Route 8300	0.501274	0.137937	27.52%	0	0.00%	0.137937	27.52%
State Route 8918	0.13352	0	0.00%	0	0.00%	0	0.00%
State Route 8930	4.941677	0.057234	1.16%	0	0.00%	0.057234	1.16%
State Route 8940	3.321223	0	0.00%	0	0.00%	0	0.00%
State Route 8945	0.984948	0	0.00%	0	0.00%	0	0.00%
State Route 8955	2.697864	0	0.00%	0	0.00%	0	0.00%
State Route H-1	54.2852	2.290425	4.22%	0	0.00%	2.290425	4.22%
State Route H-2	16.631646	0.083714	0.50%	0	0.00%	0.083714	0.50%
State Route H-201	8.479473	0.248242	2.93%	0	0.00%	0.248242	2.93%
State Route H-3	30.593733	0.140233	0.46%	0	0.00%	0.140233	0.46%
Total	**374.921172**	**36.669051**	**9.78%**	**8.320804**	**2.22%**	**44.989855**	**12.00%**
County of Maui							
State Route 30	41.599628	1.826108	4.39%	0.750982	1.81%	2.57709	6.19%
State Route 31	7.147053	0.374025	5.23%	0	0.00%	0.374025	5.23%

State Route	Length (in miles)						
	Total Length	Length in the A-Zone	Exposed Length as % of Total Length	Length in the V-Zone	Exposed Length as % of Total Length	Length in the SFHA	Exposed Length as % of Total Length
State Route 32	2.855291	0.198748	6.96%	0.266274	9.33%	0.465023	16.29%
State Route 36	16.225414	0.86868	5.35%	0.007046	0.04%	0.875725	5.40%
State Route 37	21.33757	0	0.00%	0	0.00%	0	0.00%
State Route 310	3.609294	0.506049	14.02%	1.779762	49.31%	2.285811	63.33%
State Route 311	6.415815	0.610825	9.52%	0	0.00%	0.610825	9.52%
State Route 340	4.265623	0.237162	5.56%	0	0.00%	0.237162	5.56%
State Route 360	34.838612	0.389633	1.12%	0.266775	0.77%	0.656409	1.88%
State Route 377	9.136002	0	0.00%	0	0.00%	0	0.00%
State Route 378	10.082808	0	0.00%	0	0.00%	0	0.00%
State Route 380	6.197863	0.008508	0.14%	0	0.00%	0.008508	0.14%
State Route 440	13.153636	0	0.00%	0	0.00%	0	0.00%
State Route 441	0.476716	0	0.00%	0	0.00%	0	0.00%
State Route 442	0.022862	0	0.00%	0	0.00%	0	0.00%
State Route 450	27.477007	9.459703	34.43%	0.472208	1.72%	9.931911	36.15%
State Route 460	16.534641	1.081467	6.54%	0.004833	0.03%	1.0863	6.57%
State Route 470	10.74695	0	0.00%	0	0.00%	0	0.00%
State Route 480	5.898639	0	0.00%	0	0.00%	0	0.00%
State Route 3000	2.346263	0.026487	1.13%	0	0.00%	0.026487	1.13%
State Route 3400	2.635502	0.09653	3.66%	0.98459	37.36%	1.08112	41.02%
State Route 3500	1.125483	0.065402	5.81%	0.029741	2.64%	0.095143	8.45%
State Route 3800	0.625243	0	0.00%	0	0.00%	0	0.00%
State Route 32A	0.400435	0.08587	21.44%	0.123114	30.75%	0.208985	52.19%
State Route 32B	0.172196	0.006039	3.51%	0.166157	96.49%	0.172196	100.00%
State Route 36A	0.526104		0.00%	0	0.00%	0	0.00%
Total	**245.85265**	**15.841236**	**6.44%**	**4.851482**	**30.63%**	**20.69272**	**8.42%**
County of Hawaiʻi							
State Route 11	117.608086	1.011829	0.86%	0	0.00%	1.011829	0.86%
State Route 19	93.300605	1.40357	1.50%	1.088591	1.17%	2.49216	2.67%
State Route 130	21.68728	0	0.00%	0	0.00%	0	0.00%
State Route 139	1.197816	0	0.00%	0	0.00%	0	0.00%
State Route 160	3.821277	0.15051	3.94%	0	0.00%	0.15051	3.94%
State Route 163	0.133863	0.000634	0.47%	0	0.00%	0.000634	0.47%
State Route 190	34.085758	0	0.00%	0	0.00%	0	0.00%
State Route 197	1.17843	0	0.00%	0	0.00%	0	0.00%
State Route 200	43.219679	0	0.00%	0	0.00%	0	0.00%
State Route 220	3.754068	0	0.00%	0	0.00%	0	0.00%
State Route 240	9.601941	0.215562	2.24%	0	0.00%	0.215562	2.24%
State Route 250	19.266672	0.254446	1.32%	0	0.00%	0.254446	1.32%

State Route	Length (in miles)						
	Total Length	Length in the A-Zone	Exposed Length as % of Total Length	Length in the V-Zone	Exposed Length as % of Total Length	Length in the SFHA	Exposed Length as % of Total Length
State Route 270	27.020618	0.038042	0.14%	0	0.00%	0.038042	0.14%
State Route 1370	0.191175	0.175693	91.90%	0	0.00%	0.175693	91.90%
State Route 1970	0.923307	0	0.00%	0	0.00%	0	0.00%
State Route 2000	2.184464	0.065077	2.98%	0	0.00%	0.065077	2.98%
Total	379.175039	3.315363	0.87%	1.088591	0.29%	4.403953	1.16%

Source: State of Hawaii Department of Transportation 2022; FEMA Map Service Center 2021

Table F-25 and Table F-26 summarize the population located in the A-Zone and V-Zones by county.

Table F-25. 2020 U.S. Census Population Located in the A-Zone by County

County	Population				
	Total Population	Population in the A-Zone	Population Exposed as Percent (%) of Total Population	Socially Vulnerable Population Located in Hazard Area	Population Exposed as Percent (%) of Total Population
County of Kaua'i	71,949	3,163	4.40%	156	0.22%
City and County of Honolulu	979,682	66,793	6.82%	11,029	1.13%
County of Maui	167,093	7,773	4.65%	858	0.51%
County of Hawai'i	201,350	4,308	2.14%	872	0.43%
Total	**1,420,074**	**82,036**	**5.78%**	**12,915**	**0.91%**

Source: U.S. Census Bureau 2020; Centers for Disease Control and Prevention 2018; FEMA Map Service Center 2021

Table F-26. 2020 U.S. Census Population Located in the V-Zone by County

County	Population				
	Total Population	Population in the V-Zone	Population Exposed as Percent (%) of Total Population	Socially Vulnerable Population Located in Hazard Area	Population Exposed as Percent (%) of Total Population
County of Kaua'i	71,949	363	0.50%	55	0.08%
City and County of Honolulu	979,682	6,918	0.71%	2,197	0.22%
County of Maui	167,093	1,433	0.86%	367	0.22%
County of Hawai'i	201,350	711	0.35%	266	0.13%
Total	**1,420,074**	**9,425**	**0.66%**	**2,884**	**0.20%**

Source: U.S. Census Bureau 2020; Centers for Disease Control and Prevention 2018; FEMA Map Service Center 2021

Table F-27 summarizes the general building stock exposure and estimated potential losses in the A-Zone from the 1% annual chance flood event.

Table F-27. General Building Stock Exposure and Potential Losses to Buildings in the A-Zone from the 1% Annual Chance Flood Event

County	Total Replacement Cost Value	Replacement Cost Value in the A-Zone	Percent (%) of Total in the A-Zone	Estimated Potential Loss	
				Replacement Cost Value	Percent (%) of Total
County of Kauaʻi	$24,246,497,228	$2,935,744,738	12.11%	$467,606,000	1.93%
City and County of Honolulu	$239,152,051,766	$23,784,708,757	9.95%	$1,265,913,000	0.53%
County of Maui	$50,796,693,140	$2,978,602,659	5.86%	$106,484,000	0.21%
County of Hawaiʻi	$58,395,349,136	$1,521,518,044	2.61%	$48,130,000	0.08%
Total	**$372,590,591,270**	**$31,220,574,198**	**8.38%**	**$1,888,133,000**	**0.51%**

Source: NIYAM IT 2022; United States Army Corps of Engineers 2022; FEMA Map Service Center 2021

Table F-28 summarizes the general building stock exposure and estimated potential losses in the V-Zone from the 1% annual chance flood event.

Table F-28. General Building Stock Exposure and Potential Losses to Buildings in the V-Zone from the 1% Annual Chance Flood Event

County	Total Replacement Cost Value	Replacement Cost Value in the V-Zone	Percent (%) of Total in the V-Zone	Estimated Potential Loss	
				Replacement Cost Value	Percent (%) of Total
County of Kauaʻi	$24,246,497,228	$470,963,159	1.94%	$107,754,000	0.44%
City and County of Honolulu	$239,152,051,766	$1,132,348,207	0.47%	$73,291,000	0.03%
County of Maui	$50,796,693,140	$1,328,441,033	2.62%	$134,247,000	0.26%
County of Hawaiʻi	$58,395,349,136	$799,981,884	1.37%	$43,949,000	0.08%
Total	**$372,590,591,270**	**$3,731,734,282**	**1.00%**	**$359,241,000**	**0.10%**

Source: NIYAM IT 2022; United States Army Corps of Engineers 2022; FEMA Map Service Center 2021

Table F-29 shows the square miles of the SFHA (total SFHA, A-Zones and V-Zones) in each State Land Use District in each county.

Table F-29. State Land Use Districts Located in the SFHA

Land Use District	Area (in square miles)									
	Total Square Miles	Square Miles in A-Zone Hazard Area	Hazard Area as % of Total Area	Hazard Area as % of Total Hazard Exposure	Square Miles in V-Zone Hazard Area	Hazard Area as % of Total Area	Hazard Area as % of Total Hazard Exposure	Square Miles in SFHA Hazard Area	Hazard Area as % of Total Area	Hazard Area as % of Total Hazard Exposure
County of Kaua'i										
Agricultural	297.078539	11.573782	3.90%	68.93%	0.452032	0.15%	11.04%	12.025813	4.05%	57.58%
Conservation	304.260357	2.244024	0.74%	13.37%	2.701255	0.89%	65.97%	4.945279	1.63%	23.68%
Rural	2.146976	0.495891	23.10%	2.95%	0.054126	2.52%	1.32%	0.550017	25.62%	2.63%
Urban	23.643203	2.476401	10.47%	14.75%	0.887384	3.75%	21.67%	3.363785	14.23%	16.11%
Total	627.129075	16.790098	2.68%	100.00%	4.094797	0.65%	100.00%	20.884894	3.33%	100.00%
City and County of Honolulu										
Agricultural	188.479146	7.521811	3.99%	32.37%	0.632025	0.34%	14.59%	8.153837	4.33%	29.58%
Conservation	247.601978	2.501441	1.01%	10.76%	0.790942	0.32%	18.26%	3.292382	1.33%	11.94%
Rural	0	0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%
Urban	162.455059	13.213823	8.13%	56.87%	2.90936	1.79%	67.15%	16.123183	9.92%	58.48%
Total	598.536183	23.237075	3.88%	100.00%	4.332327	0.72%	100.00%	27.569402	4.61%	100.00%
County of Maui										
Agricultural	637.731138	8.339142	1.31%	56.68%	0.695727	0.11%	7.38%	9.034869	1.42%	37.43%
Conservation	552.35574	2.697096	0.49%	18.33%	5.769304	1.04%	61.23%	8.466399	1.53%	35.08%
Rural	12.824585	0.863568	6.73%	5.87%	0.69879	5.45%	7.42%	1.562359	12.18%	6.47%
Urban	45.187433	2.813841	6.23%	19.12%	2.258934	5.00%	23.97%	5.072774	11.23%	21.02%
Total	1,248	14.713647	1.18%	100.00%	9.422755	0.75%	100.00%	24.136401	1.93%	100.00%
County of Hawai'i										
Agricultural	1,850.31	6.798008	0.37%	59.13%	0.840465	0.05%	9.12%	7.638472	0.41%	36.87%
Conservation	2,098.66	2.506877	0.12%	21.81%	6.318861	0.30%	68.54%	8.825738	0.42%	42.60%
Rural	1.36344	0.010702	0.78%	0.09%	0	0.00%	0.00%	0.010702	0.78%	0.05%
Urban	87.847736	2.181132	2.48%	18.97%	2.059405	2.34%	22.34%	4.240537	4.83%	20.47%
Total	4,038	11.496719	0.28%	100.00%	9.218731	0.23%	100.00%	20.715449	0.51%	100.00%

Source: *FEMA Map Service Center 2021; State Land Use Commission, Hawaii Statewide GIS Program 2021; Honolulu County GIS 2022*

F.8 Hazardous Materials

There are no additional tables to support Section 4.7 (Hazardous Materials).

F.9 Health Risks

There are no additional tables to support Section 4.8 (Health Risks).

F.10 Hurricane

F.10.1 STATE BUILDINGS

Table F-30 through Table F-32 show the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) Model data for each Hurricane Category (Cat) 1 through 3 concerning State buildings exposure by county. Table F-33 through Table F-35 show the Hurricane Cat 1 through 3 storm surge SLOSH Inundation areas results by state agency.

Table F-30. State Buildings Located in the Category 1 SLOSH Inundation Area by County

County	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in the Cat 1 SLOSH	Percent (%) of Total Buildings	Total Value of State Buildings in the Cat 1 SLOSH	Percent (%) of Total Value
County of Kauaʻi	531	$990,850,824	10	1.88%	$24,359,606	2.46%
City and County of Honolulu	3,472	$17,393,945,915	158	4.55%	$1,286,465,159	7.40%
County of Maui	831	$3,097,491,689	5	0.60%	$13,872,321	0.45%
County of Hawaiʻi	1,261	$4,638,567,141	0	0.00%	$0	0.00%
Total	**6,095**	**$26,120,855,568**	**173**	**2.84%**	**$1,324,697,085**	**5.07%**

Source: Federal Emergency Management Agency; National Weather Service; National Oceanic and Atmospheric Administration; State of Hawaii Risk Management Office 2017

Table F-31. State Buildings Located in the Category 2 SLOSH Inundation Area by County

County	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in the Cat 2 SLOSH	Percent (%) of Total Buildings	Total Value of State Buildings in the Cat 2 SLOSH	Percent (%) of Total Value
County of Kauaʻi	531	$990,850,824	12	2.26%	$26,776,217	2.70%
City and County of Honolulu	3,472	$17,393,945,915	215	6.19%	$1,574,581,471	9.05%
County of Maui	831	$3,097,491,689	35	4.21%	$55,394,451	1.79%
County of Hawaiʻi	1,261	$4,638,567,141	6	0.48%	$3,050,000	0.07%
Total	**6,095**	**$26,120,855,568**	**268**	**4.40%**	**$1,659,802,139**	**6.35%**

Source: Federal Emergency Management Agency; National Weather Service; National Oceanic and Atmospheric Administration; State of Hawaii Risk Management Office 2017

Table F-32. State Buildings Located in the Category 3 SLOSH Inundation Area by County

County	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in the Cat 3 SLOSH	Percent (%) of Total Buildings	Total Value of State Buildings in the Cat 3 SLOSH	Percent (%) of Total Value
County of Kaua'i	531	$990,850,824	34	6.40%	$133,107,021	13.43%
City and County of Honolulu	3,472	$17,393,945,915	347	9.99%	$2,485,357,632	14.29%
County of Maui	831	$3,097,491,689	47	5.66%	$168,614,605	5.44%
County of Hawai'i	1,261	$4,638,567,141	14	1.11%	$81,047,470	1.75%
Total	**6,095**	**$26,120,855,568**	**442**	**7.25%**	**$2,868,126,728**	**10.98%**

Source: *Federal Emergency Management Agency; National Weather Service; National Oceanic and Atmospheric Administration; State of Hawaii Risk Management Office 2017*

Table F-33. State Buildings Located in the Category 1 SLOSH Inundation Area by Agency

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in the Cat 1 SLOSH	Percent (%) of Total Buildings	Total Value of State Buildings in the Cat 1 SLOSH	Percent (%) of Total Value
Dept. of Accounting & General Services	66	$953,963,738	5	7.58%	$45,183,897	4.74%
Dept. of Agriculture	70	$147,607,399	0	0.00%	$0	0.00%
Dept. of Attorney General	15	$108,425,480	2	13.33%	$16,180,875	14.92%
Dept. of Budget & Finance	16	$28,968,679	1	6.25%	$4,806,631	16.59%
Dept. of Business, Economic Development and Tourism	25	$645,480,379	4	16.00%	$549,663,751	85.16%
Dept. of Commerce & Consumer Affairs	2	$40,197,360	0	0.00%	$0	0.00%
Dept. of Defense	69	$267,352,836	7	10.14%	$20,849,967	7.80%
Dept. of Education	4,090	$10,598,205,739	86	2.10%	$209,317,922	1.98%
Dept. of Hawaiian Home Lands	12	$110,427,352	1	8.33%	$5,489,080	4.97%
Dept. of Health	44	$387,068,440	2	4.55%	$6,599,918	1.71%
Dept. of Human Resources Development	1	$5,973,872	0	0.00%	$0	0.00%
Dept. of Human Services	130	$480,212,294	20	15.38%	$163,442,617	34.04%
Dept. of Labor and Industrial Relations	22	$90,076,209	0	0.00%	$0	0.00%
Dept. of Land and Natural Resources	90	$101,441,821	17	18.89%	$4,244,180	4.18%
Dept. of Public Safety	154	$440,774,415	4	2.60%	$29,532,012	6.70%

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in the Cat 1 SLOSH	Percent (%) of Total Buildings	Total Value of State Buildings in the Cat 1 SLOSH	Percent (%) of Total Value
Dept. of Taxation	1	$7,174,162	0	0.00%	$0	0.00%
Dept. of Transportation	68	$2,935,208,214	5	7.35%	$22,734,092	0.77%
Hawaiʻi State Ethics Commission	1	$984,533	0	0.00%	$0	0.00%
Hawaiʻi Health Systems Corporation	106	$1,230,852,871	0	0.00%	$0	0.00%
Hawaiʻi Housing Finance & Development Corporation	86	$360,851,671	5	5.81%	$118,247,972	32.77%
Hawaiʻi Public Housing Authority	273	$982,981,701	0	0.00%	$0	0.00%
Hawaiʻi State Legislature	2	$48,555,381	0	0.00%	$0	0.00%
Hawaiʻi State Public Library System	53	$525,584,082	5	9.43%	$10,023,473	1.91%
Judiciary	41	$534,877,354	4	9.76%	$71,970,923	13.46%
Legislative Reference Bureau	1	$2,996,162	0	0.00%	$0	0.00%
Office of Hawaiian Affairs	11	$54,125,645	2	18.18%	$16,400,000	30.30%
Office of the Auditor	2	$1,921,180	0	0.00%	$0	0.00%
Office of the Governor	1	$2,996,162	0	0.00%	$0	0.00%
Office of the Lieutenant Governor	2	$4,588,849	0	0.00%	$0	0.00%
Office of the Ombudsman	1	$1,818,060	0	0.00%	$0	0.00%
Research Corporation of the University of Hawaiʻi	3	$4,189,026	0	0.00%	$0	0.00%
University of Hawaiʻi	637	$5,014,974,503	3	0.47%	$30,009,776	0.60%
Total	**6,095**	**$26,120,855,568**	**173**	**2.84%**	**$1,279,513,188**	**4.90%**

Source: Federal Emergency Management Agency; National Weather Service; National Oceanic and Atmospheric Administration; State of Hawaii Risk Management Office 2017

Table F-34. State Buildings Located in the Category 2 SLOSH Inundation Area by Agency

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in the Cat 2 SLOSH	Percent (%) of Total Buildings	Total Value of State Buildings in the Cat 2 SLOSH	Percent (%) of Total Value
Dept. of Accounting & General Services	66	$953,963,738	8	12.12%	$67,089,197	7.03%
Dept. of Agriculture	70	$147,607,399	1	1.43%	$2,350,211	1.59%
Dept. of Attorney General	15	$108,425,480	2	13.33%	$16,180,875	14.92%
Dept. of Budget & Finance	16	$28,968,679	3	18.75%	$21,515,418	74.27%
Dept. of Business, Economic Development and Tourism	25	$645,480,379	6	24.00%	$560,518,082	86.84%
Dept. of Commerce & Consumer Affairs	2	$40,197,360	0	0.00%	$0	0.00%
Dept. of Defense	69	$267,352,836	7	10.14%	$20,849,967	7.80%
Dept. of Education	4,090	$10,598,205,739	135	3.30%	$360,575,144	3.40%
Dept. of Hawaiian Home Lands	12	$110,427,352	1	8.33%	$5,489,080	4.97%
Dept. of Health	44	$387,068,440	3	6.82%	$7,922,830	2.05%
Dept. of Human Resources Development	1	$5,973,872	0	0.00%	$0	0.00%
Dept. of Human Services	130	$480,212,294	22	16.92%	$168,627,477	35.12%
Dept. of Labor and Industrial Relations	22	$90,076,209	2	9.09%	$2,790,797	3.10%
Dept. of Land and Natural Resources	90	$101,441,821	19	21.11%	$4,614,552	4.55%
Dept. of Public Safety	154	$440,774,415	4	2.60%	$29,532,012	6.70%
Dept. of Taxation	1	$7,174,162	0	0.00%	$0	0.00%
Dept. of Transportation	68	$2,935,208,214	22	32.35%	$127,718,617	4.35%
Hawaiʻi State Ethics Commission	1	$984,533	0	0.00%	$0	0.00%
Hawaiʻi Health Systems Corporation	106	$1,230,852,871	0	0.00%	$0	0.00%
Hawaiʻi Housing Finance & Development Corporation	86	$360,851,671	5	5.81%	$118,247,972	32.77%
Hawaiʻi Public Housing Authority	273	$982,981,701	0	0.00%	$0	0.00%
Hawaiʻi State Legislature	2	$48,555,381	0	0.00%	$0	0.00%
Hawaiʻi State Public Library System	53	$525,584,082	7	13.21%	$15,342,397	2.92%
Judiciary	41	$534,877,354	7	17.07%	$75,272,153	14.07%
Legislative Reference Bureau	1	$2,996,162	0	0.00%	$0	0.00%
Office of Hawaiian Affairs	11	$54,125,645	3	27.27%	$16,648,896	30.76%

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in the Cat 2 SLOSH	Percent (%) of Total Buildings	Total Value of State Buildings in the Cat 2 SLOSH	Percent (%) of Total Value
Office of the Auditor	2	$1,921,180	0	0.00%	$0	0.00%
Office of the Governor	1	$2,996,162	0	0.00%	$0	0.00%
Office of the Lieutenant Governor	2	$4,588,849	0	0.00%	$0	0.00%
Office of the Ombudsman	1	$1,818,060	0	0.00%	$0	0.00%
Research Corporation of the University of Hawaiʻi	3	$4,189,026	0	0.00%	$0	0.00%
University of Hawaiʻi	637	$5,014,974,503	11	1.73%	$38,516,463	0.77%
Total	**6,095**	**$26,120,855,568**	**268**	**4.40%**	**$1,659,802,139**	**6.35%**

Source: *Federal Emergency Management Agency; National Weather Service; National Oceanic and Atmospheric Administration; State of Hawaii Risk Management Office 2017*

Table F-35. State Buildings Located in the Category 3 SLOSH Inundation Area by Agency

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in the Cat 3 SLOSH	Percent (%) of Total Buildings	Total Value of State Buildings in the Cat 3 SLOSH	Percent (%) of Total Value
Dept. of Accounting & General Services	66	$953,963,738	11	16.67%	$162,105,561	16.99%
Dept. of Agriculture	70	$147,607,399	12	17.14%	$23,658,906	16.03%
Dept. of Attorney General	15	$108,425,480	3	20.00%	$28,902,617	26.66%
Dept. of Budget & Finance	16	$28,968,679	3	18.75%	$21,515,418	74.27%
Dept. of Business, Economic Development and Tourism	25	$645,480,379	6	24.00%	$560,518,082	86.84%
Dept. of Commerce & Consumer Affairs	2	$40,197,360	0	0.00%	$0	0.00%
Dept. of Defense	69	$267,352,836	9	13.04%	$29,801,107	11.15%
Dept. of Education	4,090	$10,598,205,739	244	5.97%	$649,741,226	6.13%
Dept. of Hawaiian Home Lands	12	$110,427,352	1	8.33%	$5,489,080	4.97%
Dept. of Health	44	$387,068,440	3	6.82%	$7,922,830	2.05%
Dept. of Human Resources Development	1	$5,973,872	0	0.00%	$0	0.00%
Dept. of Human Services	130	$480,212,294	24	18.46%	$169,297,148	35.25%
Dept. of Labor and Industrial Relations	22	$90,076,209	4	18.18%	$59,693,544	66.27%

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in the Cat 3 SLOSH	Percent (%) of Total Buildings	Total Value of State Buildings in the Cat 3 SLOSH	Percent (%) of Total Value
Dept. of Land and Natural Resources	90	$101,441,821	20	22.22%	$9,090,122	8.96%
Dept. of Public Safety	154	$440,774,415	15	9.74%	$36,397,935	8.26%
Dept. of Taxation	1	$7,174,162	1	100.00%	$7,174,162	100.00%
Dept. of Transportation	68	$2,935,208,214	40	58.82%	$397,604,634	13.55%
Hawai'i State Ethics Commission	1	$984,533	0	0.00%	$0	0.00%
Hawai'i Health Systems Corporation	106	$1,230,852,871	0	0.00%	$0	0.00%
Hawai'i Housing Finance & Development Corporation	86	$360,851,671	5	5.81%	$118,247,972	32.77%
Hawai'i Public Housing Authority	273	$982,981,701	3	1.10%	$13,437,105	1.37%
Hawai'i State Legislature	2	$48,555,381	0	0.00%	$0	0.00%
Hawai'i State Public Library System	53	$525,584,082	9	16.98%	$20,459,322	3.89%
Judiciary	41	$534,877,354	7	17.07%	$75,272,153	14.07%
Legislative Reference Bureau	1	$2,996,162	0	0.00%	$0	0.00%
Office of Hawaiian Affairs	11	$54,125,645	4	36.36%	$42,448,896	78.43%
Office of the Auditor	2	$1,921,180	0	0.00%	$0	0.00%
Office of the Governor	1	$2,996,162	0	0.00%	$0	0.00%
Office of the Lieutenant Governor	2	$4,588,849	0	0.00%	$0	0.00%
Office of the Ombudsman	1	$1,818,060	0	0.00%	$0	0.00%
Research Corporation of the University of Hawai'i	3	$4,189,026	0	0.00%	$0	0.00%
University of Hawai'i	637	$5,014,974,503	18	2.83%	$429,348,908	8.56%
Total	**6,095**	**$26,120,855,568**	**442**	**7.25%**	**$2,868,126,728**	**10.98%**

Source: Federal Emergency Management Agency; National Weather Service; National Oceanic and Atmospheric Administration; State of Hawaii Risk Management Office 2017

Table F-36 summarizes the number of miles of State roads by state route located in category 1 through 4 SLOSH inundation areas, organized by county.

Table F-36. State Road Exposure to SLOSH Inundation Areas by County

State Route	Length (in miles)								
	Total Length	Cat 1 Length	Exposed Length as % of Total Length	Cat 2 Length	Exposed Length as % of Total Length	Cat 3 Length	Exposed Length as % of Total Length	Cat 4 Length	Exposed Length as % of Total Length
County of Kauaʻi									
State Route 50	32.89242	0.091329	0.28%	0.138787	0.42%	2.85477	8.68%	5.457716	16.59%
State Route 51	3.457222	0.072958	2.11%	0.106746	3.09%	0.112444	3.25%	0.128318	3.71%
State Route 56	28.316299	1.76363	6.23%	2.437216	8.61%	3.982471	14.06%	4.159598	14.69%
State Route 58	2.052085	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 540	3.884869	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 541	0.37465	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 550	14.03193	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 560	9.98938	0.467044	4.68%	1.121657	11.23%	1.448199	14.50%	2.05043	20.53%
State Route 570	1.125605	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 580	6.668581	0.096774	1.45%	0.439189	6.59%	0.6105	9.15%	0.667866	10.02%
State Route 583	0.921237	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Total	**103.714278**	**2.491735**	**2.40%**	**4.243595**	**4.09%**	**9.008384**	**8.69%**	**12.463928**	**12.02%**
City and County of Honolulu									
State Route 61	21.173569	0.021404	0.10%	0.021404	0.10%	0.029579	0.14%	0.06374	0.30%
State Route 63	16.618809	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 64	2.624714	0.440512	16.78%	1.647923	62.78%	2.100716	80.04%	2.337003	89.04%
State Route 65	6.584201	0	0.00%	0	0.00%	0	0.00%	0.485132	7.37%
State Route 72	22.766927	1.155768	5.08%	3.216673	14.13%	4.921268	21.62%	6.362638	27.95%
State Route 76	11.059837	1.013057	9.16%	1.336795	12.09%	1.482523	13.40%	1.690596	15.29%
State Route 78	1.346173	0.034919	2.59%	0.115605	8.59%	0.122884	9.13%	0.1359	10.10%
State Route 80	1.893686	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 83	47.821595	3.363868	7.03%	6.768887	14.15%	9.23619	19.31%	12.07292	25.25%
State Route 92	18.685552	7.163123	38.34%	9.633242	51.55%	10.581794	56.63%	11.030269	59.03%
State Route 93	19.522013	0.02739	0.14%	0.065228	0.33%	0.629039	3.22%	1.561741	8.00%
State Route 98	3.470599	0	0.00%	0	0.00%	0.002233	0.06%	0.00893	0.26%
State Route 99	41.120805	0.106847	0.26%	0.240252	0.58%	0.567932	1.38%	1.158587	2.82%
State Route 750	8.056213	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 901	1.403364	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 930	10.054945	0	0.00%	0.023516	0.23%	0.056898	0.57%	0.508456	5.06%
State Route 7012	1.862959	0	0.00%	0	0.00%	0	0.00%	0	0.00%

State Route	Length (in miles)								
	Total Length	Cat 1 Length	Exposed Length as % of Total Length	Cat 2 Length	Exposed Length as % of Total Length	Cat 3 Length	Exposed Length as % of Total Length	Cat 4 Length	Exposed Length as % of Total Length
State Route 7101	5.865258	0.202569	3.45%	1.083771	18.48%	1.34381	22.91%	1.471826	25.09%
State Route 7110	0.609843	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 7141	1.50208	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 7210	0.115075	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 7239	0.338737	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 7241	2.331816	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 7310	1.041137	0	0.00%	0.195723	18.80%	0.296653	28.49%	0.410893	39.47%
State Route 7345	0.554715	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 7350	0.597196	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 7351	0.243914	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 7401	0.214056	0.064391	30.08%	0.164826	77.00%	0.164826	77.00%	0.164826	77.00%
State Route 7413	0.352495	0	0.00%	0	0.00%	0	0.00%	0.005246	1.49%
State Route 7415	0.536255	0.012136	2.26%	0.125754	23.45%	0.187681	35.00%	0.196531	36.65%
State Route 7526	0.397834	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 7601	0.432591	0	0.00%	0	0.00%	0	0.00%	0.009456	2.19%
State Route 7801	1.151651	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 8300	0.501274	0.016638	3.32%	0.016638	3.32%	0.016638	3.32%	0.016638	3.32%
State Route 8918	0.13352	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 8930	4.941677	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 8940	3.321223	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 8945	0.984948	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 8955	2.697864	0.191811	7.11%	0.726912	26.94%	0.837515	31.04%	0.865264	32.07%
State Route H-1	54.2852	0.794879	1.46%	1.128766	2.08%	1.379163	2.54%	2.117247	3.90%
State Route H-2	16.631646	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route H-201	8.479473	0	0.00%	0.007515	0.09%	0.009948	0.12%	0.284022	3.35%
State Route H-3	30.593733	0.031551	0.10%	0.141094	0.46%	0.332241	1.09%	0.515264	1.68%
Total	374.921172	14.640863	3.91%	26.660524	7.11%	34.299531	9.15%	43.473125	11.60%
County of Maui									
State Route 30	41.599628	0.059461	0.14%	0.133133	0.32%	1.005057	2.42%	1.779082	4.28%
State Route 31	7.147053	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 32	2.855291	0	0.00%	0.03031	1.06%	0.604591	21.17%	0.870137	30.47%
State Route 36	16.225414	0	0.00%	0.293663	1.81%	0.819678	5.05%	0.955024	5.89%

State Route	Length (in miles)								
	Total Length	Cat 1 Length	Exposed Length as % of Total Length	Cat 2 Length	Exposed Length as % of Total Length	Cat 3 Length	Exposed Length as % of Total Length	Cat 4 Length	Exposed Length as % of Total Length
State Route 37	21.33757	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 310	3.609294	0.462804	12.82%	1.284677	35.59%	1.756266	48.66%	1.988678	55.10%
State Route 311	6.415815	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 340	4.265623	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 360	34.838612	0.01129	0.03%	0.01129	0.03%	0.02958	0.08%	0.02958	0.08%
State Route 377	9.136002	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 378	10.082808	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 380	6.197863	0	0.00%	0	0.00%	0.17101	2.76%	0.22903	3.70%
State Route 440	13.153636	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 441	0.476716	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 442	0.022862	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 450	27.477007	5.559171	20.23%	8.097149	29.47%	9.4879	34.53%	10.263164	37.35%
State Route 460	16.534641	1.188869	7.19%	1.524283	9.22%	1.8038	10.91%	1.853104	11.21%
State Route 470	10.74695	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 480	5.898639	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 3000	2.346263	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 3400	2.635502	0.085782	3.25%	0.13705	5.20%	0.294525	11.18%	0.531229	20.16%
State Route 3500	1.125483	0	0.00%	0.07879	7.00%	0.542926	48.24%	0.636708	56.57%
State Route 3800	0.625243	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 32A	0.400435	0	0.00%	0.132783	33.16%	0.350359	87.49%	0.400435	100.00%
State Route 32B	0.172196	0	0.00%	0	0.00%	0.16977	98.59%	0.172196	100.00%
State Route 36A	0.526104	0	0.00%	0.136501	25.95%	0.205764	39.11%	0.456797	86.83%
Total	245.85265	7.367377	3.00%	11.859629	4.82%	17.241226	7.01%	20.165164	8.20%
County of Hawaiʻi									
State Route 11	117.608086	0	0.00%	0	0.00%	0	0.00%	0.233368	0.20%
State Route 19	93.300605	0.051088	0.05%	0.074349	0.08%	0.237819	0.25%	1.082416	1.16%
State Route 130	21.68728	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 139	1.197816	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 160	3.821277	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 163	0.133863	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 190	34.085758	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 197	1.17843	0	0.00%	0	0.00%	0	0.00%	0	0.00%

State Route	Length (in miles)								
	Total Length	Cat 1 Length	Exposed Length as % of Total Length	Cat 2 Length	Exposed Length as % of Total Length	Cat 3 Length	Exposed Length as % of Total Length	Cat 4 Length	Exposed Length as % of Total Length
State Route 200	43.219679	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 220	3.754068	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 240	9.601941	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 250	19.266672	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 270	27.020618	0	0.00%	0	0.00%	0.167082	0.62%	0.398966	1.48%
State Route 1370	0.191175	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 1970	0.923307	0	0.00%	0	0.00%	0	0.00%	0	0.00%
State Route 2000	2.184464	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Total	379.175039	0.051088	0.01%	0.074349	0.02%	0.404901	0.11%	1.71475	0.45%

Source: State of Hawaiʻi Department of Transportation 2022; Federal Emergency Management Agency; National Weather Service; National Oceanic and Atmospheric Administration

F.10.2 COMMUNITY LIFELINES AND CRITICAL FACILITIES

Table F-37 through Table F-39 shows the community lifelines and critical facilities located in the Hurricane Category (Cat) 1 through 3 Storm Surge SLOSH Inundation areas by county.

Table F-37. Community Lifelines and Critical Facilities Located in the Category 1 SLOSH Inundation Areas by County

County	Lifeline Category							Additional Critical Facilities	Total Number of Facilities in the Hazard Area
	Communications	Energy	Food, Water, Shelter	Hazardous Material	Health and Medical	Safety and Security	Transportation		
County of Kauaʻi	0	0	3	0	0	2	0	0	5
City and County of Honolulu	13	11	14	0	4	12	0	3	57
County of Maui	1	0	3	0	2	3	1	0	10
County of Hawaiʻi	0	0	0	0	0	0	0	0	0
Total	**14**	**11**	**20**	**0**	**6**	**17**	**1**	**3**	**72**

Source: Federal Emergency Management Agency; National Weather Service; National Oceanic and Atmospheric Administration; Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020

Table F-38. Critical Facilities Exposure to Category 2 SLOSH Inundation Areas by County

County	Lifeline Category: Communications	Energy	Food, Water, Shelter	Hazardous Material	Health and Medical	Safety and Security	Transportation	Additional Critical Facilities	Total Number of Facilities in the Hazard Area
County of Kaua'i	0	0	3	0	0	4	0	1	8
City and County of Honolulu	16	17	35	0	4	15	1	3	91
County of Maui	1	0	8	0	2	6	2	1	20
County of Hawai'i	0	0	0	0	0	0	0	0	0
Total	**17**	**17**	**46**	**0**	**6**	**25**	**3**	**5**	**119**

Source: Federal Emergency Management Agency; National Weather Service; National Oceanic and Atmospheric Administration; Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020

Table F-39. Critical Facilities Exposure to Category 3 SLOSH Inundation Areas by County

County	Lifeline Category: Communications	Energy	Food, Water, Shelter	Hazardous Material	Health and Medical	Safety and Security	Transportation	Additional Critical Facilities	Total Number of Facilities in the Hazard Area
County of Kaua'i	1	2	9	0	0	6	2	1	21
City and County of Honolulu	24	18	40	0	4	20	1	3	110
County of Maui	1	0	10	0	3	9	2	1	26
County of Hawai'i	0	0	2	0	0	0	2	0	4
Total	**26**	**20**	**61**	**0**	**7**	**35**	**7**	**5**	**161**

Source: Federal Emergency Management Agency; National Weather Service; National Oceanic and Atmospheric Administration; Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020

Table F-40 through Table F-42 shows the community lifelines and critical facilities located in the hurricane category 1 through 3 SLOSH Inundation areas.

Table F-40. Community Lifelines and Critical Facilities Exposure to Category 1 SLOSH Inundation Areas by Category

Category	Total Number of Facilities	Total Replacement Cost Value	Number of Facilities in Hazard Area	Percent (%) of Total Facilities	Value in the Hazard Area	Percent (%) of Total Value
Communications	188	$776,797,683	14	7.45%	$40,156,935	5.17%
Energy	89	$3,093,949,530	11	12.36%	$397,588,020	12.85%
Food, Water, Shelter	345	$11,847,189,588	20	5.80%	$671,461,285	5.67%
Hazardous Material	12	$436,474,800	0	0.00%	$0	0.00%
Health and Medical	193	$4,606,713,364	6	3.11%	$90,902,124	1.97%
Safety and Security	486	$38,164,188,232	17	3.50%	$2,329,181,390	6.10%

Category	Total Number of Facilities	Total Replacement Cost Value	Number of Facilities in Hazard Area	Percent (%) of Total Facilities	Value in the Hazard Area	Percent (%) of Total Value
Transportation	56	$2,039,091,600	1	1.79%	$36,294,000	1.78%
Additional Facilities	106	$447,698,794	3	2.83%	$14,662,680	3.28%
Total	1,475	$61,412,103,591	72	4.88%	$3,580,246,434	5.83%

Source: *Federal Emergency Management Agency; National Weather Service; National Oceanic and Atmospheric Administration; Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020*

Table F-41. Community Lifelines and Critical Facilities Exposure to Category 2 SLOSH Inundation Areas by Category

Category	Total Number of Facilities	Total Replacement Cost Value	Number of Facilities in Hazard Area	Percent (%) of Total Facilities	Value in the Hazard Area	Percent (%) of Total Value
Communications	188	$776,797,683	17	9.04%	$48,787,986	6.28%
Energy	89	$3,093,949,530	17	19.10%	$616,750,790	19.93%
Food, Water, Shelter	345	$11,847,189,588	46	13.33%	$1,598,913,690	13.50%
Hazardous Material	12	$436,474,800	0	0.00%	$0	0.00%
Health and Medical	193	$4,606,713,364	6	3.11%	$90,902,124	1.97%
Safety and Security	486	$38,164,188,232	25	5.14%	$2,440,253,134	6.39%
Transportation	56	$2,039,091,600	3	5.36%	$109,828,800	5.39%
Additional Facilities	106	$447,698,794	5	4.72%	$21,967,480	4.91%
Total	1,475	$61,412,103,591	119	8.07%	$4,927,404,004	8.02%

Source: *Federal Emergency Management Agency; National Weather Service; National Oceanic and Atmospheric Administration; Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020*

Table F-42. Community Lifelines and Critical Facilities Exposure to Category 3 SLOSH Inundation Areas by Category

Category	Total Number of Facilities	Total Replacement Cost Value	Number of Facilities in Hazard Area	Percent (%) of Total Facilities	Value in the Hazard Area	Percent (%) of Total Value
Communications	188	$776,797,683	26	13.83%	$74,242,272	9.56%
Energy	89	$3,093,949,530	20	22.47%	$702,937,980	22.72%
Food, Water, Shelter	345	$11,847,189,588	61	17.68%	$2,081,827,690	17.57%
Hazardous Material	12	$436,474,800	0	0.00%	$0	0.00%
Health and Medical	193	$4,606,713,364	7	3.63%	$96,271,474	2.09%
Safety and Security	486	$38,164,188,232	35	7.20%	$2,686,249,378	7.04%
Transportation	56	$2,039,091,600	7	12.50%	$255,004,800	12.51%
Additional Facilities	106	$447,698,794	5	4.72%	$21,967,480	4.91%
Total	1,475	$61,412,103,591	161	10.92%	$5,918,501,074	9.64%

Source: *Federal Emergency Management Agency; National Weather Service; National Oceanic and Atmospheric Administration; Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020*

F.10.3 HAZUS SCENARIOS

Wind field import files provided by the Pacific Disaster Center were used for the Hazus analyses. The wind field files were created for the *2015 Hawaiʻi Catastrophic Hurricane Plan* and include one statewide scenario and four county-specific scenarios as described in Section 4.1. The estimate potential general building stock losses and sheltering needs are presented in the tables below for each scenario; statewide hurricane scenario and each county-specific hurricane scenario.

Table F-43. Estimated Sheltering Needs from a 500-Year Mean Return Period Statewide Hurricane Scenario in Hazus

County	Displaced Households	Short-Term Sheltering Needs
County of Kauaʻi	2	1
City and County of Honolulu	26,596	16,642
County of Maui	11,679	7,341
County of Hawaiʻi	16,965	11,452
Total	**55,242**	**35,436**

Source: FEMA Hazus v5.1

Table F-44. Estimated General Building Stock Loss and Sheltering Needs from a Category 4 Hurricane Scenario for County of Kauaʻi

County	Total Replacement Cost Value	Displaced Households		Short-Term Sheltering Needs	
		Estimated Loss	Estimated Loss as % of Total RCV	Estimated Loss	Estimated Loss as % of Total RCV
County of Kauaʻi	$24,246,497,228	$6,175,235,960	46.50%	1404700.00%	316900.00%
City and County of Honolulu	$239,152,051,766	$44,992,388	0.00%	0.00%	0.00%
County of Maui	$50,796,693,140	$0	0.00%	0.00%	0.00%
County of Hawaiʻi	$58,395,349,136	$0	0.00%	0.00%	0.00%
Total	**$372,590,591,270**	**$6,220,228,348**	**2.60%**	**1404700.00%**	**0.00%**

Source: *NIYAM IT 2022; United States Army Corps of Engineers 2022; FEMA Hazus v5.1*

Table F-45. Estimated General Building Stock Loss and Sheltering Needs from a Category 4 Hurricane for City and County of Honolulu

County	Total Replacement Cost Value	Displaced Households		Short-Term Sheltering Needs	
		Estimated Loss	Estimated Loss as % of Total RCV	Estimated Loss	Estimated Loss as % of Total RCV
County of Kauaʻi	$24,246,497,228	$969,211.00	0.00%	$0.00	0.00%
City and County of Honolulu	$239,152,051,766	$80,890,824,106.00	49.10%	$217,193.00	4704600.00%
County of Maui	$50,796,693,140	$122,955,340.00	0.40%	$105.00	2400.00%
County of Hawaiʻi	$58,395,349,136	$0.00	0.00%	$0.00	0.00%
Total	**$372,590,591,270**	**$81,014,748,658.00**	**33.40%**	**$217,298.00**	**0.00%**

Source: NIYAM IT 2022; United States Army Corps of Engineers 2022; FEMA Hazus v5.1

Table F-46. Estimated General Building Stock Loss and Sheltering Needs from a Category 4 Hurricane for County of Maui

County	Total Replacement Cost Value	Displaced Households		Short-Term Sheltering Needs	
		Estimated Loss	Estimated Loss as % of Total RCV	Estimated Loss	Estimated Loss as % of Total RCV
County of Kauaʻi	$24,246,497,228	$0.00	0.00%	$0.00	0.00%
City and County of Honolulu	$239,152,051,766	$0.00	0.00%	$0.00	0.00%
County of Maui	$50,796,693,140	$11,869,243,202.00	37.90%	$27,596.00	593000.00%
County of Hawaiʻi	$58,395,349,136	$207,337,617.00	0.60%	$136.00	2800.00%
Total	**$372,590,591,270**	**$12,076,580,819.00**	**5.00%**	**$27,732.00**	**0.00%**

Source: NIYAM IT 2022; United States Army Corps of Engineers 2022; FEMA Hazus v5.1

Table F-47. Estimated General Building Stock Loss and Sheltering Needs from a Category 4 Hurricane for County of Hawaiʻi

County	Total Replacement Cost Value	Displaced Households		Short-Term Sheltering Needs	
		Estimated Loss	Estimated Loss as % of Total RCV	Estimated Loss	Estimated Loss as % of Total RCV
County of Kauaʻi	$24,246,497,228	$0	0.00%	0.00%	0.00%
City and County of Honolulu	$239,152,051,766	$0	0.00%	0.00%	0.00%
County of Maui	$50,796,693,140	$541,178	0.00%	0.00%	0.00%
County of Hawaiʻi	$58,395,349,136	$8,845,149,253	26.50%	1982800.00%	431900.00%
Total	**$372,590,591,270**	**$8,845,690,431**	**3.60%**	**1982800.00%**	**0.00%**

Source: NIYAM IT 2022; United States Army Corps of Engineers 2022; FEMA Hazus v5.1

Table F-48 shows the total number of square miles environmental resources located in the SLOSH inundation areas (Categories 1 through 4).

Table F-48. Total Area of Environmental Resources located in the SLOSH Inundation Areas

County	Area (in square miles)								
	Total Area	Cat 1 Hazard Area	Hazard Area as % of Total Area	Cat 2 Hazard Area	Hazard Area as % of Total Area	Cat 3 Hazard Area	Hazard Area as % of Total Area	Cat 4 Hazard Area	Hazard Area as % of Total Area
County of Kauaʻi	919.953924	3.830831	0.42%	4.641689	0.50%	7.413525	0.81%	8.797537	1%
City and County of Honolulu	762.964336	4.055786	0.53%	7.721169	1.01%	10.192861	1.34%	10.863595	1%
County of Maui	2,109.97	6.677426	0.32%	8.326711	0.39%	9.03072	0.43%	9.524094	0%
County of Hawaiʻi	3,626.96	2.571946	0.07%	2.925765	0.08%	3.368075	0.09%	3.868921	0%
Total	**7,419.85**	**17.135989**	**0.23%**	**23.615334**	**0.32%**	**30.005181**	**0.40%**	**33.054147**	**0.45%**

Source Federal Emergency Management Agency; National Weather Service; National Oceanic and Atmospheric Administration; U.S. Fish and Wildlife Service, Pacific Islands Office, 2022, U.S. Fish and Wildlife Service 2021; 2017, Hawaii State Department of Land and Natural Resources, Division of Forestry and Wildlife 2022, NOAA raster nautical charts 2020b, State of Hawaii Department of Land and Natural Resources, Division of State Parks 2021

Table F-49 shows the square miles of each environmental resource located in the SLOSH inundation areas (Categories 1 through 4). Table F-50 shows the square miles of the SLOSH inundation areas in each watershed partnership area. Table F-51 shows the square miles of the SLOSH inundation areas in each State Land Use District in each county.

Table F-49. Environmental Assets Located in the SLOSH Hurricane Inundation Areas by County

Environmental Resource	Area (in square miles)								
	Total Area	Category 1 SLOSH	Category 1 as % of Total Area	Category 2 SLOSH	Category 2 as % of Total Area	Category 3 SLOSH	Category 3 as % of Total Area	Category 4 SLOSH	Category 4 as % of Total Area
County of Kauaʻi									
Critical Habitat	89.949404	0.071099	0.08%	0.097965	0.11%	0.129874	0.14%	0.174283	0.19%
Wetlands	599.856747	3.039062	0.51%	3.33769	0.56%	5.800842	0.97%	6.833477	1.14%
Parks & Reserves	225.627609	0.565748	0.25%	1.021719	0.45%	1.289758	0.57%	1.592265	0.71%
Reefs	4.520164	0.154922	3.43%	0.184315	4.08%	0.193051	4.27%	0.197512	4.37%
Total	**919.953924**	**3.830831**	**0.42%**	**4.641689**	**0.50%**	**7.413525**	**0.81%**	**8.797537**	**0.96%**
City and County of Honolulu									
Critical Habitat	120.940098	0.028801	0.02%	0.0773	0.06%	0.109615	0.09%	0.143039	0.12%
Wetlands	505.8093	2.954961	0.58%	4.675767	0.92%	5.949417	1.18%	6.289636	1.24%
Parks & Reserves	120.493604	0.807386	0.67%	2.661692	2.21%	3.798662	3.15%	4.078305	3.38%
Reefs	15.721334	0.264638	1.68%	0.30641	1.95%	0.335167	2.13%	0.352615	2.24%
Total	**762.964336**	**4.055786**	**0.53%**	**7.721169**	**1.01%**	**10.192861**	**1.34%**	**10.863595**	**1.42%**
County of Maui									
Critical Habitat	293.089135	0.375184	0.13%	0.485412	0.17%	0.582686	0.20%	0.65702	0.22%
Wetlands	1,382.29	4.824587	0.35%	5.665934	0.41%	6.033595	0.44%	6.279072	0.45%
Parks & Reserves	408.607306	1.044554	0.26%	1.726279	0.42%	1.94967	0.48%	2.106948	0.52%
Reefs	25.988851	0.433101	1.67%	0.449086	1.73%	0.464769	1.79%	0.481054	1.85%
Total	**2,109.97**	**6.677426**	**0.32%**	**8.326711**	**0.39%**	**9.03072**	**0.43%**	**9.524094**	**0.45%**
County of Hawaiʻi									
Critical Habitat	446.603954	0.018414	0.00%	0.021188	0.00%	0.031773	0.01%	0.049524	0.01%
Wetlands	1,148.77	1.770142	0.15%	1.893513	0.16%	2.003302	0.17%	2.145768	0.19%
Parks & Reserves	2,022.98	0.545323	0.03%	0.751505	0.04%	1.054814	0.05%	1.380874	0.07%
Reefs	8.603698	0.238067	2.77%	0.259559	3.02%	0.278186	3.23%	0.292755	3.40%
Total	3,626.96	2.571946	0.07%	2.925765	0.08%	3.368075	0.09%	3.868921	0.11%

Source: *Federal Emergency Management Agency; National Weather Service; National Oceanic and Atmospheric Administration; U.S. Fish and Wildlife Service, Pacific Islands Office, 2022, U.S. Fish and Wildlife Service 2021; 2017, Hawaii State Department of Land and Natural Resources, Division of Forestry and Wildlife 2022, NOAA raster nautical charts 2020b, State of Hawaii Department of Land and Natural Resources, Division of State Parks 2021*

Table F-50. Watershed Partnership Areas Located in the SLOSH Hurricane Areas

Watershed	Area (in square miles)								
	Total Area (square miles)	Cat 1 Hazard Area	Hazard Area as % of Total Area	Cat 2 Hazard Area	Hazard Area as % of Total Area	Cat 3 Hazard Area	Hazard Area as % of Total Area	Cat 4 Hazard Area	Hazard Area as % of Total Area
County of Kauaʻi									
Kauaʻi Watershed Alliance	225.61	0.023	0.01%	0.031	0.01%	0.039	0.02%	0.051	0.02%
City and County of Honolulu									
Koʻolau Mountains Watershed Partnership	160.62	0.129	0.08%	0.196	0.12%	0.239	0.15%	0.263	0.16%
Waiʻanae Mountains Watershed Partnership	73.59	0.032	0.04%	0.042	0.06%	0.059	0.08%	0.105	0.14%
Total	**234.21**	**0.161**	**0.12%**	**0.238**	**0.18%**	**0.298**	**0.23%**	**0.368**	**0.30%**
County of Maui									
East Maui Watershed Partnership	173.01	0.002	0.00%	0.003	0.00%	0.006	0.00%	0.009	0.00%
East Molokaʻi Watershed Partnership	105.27	0.525	0.50%	0.652	0.62%	0.747	0.71%	0.831	0.79%
Leeward Haleakalā Watershed Restoration Partnership	53.56	0.000	0.00%	0.000	0.00%	0.000	0.00%	0.000	0.00%
West Maui Mountains Watershed Partnership	73.94	0.000	0.00%	0.000	0.00%	0.000	0.00%	0.000	0.00%
Lānaʻi Forest and Watershed Partnership	14.84	0.000	0.00%	0.000	0.00%	0.000	0.00%	0.000	0.00%
Overlap East Maui Watershed Partnership and Leeward Haleakalā Watershed Restoration Partnership	13.72	0.000	0.00%	0.000	0.00%	0.000	0.00%	0.000	0.00%
Total	**434.34**	**0.527**	**0.50%**	**0.655**	**0.62%**	**0.753**	**0.71%**	**0.84**	**0.79%**
County of Hawaiʻi									
Kohala Watershed Partnership	115.81	0.015	0.01%	0.019	0.02%	0.028	0.02%	0.095	0.08%
Mauna Kea Watershed Alliance	400.39	0.000	0.00%	0.000	0.00%	0.000	0.00%	0.000	0.00%
Three Mountain Alliance	1767.20	0.224	0.01%	0.292	0.02%	0.364	0.02%	0.498	0.03%
Total	**2283.4**	**0.239**	**0.02%**	**0.311**	**0.04%**	**0.392**	**0.04%**	**0.593**	**0.11%**

Source: Federal Emergency Management Agency; National Weather Service; National Oceanic and Atmospheric Administration; Department of Land & Natural Resources, Division of Forestry and Wildlife 2020

Table F-51. State Land Use Districts Located in SLOSH Inundation Area

Land Use District	Area (in square miles)												
	Total Square Miles	Square Miles in Category 1 Hazard Area	Hazard Area as % of Total Area	Hazard Area as % of Total Hazard Exposure	Square Miles in Category 2 Hazard Area	Hazard Area as % of Total Area	Hazard Area as % of Total Hazard Exposure	Square Miles in Category 3 Hazard Area	Hazard Area as % of Total Area	Hazard Area as % of Total Hazard Exposure	Square Miles in Category 4 Hazard Area	Hazard Area as % of Total Area	Hazard Area as % of Total Hazard Exposure
County of Kaua'i													
Agricultural	297.078539	2.635421	0.89%	59.72%	3.005075	1.01%	52.55%	6.008907	2.02%	60.40%	7.243863	2.44%	60.13%
Conservation	304.260357	0.703152	0.23%	15.93%	1.104049	0.36%	19.31%	1.516014	0.50%	15.24%	1.747253	0.57%	14.50%
Rural	2.146976	0.012794	0.60%	0.29%	0.018812	0.88%	0.33%	0.04089	1.90%	0.41%	0.142287	6.63%	1.18%
Urban	23.643203	1.061435	4.49%	24.05%	1.590473	6.73%	27.81%	2.383469	10.08%	23.96%	2.914551	12.33%	24.19%
Total	627.129075	4.412802	0.70%	100.00%	5.718409	0.91%	100.00%	9.94928	1.59%	100.00%	12.047954	1.92%	100.00%
City and County of Honolulu													
Agricultural	188.479146	1.272761	0.68%	11.71%	3.72498	1.98%	16.65%	5.027304	2.67%	15.79%	6.173966	3.28%	16.14%
Conservation	247.601978	1.237519	0.50%	11.38%	2.02288	0.82%	9.04%	2.98093	1.20%	9.36%	3.188242	1.29%	8.34%
Rural	0	0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%
Urban	162.455059	8.361315	5.15%	76.91%	16.620094	10.23%	74.30%	23.830284	14.67%	74.85%	28.88268	17.78%	75.52%
Total	598.536183	10.871595	1.82%	100.00%	22.367954	3.74%	100.00%	31.838518	5.32%	100.00%	38.244888	6.39%	100.00%
County of Maui													
Agricultural	637.731138	2.570695	0.40%	39.52%	3.446269	0.54%	39.95%	4.048856	0.63%	37.98%	4.334316	0.68%	35.21%
Conservation	552.35574	2.485597	0.45%	38.21%	3.126331	0.57%	36.24%	3.587395	0.65%	33.65%	4.00452	0.72%	32.53%
Rural	12.824585	0.643721	5.02%	9.90%	0.822592	6.41%	9.53%	0.997945	7.78%	9.36%	1.15273	8.99%	9.37%
Urban	45.187433	0.804994	1.78%	12.37%	1.23226	2.73%	14.28%	2.027142	4.49%	19.01%	2.817119	6.23%	22.89%
Total	1,248	6.505007	0.52%	100.00%	8.627452	0.69%	100.00%	10.661338	0.85%	100.00%	12.308685	0.99%	100.00%
County of Hawai'i													
Agricultural	1,850.31	0.024968	0.00%	1.32%	0.048565	0.00%	1.93%	0.070325	0.00%	1.90%	0.191668	0.01%	3.58%
Conservation	2,098.66	1.283846	0.06%	68.11%	1.628999	0.08%	64.68%	2.151303	0.10%	58.07%	2.775603	0.13%	51.85%
Rural	1.36344	0.002084	0.15%	0.11%	0.002239	0.16%	0.09%	0.002833	0.21%	0.08%	0.003208	0.24%	0.06%
Urban	87.847736	0.573989	0.65%	30.45%	0.838803	0.95%	33.30%	1.480486	1.69%	39.96%	2.382947	2.71%	44.51%
Total	4,038	1.884887	0.05%	100.00%	2.518606	0.06%	100.00%	3.704947	0.09%	100.00%	5.353426	0.13%	100.00%

Source: State Land Use Commission, Hawaii Statewide GIS Program 2021; Honolulu County GIS 2022; Federal Emergency Management Agency; National Weather Service; National Oceanic and Atmospheric Administration

F.11 Infrastructure Failure

The State of Hawaiʻi has a total 126 State-regulated dams, of which 118 have a classification of "high hazard". An inventory of dams, by county, is summarized in Table F-52 using the Dam Inventory System from the Department of Land and Natural Resources (DLNR 2023). Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and in low economic and/or environmental losses. Losses are principally limited to the owner's property. Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure. Dams assigned the high hazard potential are those where failure or misoperation will probably cause loss of human life.

Table F-52. Dams Located in the State of Hawaiʻi, by County, and Hazard Classification

National ID	State ID	Dam Name	County	Island	Hazard Classification
HI00063	KA-0063	ʻAʻahoaka Reservoir	Kauaʻi	Kauaʻi	High
HI00103	KA-0103	Aepo Reservoir	Kauaʻi	Kauaʻi	High
HI00110	KA-0110	Aepoalua Reservoir	Kauaʻi	Kauaʻi	High
HI00112	KA-0112	Aepoeha Reservoir	Kauaʻi	Kauaʻi	High
HI00111	KA-0111	Aepoekolu Reservoir	Kauaʻi	Kauaʻi	High
HI00011	KA-0011	Aii Reservoir	Kauaʻi	Kauaʻi	High
HI00098	KA-0098	Alexander Reservoir	Kauaʻi	Kauaʻi	High
HI00105	KA-0105	ʻElima Reservoir	Kauaʻi	Kauaʻi	High
HI00117	KA-0117	ʻElua Reservoir	Kauaʻi	Kauaʻi	High
HI00067	KA-0067	Field 1 Keālia Reservoir	Kauaʻi	Kauaʻi	High
HI00146	KA-0146	Halaʻula Reservoir	Kauaʻi	Kauaʻi	High
HI00121	KA-0121	Halenānahu Reservoir	Kauaʻi	Kauaʻi	High
HI00118	KA-0118	Hanamāʻulu Reservoir	Kauaʻi	Kauaʻi	High
HI00104	KA-0104	Huinawai Reservoir	Kauaʻi	Kauaʻi	High
HI00101	KA-0101	Hukiwai Reservoir	Kauaʻi	Kauaʻi	High
HI00102	KA-0102	Ioleau Reservoir	Kauaʻi	Kauaʻi	Low
HI00109	KA-0109	Ipuolono Reservoir	Kauaʻi	Kauaʻi	High
HI00009	KA-0009	Kaʻawanui Reservoir	Kauaʻi	Kauaʻi	High
HI00024	KA-0024	Kalihiwai Reservoir	Kauaʻi	Kauaʻi	High
HI00030	KA-0030	Kaloko Reservoir	Kauaʻi	Kauaʻi	High
HI00015	KA-0015	Kaneha Reservoir	Kauaʻi	Kauaʻi	High
HI00100	KA-0100	Kapa Reservoir	Kauaʻi	Kauaʻi	High
HI00012	KA-0012	Kapaia Reservoir	Kauaʻi	Kauaʻi	High

National ID	State ID	Dam Name	County	Island	Hazard Classification
HI00145	KA-0145	Kauaʻi Lagoons	Kauaʻi	Kauaʻi	High
HI00108	KA-0108	Kaupale Reservoir	Kauaʻi	Kauaʻi	High
HI00007	KA-0007	Kepani Reservoir	Kauaʻi	Kauaʻi	High
HI00106	KA-0106	Kumano Reservoir	Kauaʻi	Kauaʻi	High
HI00061	KA-0061	Lower Kapahi Reservoir	Kauaʻi	Kauaʻi	High
HI00005	KA-0005	Mānā Reservoir	Kauaʻi	Kauaʻi	High
HI00116	KA-0116	Mau Reservoir	Kauaʻi	Kauaʻi	High
HI00119	KA-0119	Mauka Reservoir	Kauaʻi	Kauaʻi	High
HI00016	KA-0016	Mimino Reservoir	Kauaʻi	Kauaʻi	High
HI00014	KA-0014	Okinawa Reservoir	Kauaʻi	Kauaʻi	High
HI00113	KA-0113	ʻŌmaʻo Reservoir	Kauaʻi	Kauaʻi	High
HI00120	KA-0120	Papuaa Reservoir	Kauaʻi	Kauaʻi	High
HI00115	KA-0115	Pia Mill Reservoir	Kauaʻi	Kauaʻi	High
HI00114	KA-0114	Piwai Reservoir	Kauaʻi	Kauaʻi	High
HI00155	KA-0155	Pond No. 1 at Kauaʻi Ranch	Kauaʻi	Kauaʻi	High
HI00002	KA-0002	Puʻu Lua Reservoir	Kauaʻi	Kauaʻi	High
HI00107	KA-0107	Puʻu O Hewa Reservoir	Kauaʻi	Kauaʻi	High
HI00003	KA-0003	Puʻu Opae Reservoir	Kauaʻi	Kauaʻi	Low
HI00062	KA-0062	Twin Reservoirs	Kauaʻi	Kauaʻi	High
HI00065	KA-0065	Upper Anahola Reservoir	Kauaʻi	Kauaʻi	Low
HI00010	KA-0010	Waiakalua Reservoir	Kauaʻi	Kauaʻi	High
HI00006	KA-0006	Waikaia Reservoir	Kauaʻi	Kauaʻi	High
HI00008	KA-0008	Waikoloi Reservoir	Kauaʻi	Kauaʻi	High
HI00060	KA-0060	Wailua Reservoir	Kauaʻi	Kauaʻi	High
HI00099	KA-0099	Waitā Reservoir	Kauaʻi	Kauaʻi	High
HI00023	OA-0023	Helemano 6 Reservoir	Honolulu	Oʻahu	High
HI00124	OA-0124	Kāneʻohe Dam	Honolulu	Oʻahu	High
HI00021	OA-0021	Kemoʻo 5 Reservoir	Honolulu	Oʻahu	High
HI00156	OA-0156	Koolau Reservoir	Honolulu	Oʻahu	Low
HI00025	OA-0025	Ku Tree Reservoir	Honolulu	Oʻahu	High
HI00149	OA-0149	Maunaʻolu Reservoir	Honolulu	Oʻahu	High
HI00001	OA-0001	Nuʻuanu Dam No. 4	Honolulu	Oʻahu	High
HI00154	OA-0154	Nuʻuanu Reservoir No. 1	Honolulu	Oʻahu	High
HI00137	OA-0137	Oʻahu Reservoir 155	Honolulu	Oʻahu	High
HI00018	OA-0018	Ōpaeuʻla 01 Reservoir	Honolulu	Oʻahu	High
HI00022	OA-0022	Upper Helemano Reservoir	Honolulu	Oʻahu	High

National ID	State ID	Dam Name	County	Island	Hazard Classification
HI00017	OA-0017	Wahiawā Dam	Honolulu	Oʻahu	High
HI00129	OA-0129	Waimānalo 60 Mg Reservoir	Honolulu	Oʻahu	High
HI00095	MA-0095	Haʻikū Reservoir	Maui	Maui	High
HI00056	MA-0056	Hanakaʻōʻō Reservoir	Maui	Maui	High
HI00130	MA-0130	Honokowai - Structure #8	Maui	Maui	High
HI00058	MA-0058	Honokowai Reservoir	Maui	Maui	High
HI00054	MA-0054	Horner Reservoir	Maui	Maui	High
HI00138	MA-0138	Kahakapao Reservoirs	Maui	Maui	High
HI00126	MA-0126	Kahana Nui Dam	Maui	Maui	High
HI00057	MA-0057	Kahoma Reservoir	Maui	Maui	High
HI00143	MA-0143	Kāʻili ʻIli Reservoir	Maui	Maui	High
HI00134	MA-0134	Kaʻōpala Basin	Maui	Maui	High
HI00094	MA-0094	Kapalaalaea Reservoir	Maui	Maui	High
HI00141	MA-0141	Kehalani Offsite Retention Basin	Maui	Maui	High
HI00041	MO-0041	Kualapuʻu Reservoir	Maui	Molokaʻi	High
HI00144	MA-0144	Māhinahina Reservoir	Maui	Maui	High
HI00139	MA-0139	Maui Field 290 Reservoir	Maui	Maui	High
HI00068	MA-0068	Maui Reservoir 14	Maui	Maui	High
HI00069	MA-0069	Maui Reservoir 15	Maui	Maui	High
HI00070	MA-0070	Maui Reservoir 20	Maui	Maui	High
HI00071	MA-0071	Maui Reservoir 21	Maui	Maui	High
HI00072	MA-0072	Maui Reservoir 22	Maui	Maui	High
HI00073	MA-0073	Maui Reservoir 24	Maui	Maui	High
HI00074	MA-0074	Maui Reservoir 25	Maui	Maui	High
HI00075	MA-0075	Maui Reservoir 30	Maui	Maui	High
HI00076	MA-0076	Maui Reservoir 33	Maui	Maui	High
HI00077	MA-0077	Maui Reservoir 40	Maui	Maui	High
HI00078	MA-0078	Maui Reservoir 42	Maui	Maui	High
HI00079	MA-0079	Maui Reservoir 52	Maui	Maui	High
HI00080	MA-0080	Maui Reservoir 60	Maui	Maui	High
HI00081	MA-0081	Maui Reservoir 61	Maui	Maui	High
HI00082	MA-0082	Maui Reservoir 70	Maui	Maui	High
HI00083	MA-0083	Maui Reservoir 73	Maui	Maui	High
HI00084	MA-0084	Maui Reservoir 74	Maui	Maui	High
HI00085	MA-0085	Maui Reservoir 80	Maui	Maui	High
HI00086	MA-0086	Maui Reservoir 81	Maui	Maui	High

National ID	State ID	Dam Name	County	Island	Hazard Classification
HI00087	MA-0087	Maui Reservoir 82	Maui	Maui	Significant
HI00088	MA-0088	Maui Reservoir 84	Maui	Maui	High
HI00089	MA-0089	Maui Reservoir 90	Maui	Maui	High
HI00090	MA-0090	Maui Reservoir 92	Maui	Maui	High
HI00142	MA-0142	Middle Field 14 Reservoir	Maui	Maui	High
HI00128	MA-0128	Nāpili 2-3 Desilting Basin	Maui	Maui	High
HI00127	MA-0127	Nāpili 4-5 Desilting Basin	Maui	Maui	High
HI00048	MA-0048	Olinda Reservoir	Maui	Maui	High
HI00092	MA-0092	Pāpaʻaʻea Reservoir	Maui	Maui	High
HI00096	MA-0096	Paʻuwela Reservoir	Maui	Maui	High
HI00091	MA-0091	Pe'ahi Reservoir	Maui	Maui	High
HI00047	MA-0047	Piʻiholo 50 Mg Reservoir	Maui	Maui	High
HI00153	MA-0153	Plantation Reservoir	Maui	Maui	High
HI00133	MA-0133	Puʻu Koa Reservoir	Maui	Maui	High
HI00059	MA-0059	Reservoir 140	Maui	Maui	High
HI00140	MA-0140	Ukumehame Reservoirs	Maui	Maui	High
HI00132	MA-0132	Upper Field 14 Reservoir	Maui	Maui	High
HI00046	MA-0046	Waikamoi Dam No. 2	Maui	Maui	Low
HI00152	MA-0152	Waikamoi Reservoirs	Maui	Maui	Significant
HI00151	MA-0151	Wailuku Water Reservoir 10	Maui	Maui	High
HI00150	MA-0150	Wailuku Water Reservoir 6	Maui	Maui	High
HI00051	HA-0051	Hāwī No. 5 Reservoir	Hawaiʻi	Hawaiʻi	High
HI00049	HA-0049	Keaiwa Reservoir	Hawaiʻi	Hawaiʻi	Low
HI00131	HA-0131	Paʻauilo Reservoir	Hawaiʻi	Hawaiʻi	High
HI00147	HA-0147	Pūnāwai Reservoir	Hawaiʻi	Hawaiʻi	High
HI00123	HA-0123	Puʻu Pulehu Reservoir	Hawaiʻi	Hawaiʻi	High
HI00043	HA-0043	Puʻukapu Watershed Retarding Dam R-1	Hawaiʻi	Hawaiʻi	High
HI00040	HA-0040	Waikōloa Reservoir No. 1	Hawaiʻi	Hawaiʻi	High
HI00122	HA-0122	Waikōloa Reservoir No. 2	Hawaiʻi	Hawaiʻi	High
HI00136	HA-0136	Waikōloa Reservoir No. 3	Hawaiʻi	Hawaiʻi	High
HI00042	HA-0042	Waimea 60 Mg Reservoir	Hawaiʻi	Hawaiʻi	High

Source: DLNR 2023

Table F-53 summarizes State buildings that are exposed to the dam inundation area by agency.

Table F-53. State Buildings Exposure to Dam Inundation Areas by Agency

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Hazard Area	Percent (%) of Total Buildings	Value in the Hazard Area	Percent (%) of Total Value
Dept. of Accounting & General Services	66	$953,963,738	2	3.03%	$12,312,612	1.29%
Dept. of Agriculture	70	$147,607,399	7	10.00%	$15,101,709	10.23%
Dept. of Attorney General	15	$108,425,480	1	6.67%	$1,288,081	1.19%
Dept. of Budget & Finance	16	$28,968,679	1	6.25%	$4,806,631	16.59%
Dept. of Business, Economic Development and Tourism	25	$645,480,379	0	0.00%	$0	0.00%
Dept. of Commerce & Consumer Affairs	2	$40,197,360	0	0.00%	$0	0.00%
Dept. of Defense	69	$267,352,836	2	2.90%	$8,951,140	3.35%
Dept. of Education	4,090	$10,598,205,739	95	2.32%	$506,980,435	4.78%
Dept. of Hawaiian Home Lands	12	$110,427,352	0	0.00%	$0	0.00%
Dept. of Health	44	$387,068,440	1	2.27%	$642,741	0.17%
Dept. of Human Resources Development	1	$5,973,872	0	0.00%	$0	0.00%
Dept. of Human Services	130	$480,212,294	9	6.92%	$21,728,493	4.52%
Dept. of Labor and Industrial Relations	22	$90,076,209	0	0.00%	$0	0.00%
Dept. of Land and Natural Resources	90	$101,441,821	4	4.44%	$3,377,505	3.33%
Dept. of Public Safety	154	$440,774,415	0	0.00%	$0	0.00%
Dept. of Taxation	1	$7,174,162	0	0.00%	$0	0.00%
Dept. of Transportation	68	$2,935,208,214	9	13.24%	$44,441,751	1.51%
Hawai'i State Ethics Commission	1	$984,533	0	0.00%	$0	0.00%
Hawai'i Health Systems Corporation	106	$1,230,852,871	2	1.89%	$3,086,734	0.25%
Hawai'i Housing Finance & Development Corporation	86	$360,851,671	0	0.00%	$0	0.00%
Hawai'i Public Housing Authority	273	$982,981,701	29	10.62%	$139,214,142	14.16%
Hawai'i State Legislature	2	$48,555,381	0	0.00%	$0	0.00%
Hawai'i State Public Library System	53	$525,584,082	5	9.43%	$22,596,333	4.30%
Judiciary	41	$534,877,354	0	0.00%	$0	0.00%
Legislative Reference Bureau	1	$2,996,162	0	0.00%	$0	0.00%
Office of Hawaiian Affairs	11	$54,125,645	2	18.18%	$26,025,298	48.08%
Office of the Auditor	2	$1,921,180	0	0.00%	$0	0.00%
Office of the Governor	1	$2,996,162	0	0.00%	$0	0.00%
Office of the Lieutenant Governor	2	$4,588,849	0	0.00%	$0	0.00%

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Hazard Area	Percent (%) of Total Buildings	Value in the Hazard Area	Percent (%) of Total Value
Office of the Ombudsman	1	$1,818,060	0	0.00%	$0	0.00%
Research Corporation of the University of Hawai'i	3	$4,189,026	0	0.00%	$0	0.00%
University of Hawai'i	637	$5,014,974,503	28	4.40%	$407,006,130	8.12%
Total	**6,095**	**$26,120,855,568**	**197**	**3.23%**	**$1,217,559,734**	**4.66%**

Source: Department of Land and Natural Resources 2022; Pacific Disaster Center 2022; State of Hawaii Risk Management Office 2017
Notes: All State Buildings were updated using RS Means 2022 data

Table F-54 summarizes the number of miles of State roads located in the dam inundation areas statewide.

Table F-54. State Road Exposure to Dam Inundation Areas by County

State Route	Length (in miles)		
	Total Length	Dam Failure Hazard Area Length	Exposed Length as % of Total Length
County of Kaua'i			
State Route 50	32.89242	1.442388	4.39%
State Route 51	3.457222	0.093479	2.70%
State Route 56	28.316299	0.732696	2.59%
State Route 58	2.052085	0	0.00%
State Route 540	3.884869	0.257356	6.62%
State Route 541	0.37465	0	0.00%
State Route 550	14.03193	0	0.00%
State Route 560	9.98938	0	0.00%
State Route 570	1.125605	0	0.00%
State Route 580	6.668581	0.129142	1.94%
State Route 583	0.921237	0.073831	8.01%
Total	**103.714278**	**2.728892**	**2.63%**
City and County of Honolulu			
State Route 61	21.173569	1.682194	7.94%
State Route 63	16.618809	0	0.00%
State Route 64	2.624714	0	0.00%
State Route 65	6.584201	0	0.00%
State Route 72	22.766927	0.304271	1.34%
State Route 76	11.059837	0	0.00%
State Route 78	1.346173	0	0.00%
State Route 80	1.893686	0.169505	8.95%
State Route 83	47.821595	0.632549	1.32%
State Route 92	18.685552	2.508524	13.42%
State Route 93	19.522013	0.384902	1.97%
State Route 98	3.470599	0.764858	22.04%
State Route 99	41.120805	0.447898	1.09%
State Route 750	8.056213	0	0.00%

State Route	Length (in miles)		
	Total Length	Dam Failure Hazard Area Length	Exposed Length as % of Total Length
State Route 901	1.403364	0	0.00%
State Route 930	10.054945	1.24943	12.43%
State Route 7012	1.862959	0	0.00%
State Route 7101	5.865258	0	0.00%
State Route 7110	0.609843	0	0.00%
State Route 7141	1.50208	0	0.00%
State Route 7210	0.115075	0	0.00%
State Route 7239	0.338737	0	0.00%
State Route 7241	2.331816	0	0.00%
State Route 7310	1.041137	0	0.00%
State Route 7345	0.554715	0	0.00%
State Route 7350	0.597196	0	0.00%
State Route 7351	0.243914	0	0.00%
State Route 7401	0.214056	0	0.00%
State Route 7413	0.352495	0.148353	42.09%
State Route 7415	0.536255	0	0.00%
State Route 7526	0.397834	0	0.00%
State Route 7601	0.432591	0	0.00%
State Route 7801	1.151651	0	0.00%
State Route 8300	0.501274	0.091613	18.28%
State Route 8918	0.13352	0	0.00%
State Route 8930	4.941677	0	0.00%
State Route 8940	3.321223	0	0.00%
State Route 8945	0.984948	0	0.00%
State Route 8955	2.697864	0	0.00%
State Route H-1	54.2852	0.773673	1.43%
State Route H-2	16.631646	0	0.00%
State Route H-201	8.479473	0	0.00%
State Route H-3	30.593733	0	0.00%
Total	**374.921172**	**9.15777**	**2.44%**
County of Maui			
State Route 30	41.599628	1.570027	3.77%
State Route 31	7.147053	0	0.00%
State Route 32	2.855291	0.601657	21.07%
State Route 36	16.225414	4.946908	30.49%
State Route 37	21.33757	0.76343	3.58%
State Route 310	3.609294	0.120682	3.34%
State Route 311	6.415815	1.875338	29.23%
State Route 340	4.265623	0	0.00%
State Route 360	34.838612	0.263662	0.76%
State Route 377	9.136002	0	0.00%
State Route 378	10.082808	0	0.00%
State Route 380	6.197863	0.518661	8.37%

State Route	Length (in miles)		
	Total Length	Dam Failure Hazard Area Length	Exposed Length as % of Total Length
State Route 440	13.153636	0	0.00%
State Route 441	0.476716	0	0.00%
State Route 442	0.022862	0	0.00%
State Route 450	27.477007	0	0.00%
State Route 460	16.534641	0.055914	0.34%
State Route 470	10.74695	0.506733	4.72%
State Route 480	5.898639	0	0.00%
State Route 3000	2.346263	0.01886	0.80%
State Route 3400	2.635502	0.192321	7.30%
State Route 3500	1.125483	0.407566	36.21%
State Route 3800	0.625243	0.58965	94.31%
State Route 32A	0.400435	0.400435	100.00%
State Route 32B	0.172196	0.172196	100.00%
State Route 36A	0.526104	0.318404	60.52%
Total	**245.85265**	**13.322444**	**5.42%**
County of Hawaiʻi			
State Route 11	117.608086	0	0.00%
State Route 19	93.300605	0.283422	0.30%
State Route 130	21.68728	0	0.00%
State Route 139	1.197816	0	0.00%
State Route 160	3.821277	0	0.00%
State Route 163	0.133863	0	0.00%
State Route 190	34.085758	0	0.00%
State Route 197	1.17843	0	0.00%
State Route 200	43.219679	0	0.00%
State Route 220	3.754068	0	0.00%
State Route 240	9.601941	0.105728	1.10%
State Route 250	19.266672	0.012769	0.07%
State Route 270	27.020618	0	0.00%
State Route 1370	0.191175	0	0.00%
State Route 1970	0.923307	0	0.00%
State Route 2000	2.184464	0	0.00%
Total	379.175039	0.401919	0.11%

Source: State of Hawaii Department of Transportation 2022; Department of Land and Natural Resources 2022; Pacific Disaster Center 2022

F.12 Landslide and Rockfall

Table F-55 and Table F-56 show the State buildings located in the moderate landslide susceptibility area by county and agency, respectively.

Table F-55. State Buildings Located in the Moderate Landslide Susceptibility Area by County

County	Moderate Landslide Susceptibility	
	Number of State Buildings in the Moderate Susceptibility Area	Total Replacement Cost Value of State Buildings in the Moderate Susceptibility Area
County of Kaua'i	0	$0
City and County of Honolulu	23	$60,679,449
County of Maui	0	$0
County of Hawai'i	546	$1,678,490,843
Total	**569**	**$1,739,170,292**

Source: *State of Hawaii Risk Management Office 2017; Pacific Disaster Center 2017; United States Geological Survey 2016*

Table F-56. State Buildings Located in the Moderate Landslide Susceptibility Area by Agency

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Moderate Susceptibility Area	Percent (%) of Total Buildings	Value in the Moderate Susceptibility Area	Percent (%) of Total Value
Dept. of Accounting & General Services	66	$953,963,737.70	5	7.58%	$37,925,560	3.98%
Dept. of Agriculture	70	$147,607,399.20	2	2.86%	$2,925,786	1.98%
Dept. of Attorney General	15	$108,425,479.52	4	26.67%	$5,809,228	5.36%
Dept. of Budget & Finance	16	$28,968,679.42	2	12.50%	$190,394	0.66%
Dept. of Business, Economic Development and Tourism	25	$645,480,378.64	0	0.00%	$0	0.00%
Dept. of Commerce & Consumer Affairs	2	$40,197,359.64	0	0.00%	$0	0.00%
Dept. of Defense	69	$267,352,836.23	3	4.35%	$8,436,844	3.16%
Dept. of Education	4090	$10,598,205,739.17	325	7.95%	$727,264,187	6.86%
Dept. of Hawaiian Home Lands	12	$110,427,352.13	2	16.67%	$2,156,000	1.95%
Dept. of Health	44	$387,068,440.15	3	6.82%	$3,403,157	0.88%
Dept. of Human Resources Development	1	$5,973,872.00	0	0.00%	$0	0.00%
Dept. of Human Services	130	$480,212,293.62	3	2.31%	$2,134,136	0.44%
Dept. of Labor and Industrial Relations	22	$90,076,208.64	4	18.18%	$5,930,131	6.58%
Dept. of Land and Natural Resources	90	$101,441,821.18	0	0.00%	$0	0.00%
Dept. of Public Safety	154	$440,774,414.53	42	27.27%	$33,043,217	7.50%
Dept. of Taxation	1	$7,174,162.00	0	0.00%	$0	0.00%
Dept. of Transportation	68	$2,935,208,213.60	3	4.41%	$124,757,460	4.25%
Hawai'i State Ethics Commission	1	$984,532.99	0	0.00%	$0	0.00%
Hawai'i Health Systems Corporation	106	$1,230,852,871.26	12	11.32%	$116,116,674	9.43%

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Moderate Susceptibility Area	Percent (%) of Total Buildings	Value in the Moderate Susceptibility Area	Percent (%) of Total Value
Hawai'i Housing Finance & Development Corporation	86	$360,851,671.33	1	1.16%	$3,310,800	0.92%
Hawai'i Public Housing Authority	273	$982,981,701.34	24	8.79%	$141,317,042	14.38%
Hawai'i State Legislature	2	$48,555,380.80	0	0.00%	$0	0.00%
Hawai'i State Public Library System	53	$525,584,082.00	3	5.66%	$5,405,343	1.03%
Judiciary	41	$534,877,354.35	5	12.20%	$92,484,641	17.29%
Legislative Reference Bureau	1	$2,996,162.00	0	0.00%	$0	0.00%
Office of Hawaiian Affairs	11	$54,125,645.24	1	9.09%	$339,221	0.63%
Office of the Auditor	2	$1,921,180.17	0	0.00%	$0	0.00%
Office of the Governor	1	$2,996,162.00	0	0.00%	$0	0.00%
Office of the Lieutenant Governor	2	$4,588,849.00	0	0.00%	$0	0.00%
Office of the Ombudsman	1	$1,818,060.00	0	0.00%	$0	0.00%
Research Corporation of the University of Hawai'i	3	$4,189,026.15	0	0.00%	$0	0.00%
University of Hawai'i	637	$5,014,974,502.50	125	19.62%	$426,220,471	8.50%
Total	**6,095**	**$26,120,855,568.50**	**569**	**9.34%**	**$1,739,170,292**	**6.66%**

Source: *State of Hawai'i Risk Management Office 2017; PDC 2017; USGS 2016*

Table F-57 summarizes the number of miles of State roads located in the moderate landslide susceptibility area by county.

Table F-57. State Roads Located in the Moderate Landslide Susceptibility Areas by County

County	Length (in miles)		
	Total Length	Moderate Susceptibility Area Length	Length as % of Total Length
County of Kaua'i	103.714278	3.572557	3.44%
City and County of Honolulu	374.921172	11.658545	3.11%
County of Maui	245.85265	11.075659	4.50%
County of Hawai'i	379.175039	79.12231	20.87%
Total	**1,103.66**	**105.429071**	**9.55%**

Source: *State of Hawaii Department of Transportation 2022; Pacific Disaster Center 2017; United States Geological Survey 2016*

Table F-58 summarizes the number of miles of State roads by state route located in the moderate and high landslide susceptibility areas, organized by county.

Table F-58. State Road Exposure to Moderate and High Landslide Susceptibility Areas by County

State Route	Length (in miles)				
	Total Length	Moderate Hazard Area Length	Hazard Length as % of Total Length	High Hazard Area Length	Hazard Length as % of Total Length
County of Kauaʻi					
State Route 50	32.89242	0.195156	0.59%	0	0.00%
State Route 51	3.457222	0.01879	0.54%	0	0.00%
State Route 56	28.316299	0.504317	1.78%	0.038454	0.14%
State Route 58	2.052085	0	0.00%	0	0.00%
State Route 540	3.884869	0.02868	0.74%	0.00679	0.17%
State Route 541	0.37465	0	0.00%	0	0.00%
State Route 550	14.03193	0.851831	6.07%	0.008885	0.06%
State Route 560	9.98938	1.287252	12.89%	0.143224	1.43%
State Route 570	1.125605	0	0.00%	0	0.00%
State Route 580	6.668581	0.66073	9.91%	0.0357	0.54%
State Route 583	0.921237	0.025801	2.80%	0	0.00%
Total	**103.714278**	**3.572557**	**3.44%**	**0.233053**	**0.22%**
City and County of Honolulu					
State Route 61	21.173569	1.46068	6.90%	0.202416	0.96%
State Route 63	16.618809	1.4983	9.02%	0.272046	1.64%
State Route 64	2.624714	0	0.00%	0	0.00%
State Route 65	6.584201	0.356317	5.41%	0	0.00%
State Route 72	22.766927	0.313863	1.38%	0.119579	0.53%
State Route 76	11.059837	0	0.00%	0	0.00%
State Route 78	1.346173	0	0.00%	0	0.00%
State Route 80	1.893686	0.006471	0.34%	0	0.00%
State Route 83	47.821595	0.333093	0.70%	0.025875	0.05%
State Route 92	18.685552	0	0.00%	0	0.00%
State Route 93	19.522013	0.007545	0.04%	0	0.00%
State Route 98	3.470599	0	0.00%	0	0.00%
State Route 99	41.120805	0.941658	2.29%	0.009963	0.02%
State Route 750	8.056213	0.013218	0.16%	0	0.00%
State Route 901	1.403364	0	0.00%	0	0.00%
State Route 930	10.054945	0.029195	0.29%	0	0.00%
State Route 7012	1.862959	0	0.00%	0	0.00%
State Route 7101	5.865258	0.025513	0.43%	0	0.00%
State Route 7110	0.609843	0.018648	3.06%	0	0.00%
State Route 7141	1.50208	0	0.00%	0	0.00%
State Route 7210	0.115075	0	0.00%	0	0.00%
State Route 7239	0.338737	0	0.00%	0	0.00%
State Route 7241	2.331816	0	0.00%	0	0.00%
State Route 7310	1.041137	0.000082	0.01%	0	0.00%

State Route	Length (in miles)				
	Total Length	Moderate Hazard Area Length	Hazard Length as % of Total Length	High Hazard Area Length	Hazard Length as % of Total Length
State Route 7345	0.554715	0	0.00%	0	0.00%
State Route 7350	0.597196	0	0.00%	0	0.00%
State Route 7351	0.243914	0	0.00%	0	0.00%
State Route 7401	0.214056	0	0.00%	0	0.00%
State Route 7413	0.352495	0	0.00%	0	0.00%
State Route 7415	0.536255	0	0.00%	0	0.00%
State Route 7526	0.397834	0	0.00%	0	0.00%
State Route 7601	0.432591	0	0.00%	0	0.00%
State Route 7801	1.151651	0	0.00%	0	0.00%
State Route 8300	0.501274	0	0.00%	0	0.00%
State Route 8918	0.13352	0	0.00%	0	0.00%
State Route 8930	4.941677	0	0.00%	0	0.00%
State Route 8940	3.321223	0.088322	2.66%	0	0.00%
State Route 8945	0.984948	0	0.00%	0	0.00%
State Route 8955	2.697864	0	0.00%	0	0.00%
State Route H-1	54.2852	0.346488	0.64%	0.018202	0.03%
State Route H-2	16.631646	0.721557	4.34%	0	0.00%
State Route H-201	8.479473	0.132403	1.56%	0.02392	0.28%
State Route H-3	30.593733	5.365192	17.54%	1.083214	3.54%
Total	**374.921172**	**11.658545**	**3.11%**	**1.755215**	**0.47%**
County of Maui					
State Route 30	41.599628	2.90368	6.98%	0.094201	0.23%
State Route 31	7.147053	0	0.00%	0	0.00%
State Route 32	2.855291	0	0.00%	0	0.00%
State Route 36	16.225414	0.259227	1.60%	0	0.00%
State Route 37	21.33757	0.135428	0.63%	0	0.00%
State Route 310	3.609294	0	0.00%	0	0.00%
State Route 311	6.415815	0	0.00%	0	0.00%
State Route 340	4.265623	0.376482	8.83%	0.000138	0.00%
State Route 360	34.838612	5.676019	16.29%	1.400432	4.02%
State Route 377	9.136002	0.031067	0.34%	0	0.00%
State Route 378	10.082808	0.115745	1.15%	0	0.00%
State Route 380	6.197863	0	0.00%	0	0.00%
State Route 440	13.153636	0.013673	0.10%	0	0.00%
State Route 441	0.476716	0	0.00%	0	0.00%
State Route 442	0.022862	0	0.00%	0	0.00%
State Route 450	27.477007	1.283396	4.67%	0.037545	0.14%
State Route 460	16.534641	0.076883	0.46%	0	0.00%
State Route 470	10.74695	0.120089	1.12%	0	0.00%

State Route	Length (in miles)				
	Total Length	Moderate Hazard Area Length	Hazard Length as % of Total Length	High Hazard Area Length	Hazard Length as % of Total Length
State Route 480	5.898639	0	0.00%	0	0.00%
State Route 3000	2.346263	0	0.00%	0	0.00%
State Route 3400	2.635502	0.08397	3.19%	0	0.00%
State Route 3500	1.125483	0	0.00%	0	0.00%
State Route 3800	0.625243	0	0.00%	0	0.00%
State Route 32A	0.400435	0	0.00%	0	0.00%
State Route 32B	0.172196	0	0.00%	0	0.00%
State Route 36A	0.526104	0	0.00%	0	0.00%
Total	**245.85265**	**11.075659**	**4.50%**	**1.532316**	**0.62%**
County of Hawaiʻi					
State Route 11	117.608086	27.707302	23.56%	22.38565	19.03%
State Route 19	93.300605	8.314354	8.91%	48.990845	52.51%
State Route 130	21.68728	20.156852	92.94%	1.531079	7.06%
State Route 139	1.197816	1.197816	100.00%	0	0.00%
State Route 160	3.821277	1.911951	50.03%	0.860508	22.52%
State Route 163	0.133863	0.133863	100.00%	0	0.00%
State Route 190	34.085758	0	0.00%	12.030512	35.29%
State Route 197	1.17843	0.013296	1.13%	0	0.00%
State Route 200	43.219679	15.218116	35.21%	12.472882	28.86%
State Route 220	3.754068	0.186518	4.97%	3.56249	94.90%
State Route 240	9.601941	0.331971	3.46%	8.562659	89.18%
State Route 250	19.266672	0	0.00%	19.229681	99.81%
State Route 270	27.020618	1.212455	4.49%	16.864695	62.41%
State Route 1370	0.191175	0.191175	100.00%	0	0.00%
State Route 1970	0.923307	0.923307	100.00%	0	0.00%
State Route 2000	2.184464	1.623334	74.31%	0.560295	25.65%
Total	**379.175039**	**79.12231**	**20.87%**	**147.051296**	**38.78%**

Source: State of Hawaii Department of Transportation 2022; Pacific Disaster Center 2017; United States Geological Survey 2016

Table F-59 and Table F-60 summarize the number of community lifelines and critical facilities located in the moderate landslide susceptibility area by county and category, respectively.

Table F-59. Community Lifelines and Critical Facilities Located in the Moderate Landslide Susceptibility Area by County

County	Category							
	Communications	Energy	Food, Water, Shelter	Hazardous Material	Health and Medical	Safety and Security	Transportation	Additional Critical Facilities
County of Kauaʻi	0	0	0	0	0	0	0	0
City and County of Honolulu	3	0	4	0	1	0	0	0
County of Maui	0	0	1	0	0	0	0	1
County of Hawaiʻi	10	8	29	1	6	26	12	6
Total	**13**	**8**	**34**	**1**	**7**	**26**	**12**	**7**

Source: Pacific Disaster Center 2017; United States Geological Survey 2016; Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020

Table F-60. Community Lifelines and Critical Facilities Located in the Moderate Landslide Susceptibility Area by Category

Lifeline category	Total Number of Facilities	Total Replacement Cost Value	Number of Facilities in the Moderate Susceptibility Area	Percent (%) of Total Facilities	Value in the Moderate Susceptibility Area	Percent (%) of Total Value
Communications	188	$776,797,683	13	6.91%	$36,499,710	4.70%
Energy	89	$3,093,949,530	8	8.99%	$188,244,650	6.08%
Food, Water, Shelter	345	$11,847,189,588	34	9.86%	$1,117,828,650	9.44%
Hazardous Material	12	$436,474,800	1	8.33%	$36,294,000	8.32%
Health and Medical	193	$4,606,713,364	7	3.63%	$95,711,194	2.08%
Safety and Security	486	$38,164,188,232	26	5.35%	$808,976,729	2.12%
Transportation	56	$2,039,091,600	12	21.43%	$435,528,000	21.36%
Additional Critical Facilities	106	$447,698,794	7	6.60%	$25,925,600	5.79%
Total	**1,475**	**$61,412,103,591**	**108**	**7.32%**	**$2,745,008,532**	**4.47%**

Source: Pacific Disaster Center 2017; United States Geological Survey 2016; Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020

Table F-61 summarizes the population located in the moderate landslide susceptibility area by county.

Table F-61. 2020 U.S. Census Population Located in the Moderate Landslide Susceptibility Area by County

County	Population				
	Total Population	Population in the Moderate Susceptibility Area	Population Exposed as Percent (%) of Total Population	Socially Vulnerable Population in the Moderate Susceptibility Area	Socially Vulnerable Population Exposed as Percent (%) of Total Population
County of Kauaʻi	71,949	7,886	10.96%	1,708	2.37%
City and County of Honolulu	979,682	61,246	6.25%	7,925	0.81%
County of Maui	167,093	8,455	5.06%	1,157	0.69%
County of Hawaiʻi	201,350	76,906	38.20%	23,924	11.88%
Total	**1,420,074**	**154,493**	**10.88%**	**34,714**	**2.44%**

Source: *Pacific Disaster Center 2017; United States Geological Survey 2016; U.S. Census Bureau 2020; Centers for Disease Control and Prevention 2018*

Table F-62 summarizes the buildings located in the moderate landslide susceptibility area by county.

Table F-62. General Building Stock Located in the Moderate Landslide Susceptibility Area

County	Total Replacement Cost Value	Replacement Cost Value in the Moderate Susceptibility Area	% of Total in the Moderate Susceptibility Area
County of Kauaʻi	$24,246,497,228	$149,845,864	0.62%
City and County of Honolulu	$239,152,051,766	$3,707,691,875	1.55%
County of Maui	$50,796,693,140	$369,607,819	0.73%
County of Hawaiʻi	$58,395,349,136	$20,474,065,501	35.06%
Total	**$372,590,591,270**	**$24,701,211,059**	**6.63%**

Source: Pacific Disaster Center 2017; United States Geological Survey 2016; NIYAM IT 2022; United States Army Corps of Engineers 2022

Table F-63 summarizes the square miles of Hawaiian Home Lands located in the moderate landslide susceptibility area by county.

Table F-63. Hawaiian Home Lands Located in the Moderate Landslide Susceptibility Area

County	Area (in square miles)		
	Total Area	Moderate Hazard Area	Hazard Area as % of Total Area
County of Kauaʻi	32.087158	8.954376	27.91%
City and County of Honolulu	10.612342	2.217911	20.90%
County of Maui	102.588953	12.140417	11.83%
County of Hawaiʻi	191.458448	21.261618	11.11%
Total	**336.746901**	**44.574322**	**13.24%**

Source: *Pacific Disaster Center 2017; United States Geological Survey 2016; Hawaii State Department of Hawaiian Homelands 2021*

Table F-64 summarizes the square miles of environmental resources located in the moderate landslide susceptibility area by county.

Table F-64. Environmental Resources Located in Moderate Landslide Susceptibility Area

County	Area (in square miles)		
	Total Area	Moderate Susceptibility Area	Percent (%) of Total Area
County of Kaua'i	919.953924	130.874587	14.23%
City and County of Honolulu	762.964336	121.852822	15.97%
County of Maui	2,109.97	196.687536	9.32%
County of Hawai'i	3,626.96	729.506453	20.11%
Total	**7,419.85**	**1,178.92**	**15.89%**

Source: Pacific Disaster Center 2017; United States Geological Survey 2016; U.S. Fish and Wildlife Service, Pacific Islands Office, 2022, U.S. Fish and Wildlife Service 2021; 2017, Hawaii State Department of Land and Natural Resources, Division of Forestry and Wildlife 2022, NOAA raster nautical charts 2020b, State of Hawaii Department of Land and Natural Resources, Division of State Parks 2021

Table F-65 shows the square miles of the moderate and high landslide susceptibility areas in each State Land Use District in each county.

Table F-65. State Land Use District Located in the Moderate and High Landslide Susceptibility Areas

Land Use District	Area (in square miles)						
	Total Square Miles	Square Miles in Moderate Hazard Area	Hazard Area as % of Total Area	Hazard Area as % of Total Hazard Exposure	Square Miles in High Hazard Area	Hazard Area as % of Total Area	Hazard Area as % of Total Hazard Exposure
County of Kaua'i							
Agricultural	297.078539	41.8072	14.07%	24.55%	5.2489	1.77%	7.63%
Conservation	304.260357	127.864956	42.02%	75.10%	63.505168	20.87%	92.34%
Rural	2.146976	0.078825	3.67%	0.05%	0.006235	0.29%	0.01%
Urban	23.643203	0.515212	2.18%	0.30%	0.014828	0.06%	0.02%
Total	**627.129075**	**170.266193**	**27.15%**	**100.00%**	**68.775131**	**10.97%**	**100.00%**
City and County of Honolulu							
Agricultural	188.479146	30.337508	16.10%	18.91%	3.704832	1.97%	6.77%
Conservation	247.601978	124.42643	50.25%	77.56%	50.788756	20.51%	92.78%
Rural	0	0	0.00%	0.00%	0	0.00%	0.00%
Urban	162.455059	5.662148	3.49%	3.53%	0.249769	0.15%	0.46%
Total	**598.536183**	**160.426086**	**26.80%**	**100.00%**	**54.743357**	**9.15%**	**100.00%**
County of Maui							
Agricultural	637.731138	61.155451	9.59%	28.95%	10.22242	1.60%	10.03%
Conservation	552.35574	149.096308	26.99%	70.58%	91.674086	16.60%	89.93%
Rural	12.824585	0.437947	3.41%	0.21%	0.019259	0.15%	0.02%
Urban	45.187433	0.548873	1.21%	0.26%	0.028955	0.06%	0.03%
Total	**1,248**	**211.238579**	**16.92%**	**100.00%**	**101.94472**	**8.17%**	**100.00%**
County of Hawai'i							
Agricultural	1,850.31	415.576337	22.46%	40.26%	626.362822	33.85%	66.11%
Conservation	2,098.66	592.041591	28.21%	57.36%	306.871234	14.62%	32.39%
Rural	1.36344	0.283389	20.78%	0.03%	0.161795	11.87%	0.02%
Urban	87.847736	24.28247	27.64%	2.35%	14.08882	16.04%	1.49%
Total	**4,038**	**1032.183787**	**25.56%**	**100.00%**	**947.484671**	**23.46%**	**100.00%**

Source: Pacific Disaster Center 2017; United States Geological Survey 2016; State Land Use Commission, Hawaii Statewide GIS Program 2021; Honolulu County GIS 2022

F.13 Terrorism

There are no additional tables to support Section 4.12 (Terrorism).

F.14 Tsunami

Table F-66 summarizes the number of miles of State roads by state route located in the Great Aleutian Tsunami (GAT) 1,500-year inundation area, organized by county.

Table F-66. State Roads Located in the GAT Inundation Areas by County

State Route	Length (in miles)		
	Total Length	Length in the GAT Inundation Area	Exposed Length as Percent (%) of Total Length
County of Kaua'i			
State Route 50	32.89242	10.028536	30.49%
State Route 51	3.457222	0.542591	15.69%
State Route 56	28.316299	6.630772	23.42%
State Route 58	2.052085	0.190304	9.27%
State Route 540	3.884869	0	0.00%
State Route 541	0.37465	0	0.00%
State Route 550	14.03193	0.07624	0.54%
State Route 560	9.98938	6.952468	69.60%
State Route 570	1.125605	0	0.00%
State Route 580	6.668581	0.793255	11.90%
State Route 583	0.921237	0	0.00%
Total	**103.714278**	**25.214166**	**24.31%**
City and County of Honolulu			
State Route 61	21.173569	0.094669	0.45%
State Route 63	16.618809	0	0.00%
State Route 64	2.624714	1.084624	41.32%
State Route 65	6.584201	2.118	32.17%
State Route 72	22.766927	13.49105	59.26%
State Route 76	11.059837	1.602284	14.49%
State Route 78	1.346173	0.02011	1.49%
State Route 80	1.893686	0	0.00%
State Route 83	47.821595	32.239486	67.42%
State Route 92	18.685552	8.94591	47.88%
State Route 93	19.522013	14.176511	72.62%
State Route 98	3.470599	0.013183	0.38%
State Route 99	41.120805	0.018754	0.05%
State Route 750	8.056213	0	0.00%
State Route 901	1.403364	0	0.00%
State Route 930	10.054945	8.996766	89.48%
State Route 7012	1.862959	0	0.00%
State Route 7101	5.865258	0.005478	0.09%
State Route 7110	0.609843	0	0.00%
State Route 7141	1.50208	0	0.00%
State Route 7210	0.115075	0	0.00%
State Route 7239	0.338737	0	0.00%
State Route 7241	2.331816	0	0.00%

State Route	Length (in miles)		
	Total Length	Length in the GAT Inundation Area	Exposed Length as Percent (%) of Total Length
State Route 7310	1.041137	0	0.00%
State Route 7345	0.554715	0	0.00%
State Route 7350	0.597196	0	0.00%
State Route 7351	0.243914	0	0.00%
State Route 7401	0.214056	0.049583	23.16%
State Route 7413	0.352495	0	0.00%
State Route 7415	0.536255	0.073976	13.79%
State Route 7526	0.397834	0	0.00%
State Route 7601	0.432591	0	0.00%
State Route 7801	1.151651	0	0.00%
State Route 8300	0.501274	0.49791	99.33%
State Route 8918	0.13352	0	0.00%
State Route 8930	4.941677	0	0.00%
State Route 8940	3.321223	0	0.00%
State Route 8945	0.984948	0	0.00%
State Route 8955	2.697864	1.565256	58.02%
State Route H-1	54.2852	0.847504	1.56%
State Route H-2	16.631646	0	0.00%
State Route H-201	8.479473	0.022862	0.27%
State Route H-3	30.593733	0.160586	0.52%
Total	**374.921172**	**86.024502**	**22.94%**
County of Maui			
State Route 30	41.599628	10.640062	25.58%
State Route 31	7.147053	0.141721	1.98%
State Route 32	2.855291	1.340891	46.96%
State Route 36	16.225414	5.776363	35.60%
State Route 37	21.33757	0	0.00%
State Route 310	3.609294	2.7774	76.95%
State Route 311	6.415815	0.817928	12.75%
State Route 340	4.265623	0	0.00%
State Route 360	34.838612	0.551064	1.58%
State Route 377	9.136002	0	0.00%
State Route 378	10.082808	0	0.00%
State Route 380	6.197863	1.237279	19.96%
State Route 440	13.153636	0	0.00%
State Route 441	0.476716	0	0.00%
State Route 442	0.022862	0	0.00%
State Route 450	27.477007	0	0.00%
State Route 460	16.534641	0	0.00%
State Route 470	10.74695	0	0.00%
State Route 480	5.898639	0	0.00%
State Route 3000	2.346263	0	0.00%
State Route 3400	2.635502	2.335371	88.61%
State Route 3500	1.125483	1.125483	100.00%
State Route 3800	0.625243	0.625243	100.00%
State Route 32A	0.400435	0.400435	100.00%
State Route 32B	0.172196	0.172196	100.00%
State Route 36A	0.526104	0.526104	100.00%
Total	**245.85265**	**28.46754**	**11.58%**

State Route	Length (in miles)		
	Total Length	Length in the GAT Inundation Area	Exposed Length as Percent (%) of Total Length
County of Hawaiʻi			
State Route 11	117.608086	1.697427	1.44%
State Route 19	93.300605	2.394614	2.57%
State Route 130	21.68728	0	0.00%
State Route 139	1.197816	0	0.00%
State Route 160	3.821277	0	0.00%
State Route 163	0.133863	0	0.00%
State Route 190	34.085758	0	0.00%
State Route 197	1.17843	0	0.00%
State Route 200	43.219679	0	0.00%
State Route 220	3.754068	0	0.00%
State Route 240	9.601941	0	0.00%
State Route 250	19.266672	0	0.00%
State Route 270	27.020618	0.791641	2.93%
State Route 1370	0.191175	0.191175	100.00%
State Route 1970	0.923307	0.923307	100.00%
State Route 2000	2.184464	0	0.00%
Total	379.175039	5.998164	1.58%

Source: State of Hawaii Department of Transportation 2022; Tetra Tech Requested Data from Doug Bausch 2022

Table F-67 summarizes the number of miles of State roads by state route located in the School of Ocean & Earth Science & Technology (SOEST) Historic 200-year inundation area, organized by county.

Table F-67. State Roads Located in the SOEST Inundation Areas by County

State Route	Length (in miles)		
	Total Length	Length in the SOEST Inundation Area	Exposed Length as Percent (%) of Total Length
County of Kauaʻi			
State Route 50	32.89242	7.369799	22.41%
State Route 51	3.457222	0.405717	11.74%
State Route 56	28.316299	3.912052	13.82%
State Route 58	2.052085	0.10293	5.02%
State Route 540	3.884869	0	0.00%
State Route 541	0.37465	0	0.00%
State Route 550	14.03193	0	0.00%
State Route 560	9.98938	6.069609	60.76%
State Route 570	1.125605	0	0.00%
State Route 580	6.668581	0.583143	8.74%
State Route 583	0.921237	0	0.00%
Total	**103.714278**	**18.44325**	**17.78%**
City and County of Honolulu			
State Route 61	21.173569	0	0.00%
State Route 63	16.618809	0	0.00%
State Route 64	2.624714	0.590152	22.48%
State Route 65	6.584201	0	0.00%
State Route 72	22.766927	8.957422	39.34%

State Route	Length (in miles)		
	Total Length	Length in the SOEST Inundation Area	Exposed Length as Percent (%) of Total Length
State Route 76	11.059837	0.736724	6.66%
State Route 78	1.346173	0	0.00%
State Route 80	1.893686	0	0.00%
State Route 83	47.821595	19.955558	41.73%
State Route 92	18.685552	7.308601	39.11%
State Route 93	19.522013	4.400002	22.54%
State Route 98	3.470599	0.001802	0.05%
State Route 99	41.120805	0	0.00%
State Route 750	8.056213	0	0.00%
State Route 901	1.403364	0	0.00%
State Route 930	10.054945	3.275856	32.58%
State Route 7012	1.862959	0	0.00%
State Route 7101	5.865258	0	0.00%
State Route 7110	0.609843	0	0.00%
State Route 7141	1.50208	0	0.00%
State Route 7210	0.115075	0	0.00%
State Route 7239	0.338737	0	0.00%
State Route 7241	2.331816	0	0.00%
State Route 7310	1.041137	0	0.00%
State Route 7345	0.554715	0	0.00%
State Route 7350	0.597196	0	0.00%
State Route 7351	0.243914	0	0.00%
State Route 7401	0.214056	0.00398	1.86%
State Route 7413	0.352495	0	0.00%
State Route 7415	0.536255	0	0.00%
State Route 7526	0.397834	0	0.00%
State Route 7601	0.432591	0	0.00%
State Route 7801	1.151651	0	0.00%
State Route 8300	0.501274	0.019025	3.80%
State Route 8918	0.13352	0	0.00%
State Route 8930	4.941677	0	0.00%
State Route 8940	3.321223	0	0.00%
State Route 8945	0.984948	0	0.00%
State Route 8955	2.697864	0.909003	33.69%
State Route H-1	54.2852	0.054125	0.10%
State Route H-2	16.631646	0	0.00%
State Route H-201	8.479473	0	0.00%
State Route H-3	30.593733	0	0.00%
Total	**374.921172**	**46.21225**	**12.33%**
County of Maui			
State Route 30	41.599628	8.889797	21.37%
State Route 31	7.147053	0.019082	0.27%
State Route 32	2.855291	1.161511	40.68%
State Route 36	16.225414	3.21006	19.78%
State Route 37	21.33757	0	0.00%
State Route 310	3.609294	2.599272	72.02%
State Route 311	6.415815	0.013102	0.20%
State Route 340	4.265623	0	0.00%

State Route	Length (in miles)		
	Total Length	Length in the SOEST Inundation Area	Exposed Length as Percent (%) of Total Length
State Route 360	34.838612	0.304864	0.88%
State Route 377	9.136002	0	0.00%
State Route 378	10.082808	0	0.00%
State Route 380	6.197863	0.633966	10.23%
State Route 440	13.153636	0	0.00%
State Route 441	0.476716	0	0.00%
State Route 442	0.022862	0	0.00%
State Route 450	27.477007	0	0.00%
State Route 460	16.534641	0	0.00%
State Route 470	10.74695	0	0.00%
State Route 480	5.898639	0	0.00%
State Route 3000	2.346263	0	0.00%
State Route 3400	2.635502	1.664009	63.14%
State Route 3500	1.125483	0.678861	60.32%
State Route 3800	0.625243	0.573952	91.80%
State Route 32A	0.400435	0.400435	100.00%
State Route 32B	0.172196	0.172196	100.00%
State Route 36A	0.526104	0.526104	100.00%
Total	**245.85265**	**20.847211**	**8.48%**
County of Hawaiʻi			
State Route 11	117.608086	0.275093	0.23%
State Route 19	93.300605	2.1069	2.26%
State Route 130	21.68728	0	0.00%
State Route 139	1.197816	0	0.00%
State Route 160	3.821277	0	0.00%
State Route 163	0.133863	0	0.00%
State Route 190	34.085758	0	0.00%
State Route 197	1.17843	0	0.00%
State Route 200	43.219679	0	0.00%
State Route 220	3.754068	0	0.00%
State Route 240	9.601941	0	0.00%
State Route 250	19.266672	0	0.00%
State Route 270	27.020618	0.574472	2.13%
State Route 1370	0.191175	0.191175	100.00%
State Route 1970	0.923307	0.17173	18.60%
State Route 2000	2.184464	0	0.00%
Total	**379.175039**	**3.31937**	**0.88%**

Source: State of Hawaii Department of Transportation 2022; Tetra Tech Requested Data from Doug Bausch 2022

Table F-68 summarizes the number of miles of State roads by state route located in the American Society of Civil Engineers (ASCE) Design Inundation Mapping 3,500-year inundation area, organized by county.

Table F-68. State Roads Located in the ASCE Inundation Areas by County

State Route	Length (in miles)		
	Total Length	Length in the ASCE Inundation Area	Exposed Length as Percent (%) of Total Length
County of Kauaʻi			
State Route 50	32.89242	10.970833	33.35%
State Route 51	3.457222	0.491771	14.22%
State Route 56	28.316299	6.920334	24.44%
State Route 58	2.052085	0.221808	10.81%
State Route 540	3.884869	0	0.00%
State Route 541	0.37465	0.05865	15.65%
State Route 550	14.03193	0.059935	0.43%
State Route 560	9.98938	7.742265	77.50%
State Route 570	1.125605	0	0.00%
State Route 580	6.668581	0.783235	11.75%
State Route 583	0.921237	0	0.00%
Total	**103.714278**	**27.248831**	**26.27%**
City and County of Honolulu			
State Route 61	21.173569	0.307678	1.45%
State Route 63	16.618809	0.108273	0.65%
State Route 64	2.624714	2.49981	95.24%
State Route 65	6.584201	2.581254	39.20%
State Route 72	22.766927	15.580219	68.43%
State Route 76	11.059837	2.436119	22.03%
State Route 78	1.346173	0.11694	8.69%
State Route 80	1.893686	0	0.00%
State Route 83	47.821595	34.125508	71.36%
State Route 92	18.685552	12.415322	66.44%
State Route 93	19.522013	15.550088	79.65%
State Route 98	3.470599	0.487493	14.05%
State Route 99	41.120805	0.453849	1.10%
State Route 750	8.056213	0	0.00%
State Route 901	1.403364	0	0.00%
State Route 930	10.054945	9.748388	96.95%
State Route 7012	1.862959	0	0.00%
State Route 7101	5.865258	0.145763	2.49%
State Route 7110	0.609843	0	0.00%
State Route 7141	1.50208	0	0.00%
State Route 7210	0.115075	0	0.00%
State Route 7239	0.338737	0	0.00%
State Route 7241	2.331816	0	0.00%
State Route 7310	1.041137	0.393042	37.75%
State Route 7345	0.554715	0	0.00%
State Route 7350	0.597196	0	0.00%
State Route 7351	0.243914	0	0.00%
State Route 7401	0.214056	0.13517	63.15%
State Route 7413	0.352495	0.167325	47.47%
State Route 7415	0.536255	0.215236	40.14%
State Route 7526	0.397834	0	0.00%
State Route 7601	0.432591	0	0.00%
State Route 7801	1.151651	0	0.00%

State Route	Length (in miles)		
	Total Length	Length in the ASCE Inundation Area	Exposed Length as Percent (%) of Total Length
State Route 8300	0.501274	0.501274	100.00%
State Route 8918	0.13352	0	0.00%
State Route 8930	4.941677	0	0.00%
State Route 8940	3.321223	0	0.00%
State Route 8945	0.984948	0	0.00%
State Route 8955	2.697864	1.623758	60.19%
State Route H-1	54.2852	2.707129	4.99%
State Route H-2	16.631646	0	0.00%
State Route H-201	8.479473	0.057569	0.68%
State Route H-3	30.593733	0.886405	2.90%
Total	**374.921172**	**103.243612**	**27.54%**
County of Maui			
State Route 30	41.599628	14.828809	35.65%
State Route 31	7.147053	1.309341	18.32%
State Route 32	2.855291	1.486423	52.06%
State Route 36	16.225414	7.546228	46.51%
State Route 37	21.33757	0	0.00%
State Route 310	3.609294	2.839494	78.67%
State Route 311	6.415815	2.688327	41.90%
State Route 340	4.265623	0.752489	17.64%
State Route 360	34.838612	0.793641	2.28%
State Route 377	9.136002	0	0.00%
State Route 378	10.082808	0	0.00%
State Route 380	6.197863	1.424836	22.99%
State Route 440	13.153636	0	0.00%
State Route 441	0.476716	0	0.00%
State Route 442	0.022862	0	0.00%
State Route 450	27.477007	0	0.00%
State Route 460	16.534641	0	0.00%
State Route 470	10.74695	0	0.00%
State Route 480	5.898639	0	0.00%
State Route 3000	2.346263	0	0.00%
State Route 3400	2.635502	2.243248	85.12%
State Route 3500	1.125483	1.125483	100.00%
State Route 3800	0.625243	0.625243	100.00%
State Route 32A	0.400435	0.400435	100.00%
State Route 32B	0.172196	0.172196	100.00%
State Route 36A	0.526104	0.526104	100.00%
Total	**245.85265**	**38.762297**	**15.77%**
County of Hawai'i			
State Route 11	117.608086	1.536022	1.31%
State Route 19	93.300605	4.177425	4.48%
State Route 130	21.68728	0	0.00%
State Route 139	1.197816	0	0.00%
State Route 160	3.821277	0	0.00%
State Route 163	0.133863	0	0.00%
State Route 190	34.085758	0	0.00%
State Route 197	1.17843	0	0.00%
State Route 200	43.219679	0	0.00%

State Route	Length (in miles)		
	Total Length	Length in the ASCE Inundation Area	Exposed Length as Percent (%) of Total Length
State Route 220	3.754068	0	0.00%
State Route 240	9.601941	0	0.00%
State Route 250	19.266672	0	0.00%
State Route 270	27.020618	1.191273	4.41%
State Route 1370	0.191175	0.191175	100.00%
State Route 1970	0.923307	0.923307	100.00%
State Route 2000	2.184464	0	0.00%
Total	**379.175039**	**8.019202**	**2.11%**

Source: *State of Hawaii Department of Transportation 2022; Tetra Tech Requested Data from Doug Bausch 2022*

Table F-69 shows the square miles of the GAT inundation area in each State Land Use District in each county.

Table F-69. State Land Use Districts Located in the GAT Hazard Area

Land Use District	Area (in square miles)			
	Total Square Miles	Square Miles in the GAT Hazard Area	Hazard Area as % of Total Area	Hazard Area as % of Total Hazard Exposure
County of Kauaʻi				
Agricultural	297.078539	16.494	5.55%	58.40%
Conservation	304.260357	6.934	2.28%	24.55%
Rural	2.146976	0.274	12.76%	0.97%
Urban	23.643203	4.542	19.21%	16.08%
Total	**627.129075**	**28.244**	**4.50%**	**100.00%**
City and County of Honolulu				
Agricultural	188.479146	14.926	7.92%	28.81%
Conservation	247.601978	4.547	1.84%	8.78%
Rural	0	0.000	0.00%	0.00%
Urban	162.455059	32.341	19.91%	62.42%
Total	**598.536183**	**51.814**	**8.66%**	**100.00%**
County of Maui				
Agricultural	637.731138	4.849	0.76%	29.53%
Conservation	552.35574	2.898	0.52%	17.64%
Rural	12.824585	0.297	2.32%	1.81%
Urban	45.187433	8.380	18.54%	51.02%
Total	**1,248**	**16.424**	**1.32%**	**100.00%**
County of Hawaiʻi				
Agricultural	1,850.31	5.969	0.32%	32.50%
Conservation	2,098.66	4.000	0.19%	21.78%
Rural	1.36344	0.000	0.00%	0.00%
Urban	87.847736	8.397	9.56%	45.72%
Total	**4,038**	**18.367**	**0.45%**	**100.00%**

Source: *Tetra Tech Requested Data from Doug Bausch 2022; State Land Use Commission, Hawaii Statewide GIS Program 2021; Honolulu County GIS 2022*

Table F-70 shows the square miles of the SOEST inundation area in each State Land Use District in each county.

Table F-70. State Land Use Districts Located in the SOEST Hazard Area

Land Use District	Area (in square miles)			
	Total Square Miles	Square Miles in the SOEST Hazard Area	Hazard Area as % of Total Area	Hazard Area as % of Total Hazard Exposure
County of Kaua'i				
Agricultural	297.078539	11.918	4.01%	59.32%
Conservation	304.260357	4.658	1.53%	23.18%
Rural	2.146976	0.166	7.73%	0.83%
Urban	23.643203	3.351	14.17%	16.68%
Total	**627.129075**	**20.092**	**3.20%**	**100.00%**
City and County of Honolulu				
Agricultural	188.479146	5.360	2.84%	30.66%
Conservation	247.601978	1.239	0.50%	7.09%
Rural	0	0.000	0.00%	0.00%
Urban	162.455059	10.880	6.70%	62.25%
Total	**598.536183**	**17.479**	**2.92%**	**100.00%**
County of Maui				
Agricultural	637.731138	2.137	0.34%	20.26%
Conservation	552.35574	2.578	0.47%	24.45%
Rural	12.824585	0.219	1.71%	2.08%
Urban	45.187433	5.612	12.42%	53.22%
Total	**1,248**	**10.546**	**0.84%**	**100.00%**
County of Hawai'i				
Agricultural	1,850.31	0.414	0.02%	6.45%
Conservation	2,098.66	2.232	0.11%	34.83%
Rural	1.36344	0.000	0.00%	0.00%
Urban	87.847736	3.762	4.28%	58.71%
Total	**4,038**	**6.408**	**0.16%**	**100.00%**

Source: Tetra Tech Requested Data from Doug Bausch 2022; State Land Use Commission, Hawaii Statewide GIS Program 2021; Honolulu County GIS 2022

Table F-71 shows the square miles of the ASCE inundation area in each State Land Use District in each county.

Table F-71. State Land Use Districts Located in the ASCE Hazard Area

Land Use District	Area (in square miles)			
	Total Square Miles	Square Miles in the ASCE Hazard Area	Hazard Area as % of Total Area	Hazard Area as % of Total Hazard Exposure
County of Kaua'i				
Agricultural	297.078539	18.398	6.19%	59.26%
Conservation	304.260357	7.445	2.45%	23.98%
Rural	2.146976	0.322	15.01%	1.04%
Urban	23.643203	4.879	20.64%	15.72%
Total	**627.129075**	**31.044**	**4.95%**	**100.00%**

Land Use District	Area (in square miles)			
	Total Square Miles	Square Miles in the ASCE Hazard Area	Hazard Area as % of Total Area	Hazard Area as % of Total Hazard Exposure
City and County of Honolulu				
Agricultural	188.479146	17.959	9.53%	24.37%
Conservation	247.601978	4.922	1.99%	6.68%
Rural	0	0.000	0.00%	0.00%
Urban	162.455059	50.803	31.27%	68.95%
Total	**598.536183**	**73.683**	**12.31%**	**100.00%**
County of Maui				
Agricultural	637.731138	8.419	1.32%	35.59%
Conservation	552.35574	4.262	0.77%	18.02%
Rural	12.824585	0.384	2.99%	1.62%
Urban	45.187433	10.590	23.44%	44.77%
Total	**1,248**	**23.655**	**1.90%**	**100.00%**
County of Hawaiʻi				
Agricultural	1,850.31	14.047	0.76%	38.15%
Conservation	2,098.66	10.678	0.51%	29.00%
Rural	1.36344	0.001	0.10%	0.00%
Urban	87.847736	12.098	13.77%	32.85%
Total	**4,038**	**36.825**	**0.91%**	**100.00%**

Source: Tetra Tech Requested Data from Doug Bausch 2022; State Land Use Commission, Hawaii Statewide GIS Program 2021; Honolulu County GIS 2022

F.15 Volcanic Hazards

Table F-72 summarizes the number of miles of State roads by state route located in the lava flow hazard areas, organized by county. There are no lava flow zones available in the County of Kauaʻi and City and County of Honolulu; therefore, no results are reported.

Table F-72. State Roads Located in the Lava Flow Hazard Areas by County

State Route	Length (in miles)				
	Total Length	Hawaiʻi Lava Flow Hazard Area Length	Hazard Length as % of Total Length	Maui Lava Flow Hazard Area Length	Hazard Length as % of Total Length
County of Maui					
State Route 30	41.599628	0	0	0	0.00%
State Route 31	7.147053	0	0	4.900278	68.56%
State Route 32	2.855291	0	0	0	0.00%
State Route 36	16.225414	0	0	0	0.00%
State Route 37	21.33757	0	0	5.718588	26.80%
State Route 310	3.609294	0	0	0	0.00%
State Route 311	6.415815	0	0	0	0.00%
State Route 340	4.265623	0	0	0	0.00%
State Route 360	34.838612	0	0	11.492933	32.99%
State Route 377	9.136002	0	0	0	0.00%
State Route 378	10.082808	0	0	0	0.00%

State Route	Length (in miles)				
	Total Length	Hawaiʻi Lava Flow Hazard Area Length	Hazard Length as % of Total Length	Maui Lava Flow Hazard Area Length	Hazard Length as % of Total Length
State Route 380	6.197863	0	0	0	0.00%
State Route 440	13.153636	0	0	0	0.00%
State Route 441	0.476716	0	0	0	0.00%
State Route 442	0.022862	0	0	0	0.00%
State Route 450	27.477007	0	0	0	0.00%
State Route 460	16.534641	0	0	0	0.00%
State Route 470	10.74695	0	0	0	0.00%
State Route 480	5.898639	0	0	0	0.00%
State Route 3000	2.346263	0	0	0	0.00%
State Route 3400	2.635502	0	0	0	0.00%
State Route 3500	1.125483	0	0	0	0.00%
State Route 3800	0.625243	0	0	0	0.00%
State Route 32A	0.400435	0	0	0	0.00%
State Route 32B	0.172196	0	0	0	0.00%
State Route 36A	0.526104	0	0	0	0.00%
Total	**245.85265**	**0**	**0**	**22.111799**	**8.99%**
County of Hawaiʻi					
State Route 11	117.608086	109.641045	93.23%	0	0.00%
State Route 19	93.300605	30.090763	32.25%	0	0.00%
State Route 130	21.68728	21.68728	100.00%	0	0.00%
State Route 139	1.197816	1.197816	100.00%	0	0.00%
State Route 160	3.821277	3.821277	100.00%	0	0.00%
State Route 163	0.133863	0.133863	100.00%	0	0.00%
State Route 190	34.085758	21.612995	63.41%	0	0.00%
State Route 197	1.17843	1.17843	100.00%	0	0.00%
State Route 200	43.219679	26.017024	60.20%	0	0.00%
State Route 220	3.754068	0	0.00%	0	0.00%
State Route 240	9.601941	0	0.00%	0	0.00%
State Route 250	19.266672	0	0.00%	0	0.00%
State Route 270	27.020618	0	0.00%	0	0.00%
State Route 1370	0.191175	0.191175	100.00%	0	0.00%
State Route 1970	0.923307	0.923307	100.00%	0	0.00%
State Route 2000	2.184464	2.184464	100.00%	0	0.00%
Total	**379.175039**	**218.679439**	**57.67%**	**0**	**0.00%**

Source: State of Hawaii Department of Transportation 2022; U.S. Geological Survey, Hawaiian Volcano Observatory 1992; U.S. Geological Survey 2006

Notes: County of Kauaʻi and City and County of Honolulu do not have USGS-produced lava flow maps.

Table F-73 shows the square miles of the lava flow hazard areas in each State Land Use District in each county. There are no lava flow zones available in the County of Kauaʻi and City and County of Honolulu; therefore, no results are reported.

Table F-73. State Land Use Districts Located in the Lava Flow Hazard Area by County

Land Use District	Area (in square miles)			
	Total Square Miles	Square Miles in Volcano Hazard Area	Hazard Area as % of Total Area	Hazard Area as % of Total Hazard Exposure
County of Maui				
Agricultural	637.731138	108.453385	17.01%	50.97%
Conservation	552.35574	95.007087	17.20%	44.65%
Rural	12.824585	1.919147	14.96%	0.90%
Urban	45.187433	7.416911	16.41%	3.49%
Total	**1,248**	**212.79653**	**17.05%**	**100.00%**
County of Hawaiʻi				
Agricultural	1,850.31	1014.202448	54.81%	38.24%
Conservation	2,098.66	1,568.82	74.75%	59.15%
Rural	1.36344	1.04	76.64%	0.04%
Urban	87.847736	68.076506	77.49%	2.57%
Total	**4,038**	**2652.145692**	**65.68%**	**100.00%**

Source: State Land Use Commission, Hawaii Statewide GIS Program 2021; Honolulu County GIS 2022; U.S. Geological Survey, Hawaiian Volcano Observatory 1992; U.S. Geological Survey 2006

F.16 Wildfire

Table F-74 and Table F-75 summarize the number of State buildings located in the moderate wildfire risk area by county and agency, respectively.

Table F-74. State Buildings Located in the Moderate Wildfire Risk Hazard Areas by County

County	Total Number of State Buildings	Total Replacement Cost Value	Moderate Wildfire Risk			
			Number of State Buildings in Moderate Wildfire Risk Hazard Area	Percent (%) of Total	Total Value of State Buildings in Moderate Wildfire Risk Hazard Area	Percent (%) of Total
County of Kauaʻi	531	$990,850,824.17	12	2.26%	$15,031,325.00	1.52%
City and County of Honolulu	3,472	$17,393,945,914.79	795	22.90%	$2,733,290,236.00	15.71%
County of Maui	831	$3,097,491,688.71	115	13.84%	$679,605,530.20	21.94%
County of Hawaiʻi	1,261	$4,638,567,140.82	69	5.47%	$164,570,533.70	3.55%
Total	**6,095**	**$26,120,855,568.50**	**991**	**16.26%**	**$3,592,497,624.90**	**13.75%**

Source: State of Hawaii Risk Management Office 2017; Hawaii Wildfire Management Organization, Division of Forestry and Wildlife

Table F-75. State Buildings Located in the Moderate Wildfire Risk Hazard Areas by Agency

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in the Moderate Hazard Area	Percent (%) of Total Buildings	Value in the Moderate Hazard Area	Percent (%) of Total Value
Dept. of Accounting & General Services	66	$953,963,737.70	3	4.55%	$11,815,083	1.24%
Dept. of Agriculture	70	$147,607,399.20	4	5.71%	$1,531,739	1.04%
Dept. of Attorney General	15	$108,425,479.52	1	6.67%	$345,153	0.32%
Dept. of Budget & Finance	16	$28,968,679.42	1	6.25%	$446,086	1.54%
Dept. of Business, Economic Development and Tourism	25	$645,480,378.64	13	52.00%	$14,339,661	2.22%
Dept. of Commerce & Consumer Affairs	2	$40,197,359.64	0	0.00%	$0	0.00%
Dept. of Defense	69	$267,352,836.23	34	49.28%	$115,691,662	43.27%
Dept. of Education	4090	$10,598,205,739.17	690	16.87%	$2,092,045,789	19.74%
Dept. of Hawaiian Home Lands	12	$110,427,352.13	4	33.33%	$6,403,080	5.80%
Dept. of Health	44	$387,068,440.15	20	45.45%	$199,301,863	51.49%
Dept. of Human Resources Development	1	$5,973,872.00	0	0.00%	$0	0.00%
Dept. of Human Services	130	$480,212,293.62	17	13.08%	$37,402,374	7.79%
Dept. of Labor and Industrial Relations	22	$90,076,208.64	2	9.09%	$3,329,392	3.70%
Dept. of Land and Natural Resources	90	$101,441,821.18	9	10.00%	$2,258,695	2.23%
Dept. of Public Safety	154	$440,774,414.53	12	7.79%	$48,046,007	10.90%
Dept. of Taxation	1	$7,174,162.00	0	0.00%	$0	0.00%
Dept. of Transportation	68	$2,935,208,213.60	5	7.35%	$54,169,850	1.85%
Hawai'i State Ethics Commission	1	$984,532.99	0	0.00%	$0	0.00%
Hawai'i Health Systems Corporation	106	$1,230,852,871.26	15	14.15%	$208,117,978	16.91%
Hawai'i Housing Finance & Development Corporation	86	$360,851,671.33	0	0.00%	$0	0.00%
Hawai'i Public Housing Authority	273	$982,981,701.34	54	19.78%	$276,533,029	28.13%
Hawai'i State Legislature	2	$48,555,380.80	0	0.00%	$0	0.00%
Hawai'i State Public Library System	53	$525,584,082.00	7	13.21%	$26,447,878	5.03%

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in the Moderate Hazard Area	Percent (%) of Total Buildings	Value in the Moderate Hazard Area	Percent (%) of Total Value
Judiciary	41	$534,877,354.35	5	12.20%	$15,616,867	2.92%
Legislative Reference Bureau	1	$2,996,162.00	0	0.00%	$0	0.00%
Office of Hawaiian Affairs	11	$54,125,645.24	1	9.09%	$106,463	0.20%
Office of the Auditor	2	$1,921,180.17	0	0.00%	$0	0.00%
Office of the Governor	1	$2,996,162.00	0	0.00%	$0	0.00%
Office of the Lieutenant Governor	2	$4,588,849.00	0	0.00%	$0	0.00%
Office of the Ombudsman	1	$1,818,060.00	0	0.00%	$0	0.00%
Research Corporation of the University of Hawai'i	3	$4,189,026.15	0	0.00%	$0	0.00%
University of Hawai'i	637	$5,014,974,502.50	94	14.76%	$478,548,977	9.54%
Total	**6095**	**$26,120,855,568.50**	**991**	**16.26%**	**$3,592,497,624**	**13.75%**

Source: State of Hawaii Risk Management Office 2017; Hawaii Wildfire Management Organization, Division of Forestry and Wildlife

Table F-76 summarizes the total number of miles of State roads located in the low and moderate wildfire risk areas by county.

Table F-76 State Roads Located in the Low and Moderate Wildfire Risk Hazard Areas by County

County	Length (in miles)				
	Total Length	Length in the Low Wildfire Risk Hazard Area	Percent (%) of Total Length	Length in the Moderate Wildfire Risk Hazard Area	Percent (%) of Total Length
County of Kaua'i	103.714278	16.715987	16.12%	6.158878	5.94%
City and County of Honolulu	374.921172	66.66374	17.78%	61.316717	16.35%
County of Maui	245.85265	53.626263	21.81%	22.037993	8.96%
County of Hawai'i	379.175039	91.943879	24.25%	27.621771	7.28%
Total	**1,103.66**	**228.949869**	**20.74%**	**117.135359**	**10.61%**

Source: State of Hawaii Department of Transportation 2022; Hawaii Wildfire Management Organization, Division of Forestry and Wildlife

Table F-77 summarizes the number of miles of State roads by state route located in the low, moderate, and high wildfire risk areas, organized by county.

Table F-77. State Road Exposure to Low, Moderate, and High Wildfire Risk Hazard Areas

State Route	Length (in miles)						
	Total Length	Low	Exposed Length as % of Total Length	Moderate	Exposed Length as % of Total Length	High	Exposed Length as % of Total Length
County of Kaua'i							
State Route 50	32.89242	1.822218	5.54%	0.959554	2.92%	10.01291	30.44%
State Route 51	3.457222	0	0.00%	0	0.00%	2.23557	64.66%
State Route 56	28.316299	5.944573	20.99%	1.207639	4.26%	12.826033	45.30%
State Route 58	2.052085	0	0.00%	0	0.00%	2.052085	100.00%
State Route 540	3.884869	0	0.00%	0.370198	9.53%	0.430511	11.08%
State Route 541	0.37465	0	0.00%	0	0.00%	0.37465	100.00%
State Route 550	14.03193	0	0.00%	0	0.00%	3.379203	24.08%
State Route 560	9.98938	8.949196	89.59%	0	0.00%	0	0.00%
State Route 570	1.125605	0	0.00%	0	0.00%	1.125605	100.00%
State Route 580	6.668581	0	0.00%	3.621487	54.31%	0.34591	5.19%
State Route 583	0.921237	0	0.00%	0	0.00%	0	0.00%
Total	**103.714278**	**16.715987**	**16.12%**	**6.158878**	**5.94%**	**32.782477**	**31.61%**
City and County of Honolulu							
State Route 61	21.173569	7.046414	33.28%	4.837746	22.85%	0	0.00%
State Route 63	16.618809	1.739868	10.47%	8.405708	50.58%	0	0.00%
State Route 64	2.624714	1.102798	42.02%	0	0.00%	0	0.00%
State Route 65	6.584201	0	0.00%	0	0.00%	6.584201	100.00%
State Route 72	22.766927	0.337241	1.48%	10.038096	44.09%	9.875287	43.38%
State Route 76	11.059837	0	0.00%	2.151261	19.45%	8.361009	75.60%
State Route 78	1.346173	0	0.00%	0	0.00%	1.346173	100.00%
State Route 80	1.893686	0	0.00%	0	0.00%	1.588637	83.89%
State Route 83	47.821595	21.835854	45.66%	6.704782	14.02%	17.221286	36.01%
State Route 92	18.685552	11.6297	62.24%	5.405417	28.93%	0	0.00%
State Route 93	19.522013	1.694968	8.68%	0	0.00%	13.031994	66.76%
State Route 98	3.470599	3.18727	91.84%	0.287841	8.29%	0	0.00%
State Route 99	41.120805	0	0.00%	4.809275	11.70%	26.831111	65.25%
State Route 750	8.056213	0	0.00%	0.989078	12.28%	1.896944	23.55%
State Route 901	1.403364	0	0.00%	0	0.00%	1.116667	79.57%
State Route 930	10.054945	0	0.00%	0	0.00%	10.054945	100.00%
State Route 7012	1.862959	0	0.00%	0	0.00%	1.862959	100.00%
State Route 7101	5.865258	0	0.00%	0	0.00%	5.865258	100.00%
State Route 7110	0.609843	0	0.00%	0	0.00%	0.203785	33.42%
State Route 7141	1.50208	0	0.00%	0	0.00%	0.585757	39.00%
State Route 7210	0.115075	0	0.00%	0	0.00%	0.115075	100.00%
State Route 7239	0.338737	0	0.00%	0	0.00%	0.338737	100.00%
State Route 7241	2.331816	0	0.00%	0.112325	4.82%	2.222008	95.29%
State Route 7310	1.041137	0	0.00%	1.022983	98.26%	0.018745	1.80%
State Route 7345	0.554715	0	0.00%	0	0.00%	0.554715	100.00%
State Route 7350	0.597196	0	0.00%	0.597196	100.00%	0	0.00%
State Route 7351	0.243914	0	0.00%	0.243914	100.00%	0	0.00%
State Route 7401	0.214056	0.214056	100.00%	0	0.00%	0	0.00%
State Route 7413	0.352495	0.352495	100.00%	0	0.00%	0	0.00%
State Route 7415	0.536255	0.494415	92.20%	0.042564	7.94%	0	0.00%
State Route 7526	0.397834	0.294466	74.02%	0.103368	25.98%	0	0.00%

State Route	Length (in miles)						
	Total Length	Low	Exposed Length as % of Total Length	Moderate	Exposed Length as % of Total Length	High	Exposed Length as % of Total Length
State Route 7601	0.432591	0.184518	42.65%	0	0.00%	0.243295	56.24%
State Route 7801	1.151651	0.742413	64.47%	0	0.00%	0.319869	27.77%
State Route 8300	0.501274	0	0.00%	0	0.00%	0.501274	100.00%
State Route 8918	0.13352	0	0.00%	0	0.00%	0	0.00%
State Route 8930	4.941677	0	0.00%	0	0.00%	0.052996	1.07%
State Route 8940	3.321223	0	0.00%	0	0.00%	2.875141	86.57%
State Route 8945	0.984948	0	0.00%	0	0.00%	0.984948	100.00%
State Route 8955	2.697864	0	0.00%	0	0.00%	2.697864	100.00%
State Route H-1	54.2852	15.340879	28.26%	10.858233	20.00%	18.625217	34.31%
State Route H-2	16.631646	0	0.00%	0.000746	0.00%	16.237483	97.63%
State Route H-201	8.479473	0.466385	5.50%	2.209932	26.06%	5.81185	68.54%
State Route H-3	30.593733	0	0.00%	2.496249	8.16%	6.329894	20.69%
Total	**374.921172**	**66.66374**	**17.78%**	**61.316714**	**16.35%**	**164.355124**	**43.84%**
County of Maui							
State Route 30	41.599628	0	0.00%	8.518588	20.48%	21.153807	50.85%
State Route 31	7.147053	0	0.00%	0	0.00%	7.097807	99.31%
State Route 32	2.855291	0	0.00%	0	0.00%	2.855291	100.00%
State Route 36	16.225414	8.010984	49.37%	1.557651	9.60%	1.086486	6.70%
State Route 37	21.33757	0	0.00%	2.372363	11.12%	8.551166	40.08%
State Route 310	3.609294	0	0.00%	0	0.00%	0.33541	9.29%
State Route 311	6.415815	0	0.00%	0	0.00%	0.084246	1.31%
State Route 340	4.265623	0	0.00%	0.910252	21.34%	1.632694	38.28%
State Route 360	34.838612	19.387798	55.65%	0	0.00%	0	0.00%
State Route 377	9.136002	0	0.00%	2.791085	30.55%	3.468785	37.97%
State Route 378	10.082808	0	0.00%	2.11774	21.00%	0.004682	0.05%
State Route 380	6.197863	0	0.00%	0	0.00%	2.761649	44.56%
State Route 440	13.153636	0	0.00%	1.902297	14.46%	0	0.00%
State Route 441	0.476716	0	0.00%	0	0.00%	0	0.00%
State Route 442	0.022862	0	0.00%	0.022862	100.00%	0	0.00%
State Route 450	27.477007	15.865763	57.74%	0.894314	3.25%	5.660799	20.60%
State Route 460	16.534641	0	0.00%	0	0.00%	7.341135	44.40%
State Route 470	10.74695	8.527122	79.34%	0	0.00%	0	0.00%
State Route 480	5.898639	1.834596	31.10%	0	0.00%	4.064043	68.90%
State Route 3000	2.346263	0	0.00%	0	0.00%	0.97469	41.54%
State Route 3400	2.635502	0	0.00%	0.950841	36.08%	1.684661	63.92%
State Route 3500	1.125483	0	0.00%	0	0.00%	1.125483	100.00%
State Route 3800	0.625243	0	0.00%	0	0.00%	0.429012	68.62%
State Route 32A	0.400435	0	0.00%	0	0.00%	0.400435	100.00%
State Route 32B	0.172196	0	0.00%	0	0.00%	0.172196	100.00%
State Route 36A	0.526104	0	0.00%	0	0.00%	0.526104	100.00%
Total	**245.85265**	**53.626263**	**21.81%**	**22.037993**	**8.96%**	**71.410581**	**29.05%**
County of Hawaiʻi							
State Route 11	117.608086	31.740221	26.99%	5.240364	4.46%	40.135801	34.13%
State Route 19	93.300605	21.804543	23.37%	12.966732	13.90%	16.965794	18.18%
State Route 130	21.68728	12.266005	56.56%	2.447152	11.28%	0	0.00%
State Route 139	1.197816	1.197816	100.00%	0	0.00%	0	0.00%

State Route	Length (in miles)						
	Total Length	Low	Exposed Length as % of Total Length	Moderate	Exposed Length as % of Total Length	High	Exposed Length as % of Total Length
State Route 160	3.821277	0.008749	0.23%	3.812529	99.77%	0	0.00%
State Route 163	0.133863	0	0.00%	0.133863	100.00%	0	0.00%
State Route 190	34.085758	3.363911	9.87%	0	0.00%	2.178989	6.39%
State Route 197	1.17843	0	0.00%	0	0.00%	1.17843	100.00%
State Route 200	43.219679	0.947501	2.19%	0	0.00%	1.077319	2.49%
State Route 220	3.754068	0	0.00%	0.998708	26.60%	00	0.00%
State Route 240	9.601941	2.642506	27.52%	2.022423	21.06%		0.00%
State Route 250	19.266672	3.916922	20.33%	0	0.00%	0.297573	1.54%
State Route 270	27.020618	10.756759	39.81%	0	0.00%	4.862078	17.99%
State Route 1370	0.191175	0.191175	100.00%	0	0.00%	0	0.00%
State Route 1970	0.923307	0.923307	100.00%	0	0.00%	0	0.00%
State Route 2000	2.184464	2.184464	100.00%	0	0.00%	0	0.00%
Total	**379.175039**	**91.943879**	**24.25%**	**27.621771**	**7.28%**	**66.695984**	**17.59%**

Source: State of Hawaii Department of Transportation 2022; Hawaii Wildfire Management Organization, Division of Forestry and Wildlife

Table F-78 and Table F-79 summarize the number of community lifelines and critical facilities located in the moderate wildfire risk area by county and category, respectively.

Table F-78. Community Lifelines and Critical Facilities Located in the Moderate Wildfire Risk Hazard Areas by County

County	Category							
	Communications	Energy	Food, Water, Shelter	Hazardous Material	Health and Medical	Safety and Security	Transportation	Additional Critical Facilities
County of Kaua'i	1	0	2	0	0	1	0	0
City and County of Honolulu	22	11	26	1	17	77	0	11
County of Maui	4	2	15	0	6	11	4	7
County of Hawai'i	1	1	1	0	2	2	0	2
Total	**28**	**14**	**44**	**1**	**25**	**91**	**4**	**20**

Source: Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020; Hawaii Wildfire Management Organization, Division of Forestry and Wildlife

Table F-79. Community Lifelines and Critical Facilities Located in the Moderate Wildfire Risk Hazard Areas by Category

Category	Total Number of Facilities	Total Replacement Cost Value	Number of Facilities in the Moderate Risk Hazard Area	Percent (%) of Total Facilities	Value in the Moderate Risk Hazard Area	Percent (%) of Total Value
Communications	188	$776,797,683	28	14.89%	$92,475,536.50	11.90%
Energy	89	$3,093,949,530	14	15.73%	$526,787,300.00	17.03%
Food, Water, Shelter	345	$11,847,189,588	44	12.75%	$1,490,251,295.00	12.58%
Hazardous Material	12	$436,474,800	1	8.33%	$37,240,800.00	8.53%
Health and Medical	193	$4,606,713,364	25	12.95%	$658,837,311.20	14.30%
Safety and Security	486	$38,164,188,232	91	18.72%	$6,986,691,188.00	18.31%
Transportation	56	$2,039,091,600	4	7.14%	$145,176,000.00	7.12%
Additional Critical Facilities	106	$447,698,794	20	18.87%	$61,279,440.00	13.69%
Total	**1,475**	**$61,412,103,591**	**227**	**15.39%**	**$9,998,738,870.70**	**16.28%**

Source: Hawai'i Emergency Management Agency 2017; Federal Emergency Management Agency Lifeline Data 2020; Hawaii Wildfire Management Organization, Division of Forestry and Wildlife

Table F-80 summarizes the population located in the moderate wildfire risk area.

Table F-80. 2020 U.S. Census Population Located in Moderate Wildfire Risk Hazard Areas by County

County	Population				
	Total Population	Population in Hazard Area	Population Exposed as % of Total Population	Socially Vulnerable Population Located in Hazard Area	Population Exposed as Percent (%) of Total Population
County of Kauaʻi	71,949	8,307	11.55%	435	0.60%
City and County of Honolulu	979,682	244,318	24.94%	38,961	3.98%
County of Maui	167,093	19,278	11.54%	25	0.01%
County of Hawaiʻi	201,350	10,890	5.41%	1,248	0.62%
Total	**1,420,074**	**282,794**	**19.91%**	**40,669**	**2.86%**

Source: U.S. Census Bureau 2020; Centers for Disease Control and Prevention 2018; Hawai'i Wildfire Management Organization, Division of Forestry and Wildlife

Table F-81 summarizes the general building stock located in the moderate wildfire risk area.

Table F-81. General Building Stock Located in the Moderate Wildfire Risk Hazard Areas by County

County	Total Value	Replacement Value in Hazard Area	Replacement Value Exposed as % of Total
County of Kauaʻi	$24,246,497,228	$2,091,037,500	8.62%
City and County of Honolulu	$239,152,051,766	$51,624,531,325	21.59%
County of Maui	$50,796,693,140	$9,710,233,991	19.12%
County of Hawaiʻi	$58,395,349,136	$5,058,093,772	8.66%
Total	**$372,590,591,270**	**$68,483,896,588**	**18.38%**

Source: NIYAM IT 2022; United States Army Corps of Engineers 2022; Hawaii Wildfire Management Organization, Division of Forestry and Wildlife

Table F-82 summarizes the square miles of Hawaiian Home Lands located in the low and moderate wildfire risk areas.

Table F-82. Hawaiian Home Lands Located in the Low and Moderate Wildfire Risk Hazard Areas by County

County	Area (in square miles)				
	Total Area	Low Risk Hazard Area	Hazard Area as % of Total Area	Moderate Risk Hazard Area	Hazard Area as % of Total Area
County of Kauaʻi	32.087158	0	0.00%	0.120331	0.38%
City and County of Honolulu	10.612342	0.040155	0.38%	1.428661	13.46%
County of Maui	102.588953	5.393994	5.26%	2.492814	2.43%
County of Hawaiʻi	191.458448	18.920139	9.88%	0	0.00%
Total	**336.746901**	**24.354288**	**7.23%**	**4.041806**	**1.20%**

Source: *Hawaii Wildfire Management Organization, Division of Forestry and Wildlife; Hawaii State Department of Hawaiian Homelands 2021*

Table F-83 and Table F-84 summarize the square miles of environmental resource located in the high wildfire risk hazard area by type, and county respectively.

Table F-83. Square Miles of Environmental Resources Located in the High Wildfire Risk Hazard Area

Environmental Resource	County of Kauaʻi		City and County of Honolulu		County of Maui		County of Hawaiʻi	
	Sq. Mi. in High Risk Area	% of Total Asset Area	Sq. Mi. in High Risk Area	% of Total Asset Area	Sq. Mi. in High Risk Area	% of Total Asset Area	Sq. Mi. in High Risk Area	% of Total Asset Area
Critical Habitat	1.053894	1.17%	2.677583	2.21%	24.636064	8.41%	2.735564	0.61%
Wetlands	2.529703	0.42%	4.568932	0.90%	3.8402	0.28%	1.708823	0.15%
Parks and Reserves	5.676893	2.52%	8.194622	6.80%	7.504772	1.84%	17.007563	0.84%
Reefs	0.007175	0.16%	0.22396	1.42%	0.009446	0.04%	0.020168	0.23%
Total [a]	**9.267665**	**1.01%**	**15.665097**	**2.05%**	**35.990482**	**1.71%**	**21.472118**	**0.59%**

Source: *Hawaii Wildfire Management Organization, Division of Forestry and Wildlife; U.S. Fish and Wildlife Service, Pacific Islands Office, 2022a, U.S. Fish and Wildlife Service 2021e, 2017b, Hawaii State Department of Land and Natural Resources, Division of Forestry and Wildlife 2022, NOAA raster nautical charts 2020b, State of Hawaii Department of Land and Natural Resources, Division of State Parks 2021*

Notes: *a. Total square miles may be over-reported as some environmental resource areas may overlap.*

Table F-84. Square Miles of Total Environmental Resources Located in the High Wildfire Risk Hazard Areas by County

County	Area (in square miles)		
	Total Area of Environmental Resources	Area of Environmental Resources in the High Wildfire Risk Hazard Area	Percent (%) of Total Area
County of Kaua'i	919.953924	9.267665	1%
City and County of Honolulu	762.964336	15.665097	2%
County of Maui	2,109.97	35.990482	2%
County of Hawai'i	3,626.96	21.472118	1%
Total	**7,419.85**	**82.395362**	**1%**

Source: Hawaii Wildfire Management Organization, Division of Forestry and Wildlife; U.S. Fish and Wildlife Service, Pacific Islands Office, 2022; U.S. Fish and Wildlife Service 2021, 2017; Hawaii State Department of Land and Natural Resources, Division of Forestry and Wildlife 2022, NOAA raster nautical charts 2020; State of Hawaii Department of Land and Natural Resources, Division of State Parks 2021

Table F-85 summarizes the square miles of environmental resources located in the low and moderate wildfire risk areas by county.

Table F-85. Environmental Resources Located in the Low and Moderate Wildfire Risk Areas

County	Area (in square miles)				
	Total Area	Low Risk Area	Low Risk as Percent (%) of Total Area	Moderate Risk Area	Moderate Risk as Percent (%) of Total Area
County of Kaua'i	919.953924	2.230916	0.2%	1.552865	0.2%
City and County of Honolulu	762.964336	13.716753	1.8%	5.82849	0.8%
County of Maui	2,109.97	4.162469	0.2%	10.408918	0.5%
County of Hawai'i	3,626.96	53.314766	1.5%	13.431722	0.4%
Total	**7,419.85**	**73.424904**	**1.0%**	**31.221995**	**0.4%**

Source: Hawaii Wildfire Management Organization, Division of Forestry and Wildlife; U.S. Fish and Wildlife Service, Pacific Islands Office, 2022; U.S. Fish and Wildlife Service 2021, 2017; Hawaii State Department of Land and Natural Resources, Division of Forestry and Wildlife 2022, NOAA raster nautical charts 2020; State of Hawaii Department of Land and Natural Resources, Division of State Parks 2021

Table F-86 summarizes the square miles of conservation areas located in the low and moderate wildfire risk areas by county.

Table F-86. Conservation Areas Located in the Low and Moderate Wildfire Risk Areas

County	Area (in square miles)				
	Total Area	Low Risk Area	Low Risk Area as Percent (%) of Total Area	Moderate Risk Area	Moderate Risk Area as Percent (%) of Total Area
County of Kaua'i	195,692.70	1,275.30	0.65%	483	0.25%
City and County of Honolulu	158,989.00	9,101.20	5.72%	6,281.40	3.95%
County of Maui	325,580.30	3,173.60	0.97%	2,038.20	0.63%
County of Hawai'i	1,339,647.20	32,494.40	2.43%	11,750.20	0.88%
Total	**2,019,909**	**46,044**	**2.28%**	**20,553**	**1.02%**

Source: Hawaii Wildfire Management Organization, Division of Forestry and Wildlife

Table F-87 summarizes the square miles of watershed located in the low and moderate wildfire risk areas by county.

Table F-87. Watershed Partnership Areas Located in Low and Moderate Wildfire Risk Areas

Watershed Partnership	Area (in square miles)				
	Total Area	Area in the Low Wildfire Risk Area	Percent (%) of Total Area	Area in the Moderate Wildfire Risk Area	Percent (%) of Total Area
County of Kauaʻi					
Kauaʻi Watershed Alliance	225.61	0.118	0.05%	0.117078	0.05%
Total	**225.61**	**0.118**	**0.05%**	**0.117078**	**0.05%**
City and County of Honolulu					
Koolau Mountains Watershed Partnership	160.62	10.486	6.53%	5.43	3.38%
Waianae Mountains Watershed Partnership	73.59	0.000	0.00%	3.78	5.14%
Total	**234.21**	**10.486**	**4.48%**	**9.21**	**3.93%**
County of Maui					
East Maui Watershed Partnership	173.01	4.079	2.36%	0.37	0.21%
East Molokaʻi Watershed Partnership	105.27	4.299	4.08%	8.875392	8.43%
Leeward Haleakala Watershed Restoration Partnership	53.56	0.000	0.00%	0.000023	0.00%
West Maui Mountains Watershed Partnership	73.94	0.000	0.00%	0.17	0.23%
Lanai Forest and Watershed Partnership	14.84	0.000	0.00%	0.00	0.00%
Overlap East Maui Watershed Partnership and Leeward Haleakala Watershed Restoration Partnership	13.72	0.000	0.00%	0.004334	0.03%
Total	**434.34**	**8.379**	**1.93%**	**9.42**	**2.17%**
County of Hawaiʻi					
Kohala Watershed Partnership	115.81	1.330	1.15%	0	0.00%
Mauna Kea Watershed Alliance	400.39	1.349	0.34%	1.84	0.46%
Three Mountain Alliance	1767.20	47.566	2.69%	16.972761	0.96%
Total	**2283.41**	**50.245**	**2.20%**	**18.815187**	**0.82%**

Source: *Hawaiʻi Wildfire Management Organization, Division of Forestry and Wildlife; Department of Land & Natural Resources, Division of Forestry and Wildlife 2020*

Table F-88 shows the square miles of the wildfire risk areas in each State Land Use District in each county.

Table F-88. State Land Use Districts Located in Wildfire Risk Areas by County

Land Use District	Area (in square miles)									
	Total Square Miles	Square Miles in Low Risk Area	Hazard Area as % of Total Area	Hazard Area as % of Total Hazard Exposure	Square Miles in Medium Risk Area	Hazard Area as % of Total Area	Hazard Area as % of Total Hazard Exposure	Square Miles in High Risk Area	Hazard Area as % of Total Area	Hazard Area as % of Total Hazard Exposure
County of Kaua'i										
Agricultural	297.078539	9.708012	3.27%	61.10%	4.030501	1.36%	57.93%	17.630686	5.93%	47.14%
Conservation	304.260357	1.981192	0.65%	12.47%	0.751409	0.25%	10.80%	5.320846	1.75%	14.23%
Rural	2.146976	0.301923	14.06%	1.90%	1.011272	47.10%	14.54%	0.764835	35.62%	2.04%
Urban	23.643203	3.896305	16.48%	24.52%	1.163867	4.92%	16.73%	13.685451	57.88%	36.59%
Total	**627.129075**	**15.887432**	**2.53%**	**100.00%**	**6.957049**	**1.11%**	**100.00%**	**37.401818**	**5.96%**	**100.00%**
City and County of Honolulu										
Agricultural	188.479146	9.410908	4.99%	20.34%	5.905205	3.13%	12.63%	46.900582	24.88%	34.00%
Conservation	247.601978	14.244886	5.75%	30.79%	9.923299	4.01%	21.22%	17.844421	7.21%	12.94%
Rural	0	0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%
Urban	162.455059	22.60259	13.91%	48.86%	30.9406	19.05%	66.16%	73.189699	45.05%	53.06%
Total	**598.536183**	**46.258384**	**7.73%**	**100.00%**	**46.769104**	**7.81%**	**100.00%**	**137.934702**	**23.05%**	**100.00%**
County of Maui										
Agricultural	637.731138	60.366078	9.47%	85.68%	16.893617	2.65%	52.72%	119.697919	18.77%	72.33%
Conservation	552.35574	5.913612	1.07%	8.39%	3.941915	0.71%	12.30%	18.738196	3.39%	11.32%
Rural	12.824585	1.823888	14.22%	2.59%	2.260047	17.62%	7.05%	4.294832	33.49%	2.60%
Urban	45.187433	2.355524	5.21%	3.34%	8.94767	19.80%	27.92%	22.749903	50.35%	13.75%
Total	**1,248**	**70.459102**	**5.65%**	**100.00%**	**32.043249**	**2.57%**	**100.00%**	**165.48085**	**13.26%**	**100.00%**
County of Hawai'i										
Agricultural	1,850.31	306.953072	16.59%	76.84%	66.580606	3.60%	69.59%	138.096437	7.46%	71.72%
Conservation	2,098.66	50.93668	2.43%	12.75%	18.412073	0.88%	19.24%	24.093931	1.15%	12.51%
Rural	1.36344	0.537676	39.44%	0.13%	0.202151	14.83%	0.21%	0.623133	45.70%	0.32%
Urban	87.847736	41.059991	46.74%	10.28%	10.480244	11.93%	10.95%	29.745058	33.86%	15.45%
Total	**4,038**	**399.487419**	**9.89%**	**100.00%**	**95.675074**	**2.37%**	**100.00%**	**192.558559**	**4.77%**	**100.00%**

Source: Hawaii Wildfire Management Organization, Division of Forestry and Wildlife; State Land Use Commission, Hawaii Statewide GIS Program 2021; Honolulu County GIS 2022

F.17 Windstorm

There are no additional tables to support Section 4.16 (Windstorm).

F.18 Vulnerability Summary

Table F-89 summarizes the hazard ranking statewide and for each individual county based on the 2023 risk assessment results and methodology outlined in Section 4.17 (Vulnerability Summary).

Table F-89. 2023 State and County Hazard Ranking Summary

Hazard	Statewide	County of Kauaʻi	City and County of Honolulu	County of Maui	County of Hawaiʻi
Climate Change and Sea Level Rise	High	High	High	High	High
Cyber Threat	Medium	Medium	Medium	Medium	Medium
Drought	Medium	Medium	Medium	Medium	Medium
Earthquake	High	Medium	High	High	High
Flood	Medium	Medium	High	High	Medium
Hazardous Materials	Low	Low	Low	Low	Low
Health Risks	High	High	High	High	High
Hurricane	High	High	High	High	High
Infrastructure Failure	Low	Low	Low	Medium	Low
Landslide and Rockfall	Medium	Medium	Medium	Medium	High
Terrorism	Low	Low	Low	Low	Low
Tsunami	High	High	High	High	High
Volcanic Hazards	Medium	Low	Low	Medium	High
Wildfire	Medium	High	High	High	High
Windstorm	Medium	Medium	Medium	Medium	Medium

Risk Factor Scores - High: > 4.0; Medium: 3.0 to 4.0; Low < 3.0

Appendix G. Mitigation Strategy Supplement

CONTENTS

TABLES

[1] *Section Cover Photo: Double rainbow over the Hawaiʻi Island jungle. Photo by Megan Brotherton*

APPENDIX G. MITIGATION STRATEGY SUPPLEMENT

This appendix includes detailed information that supports the Mitigation Strategy discussion presented in Section 6 (Mitigation Strategy) of this document.

G.1 2018 SHMP Goals and Objectives

At the October 2022 Forum meeting, the 2018 SHMP goals were reviewed and discussed to determine if the goals: (1) led to mitigation projects and changes in policy that reduced risk over the performance period of the 2018 SHMP; and (2) continue to articulate the long-term vision for mitigation activities in the State addressing both current and future vulnerabilities. Based on this discussion, modifications were made to the wording of goals to more closely align with the State's updated vision.

The wording of goals 1 and 2 in the 2018 SHMP was enhanced and strengthened. The remaining goals were kept as written. In addition, a new goal (2023 SHMP goal 7) was added to reflect the HI-EMA Mitigation Section's priority to advance mitigation efforts among socially vulnerable populations. Table G-1 summarizes the evaluation of the 2018 SHMP goals and the modifications made, and the updated 2023 SHMP goals. As noted in Section 6 (Mitigation Strategy), 15 new objectives were identified to align with multiple goals; refer to Section 6.2.

Table G-1. Evaluation of the 2018 SHMP Goals

2018 SHMP Goal	Evaluation	2023 SHMP Updated Goal
Goal 1—Reduce the long-term vulnerability of Hawaii's people, property, and jurisdictions, including State-owned or operated buildings, infrastructure, and critical facilities, to natural hazards while conserving the State's natural, historical, and cultural assets. This includes high-risk properties such as repetitive loss (RL) and severe repetitive loss (SRL) properties.	Keep goal; update and enhance the wording to include High Hazard Potential Dams	**Goal 1**—Reduce the long-term vulnerability of Hawaii's people, property and jurisdictions, including State-owned or operated buildings, infrastructure and critical facilities, to natural hazards while conserving the State's natural, historical, and cultural assets. This includes High Hazard Potential Dams and high-risk properties such as repetitive loss (RL) and severe repetitive loss (SRL) properties.
Goal 2—Promote actions designed to ensure long-term resiliency.	Keep goal; update and enhance the wording to include natural hazards and climate change impacts	**Goal 2**—Promote actions designed to ensure long-term resiliency to natural hazards and climate change impacts.
Goal 3—Strengthen partnerships and leverage existing resources and capabilities to identify, assess, and reduce the impact of natural hazards.	Keep goal	**Goal 3—**Strengthen partnerships and leverage existing resources and capabilities to identify, assess, and reduce the impact of natural hazards.
Goal 4—Utilize state-of-the-art methods and technology and local knowledge to identify and analyze natural hazards and assess State capabilities to reduce the impact of those hazards.	Keep goal	**Goal 4—**Utilize state-of-the-art methods and technology and local knowledge to identify and analyze natural hazards and assess State capabilities to reduce the impact of those hazards.

2018 SHMP Goal	Evaluation	2023 SHMP Updated Goal
Goal 5—Promote public awareness of natural hazard risks and public action to reduce the long-term risks	Keep goal	**Goal 5—**Promote public awareness of natural hazard risks and public action to reduce the long-term risks
Goal 6—Provide a framework for robust local hazard mitigation planning and mitigation strategy implementation in alignment with this plan.	Keep goal	**Goal 6—**Provide a framework for robust local hazard mitigation planning and mitigation strategy implementation in alignment with this plan.
	New Goal	**Goal 7—**Build capacity and capabilities to increase disaster resiliency among historically underserved populations, individuals with access and functional needs, and in communities disproportionately impacted by disasters and climate change.

Red text = New or revised goal

G.2 2018 SHMP Progress Report

A comprehensive review and evaluation of the 2018 SHMP actions is presented in Table G-2. The table includes a narrative listed under 'Comment' providing a status of each mitigation action. A brief comment on progress status is listed in column 2. If the action is complete, the funding source is identified.

Table G-2. Comprehensive Review and Evaluation of 2018 SHMP Mitigation Actions

Action Item from Previous Plan	Status and/or New Action Number
Action: State-2018-001 – Conduct non-structural retrofits of schools and hospitals in Hawaiʻi and County of Maui. 1. Assess and prioritize schools and hospitals 2. Prepare work plans 3. Procure funding 4. Implement	**No Progress** **2023 Action:** 2023-2018-001
Comment: No measurable progress was made on this action. HI-EMA is potentially prioritizing new school facilities and coordinating with Hawaiʻi Healthcare Association. HI-EMA intends to add a new mitigation action with wider scope.	
Lead Agency: HI-EMA	
Action: State-2018-002 - Multi-hazard, Non-Structural Retrofit of Hawaiʻi and County of Maui Hospitals and Schools Engage FEMA in a Cooperating Technical Partnership (CTP) to acquire technical assistance to assess the Hawaiʻi & Maui County hospitals and schools for possible seismic, high wind, and flooding non-structural vulnerabilities. The study would prioritize the hospitals and schools, prioritize non-structural actions, develop information for funding applications, and develop documentation for benefit-cost analysis.	**No Progress** **2023 Action:** 2023-2018-002
Comment: No measurable progress was made on this action. HI-EMA will consider conducting a feasibility study of structures statewide as a new mitigation action. HI-EMA will review updated data from State Department of Education following 2018 earthquake event.	
Lead Agency: HI-EMA	

Action Item from Previous Plan	Status and/or New Action Number
Action: State-2018-003 - Retrofit of Kalaheo Gym-Emergency Sheltering: Facility is currently being renovated, and the County desires to upgrade the structural integrity of the building, especially the roof. In consultation with HI-EMA, additional funds of $450,000 from the State will be added to the scope of work to upgrade the gym to a Type A shelter that will be able to withstand Category 2 hurricane winds. This will add 924 shelter spaces to the West side of the island which is faced with a serious deficiency of shelter spaces.	**Completed**
Comment: Kauai Department of Public Works completed the improvements to the Kalaheo Community Gym, including the strengthening of the roof, allowing use of the gym as a shelter. (Type A, up to Category 2 hurricane winds.). This project was funded through the State Hurricane Program Funding.	
Lead Agency: HI-EMA	
Funding Source: State Hurricane Program Funding	
Action: State-2018-004 - Additional Mitigation Staffing: Document current shortfalls in implementing recent mitigation opportunities and prepare justification for additional positions. Provide technical assistance to up-coming Local Mitigation Plan updates.	**In Progress** **2023 Action:** 2023-2018-004
Comment: A new hazard mitigation position was created in 2022: Hazard Mitigation Strategist. This position is currently funded by grant funds and moving to transition to State funds. Public outreach and education scope of the 2018 mitigation action was taken out and will be added as a new mitigation action in 2023 update. Technical assistance for public assistance staff regarding 406 mitigation was taken out and will be added as a new mitigation action in 2023 update.	
Lead Agency: HI-EMA	
Action: State-2018-005 - Earthquake Mitigation Training: Working with the public and private sectors to determine specific training needs and resources to reduce vulnerability of earthquakes.	**In Progress** **2023 Action:** 2023-2018-005
Comment: Ongoing. Redefining and expanding the project to include actionable items such as The Great ShakeOut and structural retrofit.	
Lead Agency: HETAC	
Action: State-2018-006 - Implement Actions from Natural Disaster Economic Recovery Strategy. 1. Coordinate with OPSD to re-engage with the NDERS stakeholders. 2. Review and prioritize recommendations with a focus on implementation. 3. Identify strategy "champions" and potential funding sources. 4. Provide logistical support to champions and support agencies. 5. Schedule regular follow-up stakeholder meetings to track progress and identify gaps and solution.	**In Progress** **2023 Action:** 2023-2018-006
Comment: Some progress was made on coordination with OPSD, but due to lack of staffing to support the project, significant progress on the other four items was not made. It is still a priority of the state and will be included in the plan for continued implementation as HI-EMA gains staffing support.	
Lead Agency: HI-EMA	
Action: State-2018-007 - Enhanced Coordination between HI-EMA and DLNR on Flood Mitigation Projects: HI-EMA will continue to work with DLNR to identify flood vulnerability, identify flood mitigation projects and provide technical assistance to secure grant funding to implement the mitigation projects to reduce flood losses in the State. Mitigation measures may include but are not limited to structural projects, plans, studies, outreach, and training.	**In Progress** **2023 Action:** 2023-2018-007
Comment: HI-EMA attended the Q2 2022 Floodplain Manager meeting. Enhanced coordination is still needed between HI-EMA and DLNR. HI-EMA mitigation staff will continue to be invited to quarterly Floodplain Manager Meetings and work to identify flood vulnerability and mitigation projects.	
Lead Agency: HI-EMA	

Action Item from Previous Plan	Status and/or New Action Number
Action: State-2018-008 - Long-Term Plan for GIS Staff, Training, and Technology – Implementation of GIS Assessment: 1) Hire GIS staff. 2) Acquire GIS resources (hardware, software, people, data, and methods) to fit State EOC needs and scale up as situation and County acceptance proceeds. 3) Assess GIS system during exercise and adjust as resources and situation dictates.	**Discontinued**
Comment: Discontinued because duplicative to mitigation action State-2018-009. This action is removed from the mitigation strategy.	
Lead Agency: HI-EMA	
Action: State-2018-009 - Acquire GIS Staff, Training, and Technology 1) Determine GIS needs and requirements for the Resilience Branch. 2) Hire GIS staff for Resilience Branch to conduct project tracking and assist with mitigation planning. 3) Acquire GIS licenses and equipment. 4) Analyze results and provide recommendations for implementing statewide GIS for EOCs that leverage existing resources, are cost-effective, and are technologically feasible.	**In Progress** **2023 Action:** 2023-2018-009
Comment: Progress has been made on some aspects of this action, while other aspects have not had measurable progress: 1) HI-EMA knows what the current capabilities are and has determined a need for more staff. 2) HI-EMA hired a GIS Specialist in 2020, but the position is open again. HI-EMA is continuing to try to fill the position. 3) Measurable progress has not been made on acquiring GIS licenses and equipment. 4) HI-EMA cannot dictate what the Counties have or do with their GIS capabilities. This aspect of the action will be removed in the updated action plan.	
Lead Agency: HI-EMA	
Action: State-2018-010 - Water Bags for Distribution: HI-EMA will coordinate with the Honolulu Board of Water Supply (BWS) to purchase collapsible, 1-gallon water bags with an imprinted reminder to store 1 gallon of water per person per day for at least 14 days in preparation for an impending event. HI-EMA and BWS will coordinate with various partners to distribute the water bags at various events prior to the next hurricane season.	**Completed**
Comment: This mitigation action was completed by 2022.	
Lead Agency: HI-EMA	
Funding Source: Grant funded	
Action: State-2018-011 - Housing Vulnerability Assessment: Conduct a housing stock and social vulnerability assessment for seismic, high wind, and flooding vulnerabilities. The study would prioritize the retrofit actions, including incentives for homeowners to strengthen their residences, and to develop guidance for shelter retrofit guidance consistent with FEMA's grant program guidance.	**In Progress** **2023 Action:** 2023-2018-011
Comment: A grant application was submitted in February 2023 and is currently under review. The project will advance if funding is received.	
Lead Agency: HI-EMA	

Action Item from Previous Plan	Status and/or New Action Number
Action: State-2018-012 - Retrofit of the Kaua'i War Memorial Convention Hall (KWMCH)-Emergency Shelter: Structural Analysis to determine suitability of KWMCH to serve as an emergency shelter and to determine scope of work. The retrofit will include hardening of the doors (33) and windows (40) which will serve as a minimum Type B Shelter (Category 1 hurricane). This project will add about 1,668 shelter spaces for the County and the heavily populated area of Lihue. This increases by 44% the amount of residents/visitors seeking shelters during hurricanes in the central portion of the Island.	**In Progress** **2023 Action:** 2023-2018-012
Comment: FEMA awarded Phase one of the Kauai War Memorial Convention Hall, Hardening project (HMGP DR-4365-12-12R). The Department of Parks and Recreation has begun the solicitation of a firm to do the structural assessment.	
Lead Agency: HI-EMA	
Action: State-2018-013 - Retrofit of Moloka'i High School Gym-Emergency Shelter: This facility involves extensive retrofit of the building envelope, doors, windows, and other hardening measures. An initial engineering structural analysis has been completed, and a secondary SAM will be completed to ensure the retrofits are able to meet the EHPA standard.	**In Progress** **2023 Action:** 2023-2018-013
Comment: A DR-4510 HMGP Hurricane Wind Envelope Hardening application for Moloka'i High School Gym is in development. This application will leverage the federal match opportunity and will bring the location up to the EHPA construction standard (Category 3 Hurricane Protection).	
Lead Agency: HI-EMA	
Action: State-2018-014 - Retrofit of Moloka'i High School Locker Room and Cafeteria-Emergency Shelter: This project will involve the hardening of doors and windows to create Type B shelters which will withstand hurricane-force winds up to Category 1. A total of 600 emergency shelter spaces will be created on an island which has none at this time. An engineering evaluation of the buildings has been accomplished, which certified that the buildings are sound to serve as emergency shelters.	**Discontinued**
Comment: This action is not currently a priority item. Additional resources will be provided to meet the emergency sheltering need through the structural hardening of the Moloka'i Gymnasium. The current priority for the use of State hurricane retrofit funds is for the completion of facilities to the EHPA standard of sheltering providing protection for a Category 3 hurricane. This action is discontinued and removed from the mitigation strategy.	
Lead Agency: HI-EMA	
Action: State-2018-015 - Retrofit of Kapa'a Middle School-Emergency Shelter: An engineering analysis has been conducted to ensure that the school buildings are structural sound to serve as shelters. Four quads (classrooms) will have the doors and windows hardened to become Type B shelters (Category 1 hurricane). This increase emergency shelter spaces by 600 in a County where there is a serious shortfall.	**Completed**
Comment: The project acceptance date for the Kapa'a Middle School retrofit project was April 19, 2022. Buildings H and I were hardened to meet shelter Type A criteria (i.e., designed to protect against Category 2 hurricanes).	
Lead Agency: HI-EMA	
Funding Source: State Hurricane Shelter Retrofit Program	

Action Item from Previous Plan	Status and/or New Action Number
Action: State-2018-016 - Enhance the State Technical Assistance Program to support State agencies and counties: Enhance the HI-EMA's technical assistance program to support State agencies and counties in all aspects of mitigation. Examples of program expansion and enhancement include working with specific State agencies to support obtaining grant funding, such as DHHL, and submit projects for implementation. In addition, develop a standard operating procedure for providing counties technical assistance in updating their local Hazard Mitigation Plans and implementing hazard mitigation actions to reduce future losses in the State.	**In Progress** **2023 Action:** 2023-2018-016
Comment: This is a priority in DR-4639 Mitigation Strategy. HI-EMA is coordinating with FEMA Pacific Area Office on delivering technical assistance trainings in 2022-2023. Technical assistance/training was completed in 2022. BCA, project/application development for BRIC, FMA, and HMGP, training were conducted in November 2022. HI-EMA will continue to enhance technical assistance to support state agencies and counties in the subapplication process for grant funding.	
Lead Agency: HI-EMA	
Action: State-2018-017 - Monitor water resources and conduct drought forecasts and impact assessments: 1. Continue to and expand monitoring of hydrologic elements (rainfall, stream flow, reservoir water levels, ground water levels) 2. Improve drought forecasting 3. Increase drought research 4. Collaborate with the National Integrated Drought Information System See Hawaiʻi Drought Plan 2017 Update for more details	**In Progress** **2023 Action:** 2023-2018-017
Comment: Some actions are ongoing, and some are not started: 1. CWRM continues to expand hydrologic monitoring as our budget allows. We have installed more stream gauges and monitor wells in 2018. 2. No progress on improving drought forecasting. 3. We are currently working with the Pacific Drought Knowledge Exchange to improve drought research and user products in Hawaiʻi. 4. We continue to collaborate with NIDIS and the National Drought Mitigation Center on improving drought monitoring and impact assessments in Hawaiʻi.	
Lead Agency: DLNR-CWRM	
Action: State-2018-018 - Increase water conservation, reuse, and recharge: 1. Implement the Hawaiʻi Water Conservation Plan. 2. Incentivize and promote reuse (e.g., grants, rebates, policies, etc.). 3. Protect and restore watersheds important to water supply (e.g., fencing, invasive species removal, replanting, etc.). See Hawaiʻi Drought Plan 2017 Update for more details	**In Progress** **2023 Action:** 2023-2018-018
Comment: Some projects in progress, while some are not started. 1. CWRM is continuing to implement this Plan. We have implemented annual water audits for public water systems across the state. 2. No progress on incentivizing and promoting reuse. 3. DLNR Division of Forestry and Wildlife continues to protect and restore important watersheds across the state.	
Lead Agency: DLNR-CWRM	

Action Item from Previous Plan	Status and/or New Action Number
Action: State-2018-019 - Support the Hawaiʻi Association of Watershed Partnerships: 1. Seek dedicated, long-term funding for watershed protection, restoration, and maintenance. 2. Support forest stewardship programs. See Hawaiʻi Drought Plan 2017 Update for more details	**In Progress** **2023 Action:** 2023-2018-019
Comment: **Each aspect of this project is ongoing:** 1. Increased fire suppression funds through the State legislature in 2022. Additional funding is needed in future years. 2. Supporting forest stewardship programs was done over the past five years and is an ongoing action.	
Lead Agency: DLNR-DOFAW	
Action: State-2018-020 - Develop water sources: 1. Encourage counties to develop emergency or backup water supplies. 2. Encourage County water departments to develop their own drought/water shortage plans. 3. Encourage counties to explore the use of alternative sources of water for non-potable uses (e.g., recycled wastewater, storm water). See Hawaiʻi Drought Plan 2017 Update for more details	**Discontinued**
Comment: This project is no longer under the State's jurisdiction and is not included in the updated action plan. Individual counties will implement the 2017 Hawaiʻi Drought Plan as applicable for their area.	
Lead Agency: County water departments	
Action: State-2018-021 - Provide drought public education awareness and outreach: 1. Continue to promote drought awareness campaigns and public outreach events (e.g., Wildfire & Drought LOOK OUT!; Halawa Xeriscape Garden Open House and Unthirsty Plant Sale, etc.). 2. Seek cooperative outreach & education opportunities with agricultural agencies and organizations to promote drought awareness and conservation actions. 3. Encourage water purveyors, businesses, and agricultural producers to develop individual drought plans. See Hawaiʻi Drought Plan 2017 Update for more details	**In Progress** **2023 Action:** 2023-2018-021
Comment: **Some aspects of this project had progress over the past five years, but others did not show** measurable **progress:** 1. The annual in-person events have been curtailed due to COVID, but they are beginning to come back. 2. No measurable progress on seeking cooperative outreach & education opportunities with agricultural agencies and organizations to promote drought awareness and conservation actions. 3. Encouraging water purveyors, businesses, and agricultural producers to develop individual drought plans is conducted on an ad hoc basis as we identify opportunities to work with these sectors.	
Lead Agency: DLNR-CWRM	
Action: State-2018-022 - Statewide Public Information Campaign to Increase Citizen Resilience to Flooding: 1. Work with federal agencies with a role in insurance and State insurance regulator (DCCA) to develop campaign strategy and key messages. 2. Develop a public information campaign, including public service announcements, fact sheets, and other forms of communication on the types of insurance and the need to purchase flood insurance. 3. Measure Change in the number of active flood insurance policies compared to baseline levels. As of February 2018, there are 60,423 active flood insurance policies statewide.	**Ongoing** **2023 Action:** 2023-2018-022
Comment: This is an ongoing effort to provide information and updates on the National Flood Insurance Program (NFIP). Since the last SHMP update in 2018, DLNR-ENG has partnered with FEMA, State Insurance Commissioner, various state and local chapters of national associations representing the lending, insurance, and real estate stakeholders to assist in communicating flood risk and mitigation strategies.	

Action Item from Previous Plan	Status and/or New Action Number
Although DLNR-ENG has organized and participated in many education and outreach efforts, the list below summarizes the actions that specifically address flood insurance: January 26, 2018: 2018 BIA HOME BUILDING AND REMODELING SHOW: DLNR-ENG participated in this 3-day annual event held at the Neal Blaisdell Exhibition Hall (Oahu). The purpose of participation was to increase awareness on the NFIP and regulatory requirements. March 21, 2018: 2018 KAILUA EMERGENCY PREPAREDNESS FAIR: DLNR-ENG provided Kailua Alert & Prepared president Dana Pagalaboyd with a variety of NFIP outreach material and factsheet on how to use our custom flood hazard map viewer (FHAT) for distribution at the event held at Christ Church Uniting Disciple (Oahu) to increase awareness on the NFIP. May 5, 2018: HONOLULU BOARD OF REALTORS - EAST OAHU REGIONAL GROUP: DLNR-ENG presented at the request of the group during an NFIP update during monthly meeting at Waialae Country Club (Oahu). Approximate number of attendees: 60 May 10-17, 2018: NFIP CLAIMS - INFORMATIONAL SESSION: As a result of the April 2018 severe weather that caused significant flooding on Oahu and Kauai, DLNR-ENG requested FEMA's assistance in conducting insurance outreach to property owners since many insured were confused and frustrated with the NFIP claims process. DLNR-ENG planned, advertised, invited and hosted six (6) Flood Insurance Informational Sessions on Oahu and Kauai to provide flood insured home and business owners, as well as renters, and opportunity to attend a presentation given by NFIP General Adjuster, Jonathan Hardy, and NFIP Regional Manager, Adam Lizarraga. Approximate number of attendees for the entire event: 185 May 10, 2018: Niu Valley Middle School (Oahu) 4 pm – 8 pm May 12, 2018: Kahala Mall (Oahu) 10 am – 2 pm. For more details, see below. May 14, 2018: Koloa Neighborhood Center (Kauai) 4 pm – 7 pm May 15, 2018: Hanalei Colony Resort (Kauai) 12 pm – 4 pm May 16, 2018: Anahola DHHL Clubhouse (Kauai) 4 pm – 7 pm May 17, 2018: Hale Halawai Ohana O Hanalei (Kauai) 12 pm – 4 pm May 12, 2018: 2018 EASTSIDE DISASTER PREPAREDNESS FAIR: DLNR-ENG personnel participated in this event at Kahala Shopping Mall (Oahu) from 10:00 AM – 2:00 PM. The purpose of participation is to increase awareness of the NFIP. FEMA staff was on-hand and available to answer any questions related to property owner's question on their flood damages from the April 2018 flood event and the claims process. Approximate number of visitors: 80 June 2, 2018: 2018 MAUI DISASTER PREPAREDNESS EXPO: DLNR-ENG participated in this event held at Queen Kaahumanu Center (Maui). The purpose of participation is to increase awareness on the NFIP. July 28, 2018: 2018 READY2REACT: DLNR-ENG participated in this event held at Pearlridge Shopping Mall (Oahu). The purpose of participation is to increase awareness on the NFIP. Approximate number of attendees: 100 Augus 13 and 14, 2018: 14th ANNUAL HAWAIʻI FPM CONFERENCE: DLNR-ENG hosted this conference at Pomaikai'i Ballrooms at Dole Cannery (Oahu). Approximate number of attendees: 100. 12 CEC credits approved by ASFPM. September 8, 2018: 8th ANNUAL GET READY EWA BEACH PREPAREDNESS FAIR: DLNR-ENG participated in this event at Ewa Mahiko District Park (Oahu). Approximate number of attendees: 100. January 25-27, 2019: 2019 BIA HOME BUILDING AND REMODELING SHOW: DLNR-ENG participated in this 3-day annual event held at the Neal Blaisdell Exhibition Hall (Oahu). The purpose of participation was to increase awareness on the NFIP and regulatory requirements. August 12-13, 2019: 15th ANNUAL HAWAIʻI FPM CONFERENCE: DLNR-ENG hosted this conference at the Ala Moana Hotel (Oahu). Approximate number of attendees: 108. 12 CEC credits approved by ASFPM.	

Action Item from Previous Plan	Status and/or New Action Number
Augus 14, 2019: NFIP FLOOD INSURANCE BRIEFING: DLNR-ENG co-hosted a Flood Insurance Workshop for State Department of Insurance's State Insurance Commissioner and staff. FEMA IX's flood insurance specialist, Ms. Edie Lohmann led the discussion. DLNR-ENG provided a live demo on ursin the FHAT tool. August 15, 2019: FLOOD INSURANCE TRAINING: DLNR-ENG co-hosted Flood Insurance Workshop for Insurance Agents, Realtors, and Lenders with HIIA at Ala Moana Hotel. Approximate number of attendees: 200. This workshop was approved for 3 Property & Casualty credits for licensed insurance agents. September 15, 2019: FLOOD INSURANCE OUTREACH: DLNR-ENG and Hawaiʻi State DOI collaborated to produce an article to increase awareness on the importance of flood insurance for property owners and renters. DLNR's FHAT was also highlighted in the article as a tool that individuals can use to find out their flood risk. A copy of the article can be found in HONOLULU magazine (www.honolulumagazine.com/5-things-every-local-should-know-about-flood-risk-in-hawaii/), DOI (cca.hawaii.gov/ins/) and DLNR-ENG's Wai Halana (waihalana.org) websites. January 24-26, 2020: 2020 BIA HOME BUILDING AND REMODELING SHOW: DLNR-ENG participated in this 3-day annual event held at the Neal Blaisdell Exhibition Hall (Oahu). The purpose of participation was to increase awareness on the NFIP and regulatory requirements. July 25-28, 2022: NFIP INSURANCE TRAINING: DLNR-ENG co-hosted Flood Insurance Workshop for Insurance Agents with HIIA in each County. Approximate number of attendees for entire road show: 150. This workshop was approved for 3 Property & Casualty credits for licensed insurance agents.	
Lead Agency: DLNR-ENG	
Action: State-2018-023 - Integrated Hazard Mitigation of State Coastal Highways and Beaches from Chronic Coastal Flooding: 1. Identify coastal highway segments across the state based on vulnerability to coastal hazards exacerbated by sea level rise and geological and physical viability for landward beach migration. (HDOT) 2. Select top five State coastal highway segments, in consultation with County and community stakeholders, to develop coastal highway mitigation alternatives and evaluate feasibility of each alternative. (HDOT) 3. Develop design specifications and implementation plan for the preferred alternative for each coastal highway segment. (HDOT) 4. Implement coastal highway-beach mitigation. (HDOT) 5. Conduct hazard mitigation utilizing nature-based approaches along coastal roads that are vulnerable to chronic and storm flooding and erosion, where relocation cannot be implemented in the near-term, to improve public safety and community resilience and protect public trust resources. (CC) 6. Update coastal hazards modeling and vulnerability assessment as needed based on new climate science, sea level rise projections, and methods. (CC)	**No Progress** **2023 Action:** 2023-2018-023
Comment: Minimal progress was made on this action due to lack of staffing capacity and funding. It is still a state priority; however, this will be under the lead of HDOT and the Climate Commission in the plan update.	
Lead Agency: HDOT Highway Division, Hawaiʻi Climate Change Mitigation and Adaptation Commission	
Action: State-2018-024 - Reduce and/or convert hazardous fuels on fallow agricultural lands: Implement fuel management through alternative land uses, such as reforestation and active agriculture. Also create and maintain fuel and fire breaks.	**In Progress** **2023 Action:** 2023-2018-024
Comment: Routine maintenance as well as reforestation and farming are conducted on an ongoing basis. However, additional land is in need of implementing fuel management.	
Lead Agency: DLNR-DOFAW	

Action Item from Previous Plan	Status and/or New Action Number
Action: State-2018-025 - Reduce and/or convert hazardous fuels in the Wildland Urban Interface (WUI) to reduce the threat of wildfires to communities and conservation land near them: Implement fuel breaks, including greenbreaks or vegetated fuel breaks; managed grazing; and as necessary, prescribed burns. Increase plant propagation for outplantings in the greenbreaks.	**In Progress** **2023 Action:** 2023-2018-025
Comment: Routine maintenance and restoration are performed on an ongoing basis. However, additional land is in need of restoration, which would stop the grass fire cycle by converting invasive dominated grassland to native forest.	
Lead Agency: DLNR-DOFAW	
Action: State-2018-026 - Assess, identify, and implement State nursery improvements needed to provide native plants for green breaks: Nursery improvements are needed in order to increase plant propagation for outplantings in the greenbreaks.	**In Progress** **2023 Action:** 2023-2018-026
Comment: Some planning and nursery improvements have been implemented, while additional needs exist.	
Lead Agency: DLNR-DOFAW	
Action: State-2018-027 - Develop water sources, including installation of water storage structures: Install water storage structures, such as portable catchment tanks, reservoirs, and dip tanks.	**In Progress** **2023 Action:** 2023-2018-027
Comment: Water storage structures have been installed, but additional needs exist. DOD REPI notice of funding received for four tanks on Hawaiʻi Island, but additional funding is needed through the USFS.	
Lead Agency: DLNR-DOFAW	
Action: State-2018-028 - Provide wildfire awareness, preparedness, and prevention education involving all sectors: Create a statewide, interagency wildfire prevention plan. Continue all-agency, unified wildfire and drought awareness campaign annually. Hold National Wildfire Community Preparedness Day events in each County annually. Establish Outreach and Education Specialists at each DLNR-DOFAW District Office. Reach a wider audience by participating in interagency wildfire outreach and education efforts at community emergency preparedness fairs.	**In Progress** **2023 Action:** 2023-2018-028
Comment: This is an ongoing, programmatic action that has been implemented over the past five years through the annual Wildfire & Drought LOOKOUT! awareness campaign and the National Wildfire Community Preparedness Day on the first Saturday of May each year. The COVID-19 pandemic interrupted some awareness and education events, but they are back on schedule.	
Lead Agency: DLNR-DOFAW	
Action: State-2018-029 - Maintain and improve fire and fuel breaks/access roads on State land: Clear, reduce, and convert hazardous fuel in fire and fuel breaks and on both sides of access roads. Monitor vegetative regrowth due to year-round growing season and invasive, fire-prone grasses that grow back quickly. Improve access roads, including paving, repaving, or grading.	**In Progress** **2023 Action:** 2023-2018-029
Comment: Routine maintenance is performed on an ongoing basis. The DOD REPI program will fund additional fuel breaks on leeward Hawaiʻi Island. Additional funding will be applied for from the USFS for fuel breaks on other islands.	
Lead Agency: DLNR-DOFAW	

Action Item from Previous Plan	Status and/or New Action Number
Action: State-2018-030 - Establish additional Community Wildfire Protection Plans (CWPP): There are 14 CWPPs established throughout Hawaii, which cover over half of the State. Each County has at least one CWPP. Areas not covered by a CWPP will need to be prioritized. Once funding is secured, the entity writing the CWPP will hold community and agency meetings, process data, and write plan.	**In Progress** **2023 Action:** 2023-2018-030
Comment: Additional CWPPs are needed to ensure statewide coverage. The Kahikinui was updated in 2021/2022. There are 14 total CWPPs, with one more in development in East Honolulu. Four of the existing plans are scheduled to be revised over the next 2–3 years if funding is received.	
Lead Agency: DLNR-DOFAW	
Action: State-2018-031 - Prevent structure ignition from wildfires in the home ignition zone through home hardening: Educate residents and assist them with home hardening through voluntary mitigation programs for existing communities, such as Firewise USA. Increase the number of recognized Firewise USA sites throughout the State as well as establish recognized Firewise USA sites in all counties. Increase the amount of risk reduction investment by each recognized Firewise USA site. Ensure that new development is following the State Fire Code's Chapter 17 WUI.	**In Progress** **2023 Action:** 2023-2018-031
Comment: Some communities are already recognized Firewise USA sites, while others are in the process of gaining recognition. Currently 15 communities are part of the Firewise program, with Mariner's Cove as the most recent addition. HWO program would like to train more assessors from the community and County fire departments so additional assessments can take place.	
Lead Agency: DLNR-DOFAW	
Action: State-2018-032 - Install and maintain remote automated weather stations (RAWS): Purchase and install additional RAWS. Maintain RAWS to ensure that all stations within Hawaii's network are operational.	**In Progress** **2023 Action:** 2023-2018-032
Comment: Additional RAWS are needed and current stations are maintained on an ongoing basis. No additional RAWS have been added over the past five years. This action will be included in the plan update to purchase and install additional RAWs and maintain existing RAWs to ensure all stations within the network are operational.	
Lead Agency: DLNR-DOFAW for State-operated RAWS	
Action: State-2018-033 - Cesspool Abatement Program: High-Priority Area Cesspool Abatement Program –Implement a public-private cost-share program between the State, Counties, and the private landowners to incentivize upgrades of qualified cesspools to a septic tank or aerobic treatment system, prioritizing identified high-priority areas and cesspools posing the greatest risk to ground water contamination and/or surface water impairment as a result of system overflow during heavy rainfall events.	**In Progress** **2023 Action:** 2023-2018-033
Comment: A current program exists in the State under Act 120 in which a taxpayer may apply for a tax credit of up to $10,000 for cesspools upgraded to a sewer or septic system. The program has been limited to a total of $5 million – roughly 500 cesspool upgrades per-year. To date, only about 50 taxpayers have utilized the program. A new strategy is therefore required to increase cesspool abatement participation. DOH is currently working on a pass-through loan program with the Counties of Kauai, Maui, and Hawaiʻi to fund cesspool replacement and upgrade projects. The DOH anticipates the loan program will be established by the end of State Fiscal Year 2023. This pass-through loan program includes providing Counties with principal forgiveness loans that are like grants. The Counties will provide this funding to homeowners to upgrade cesspools. We are working with the Counties to ensure that the funding is provided to cesspools that are posing the greatest risks to ground water contamination and/or surface waters using our Hazard Assessment and & Prioritization Tool.	
Lead Agency: DOH	

Action Item from Previous Plan	Status and/or New Action Number
Action: State-2018-034 - Hardening State Laboratory Facility: Harden State laboratory facility to increase all-hazards resilience: •Add protective closure for cooling tower (est. $116,000) •Add shatter proof window films (est. $197,000) •Provide second transformer and double ended switchgear (est. $1,251,000) •Provide separate feeders to mechanical equipment (est. $878,000) •Provide redundant emergency generator (est. $3,758,000) •Provide additional fuel tank for 7-day supply of emergency generator fuel (5 additional days from current capacity) (est. $428,000)	**No Progress** **2023 Action:** 2023-2018-034
Comment: An initial assessment of the facility was conducted in 2013 that identified the recommended hardening actions and provided an initial cost estimate. An additional analysis would likely be required to assess if the initial quotes provided (reflected in the project description) are still accurate and/or if additional hardening actions may be required. No further progress has been made on these hardening actions. Concern was raised that even with these hardening actions, the laboratory would still not be able to function in a power outage given that the current emergency power system does not allow lab work to be conducted in a power loss situation as it does not completely power the HVAC system. SLD is currently engaged with DAGS in construction of a 1200 +/- square foot Biosafety level 3 addition. This addition will have a separate emergency power system and would be able to function in the event of power loss using that emergency power system.	
Lead Agency: DOH	
Action: State-2018-035 - Enhance Hawai‘i Rain Gauge Network: To install more rain gauges and monitor and collect the data on a timely basis, maintain a website for this.	**Completed**
Comment: The Hawai‘i Mesonet project was funded by the National Science Foundation in late 2021 to deploy 84 new meteorological stations in the Hawaiian Islands. The purpose is to collect and produce real-time weather data. In the past, efforts were made to identify the best new stations and contact land managers and station partners. Currently, on-site visits to verify some of the metrics defined by the Hawai‘i Mesonet team for site selection and discussion with landowners in these areas are ongoing. Students will help install, calibrate, and maintain weather data. Recently, support staff on each island was hired for the project. *References* Chen, Y.R., and P.-S. Chu, 2014: Trends in precipitation extremes and return levels in the Hawaiian Islands under a changing climate. International Journal of Climatology, 34, 3913-3925. Huang and Coauthors, 2022: Hourly rainfall data from rain gauge networks and weather radar up to 2020 across the Hawaiian Islands: Scientific data. In review. Gayte, M., 2022: Characterizing rainfall regimes changes and estimating the timing of high streamflow events across the five main Hawaiian Islands. M.S. thesis, Department of Natural Resources and Environmental Management, University of Hawaii-Manoa, 97 pp.	
Lead Agency: Hawai‘i State Climate Office	
Funding Source: National Science Foundation	

Action Item from Previous Plan	Status and/or New Action Number
Action: State-2018-036 - High-resolution Numerical Simulation of the April 2018 Kauaʻi Flooding Events: Use a high-resolution numerical weather model and the large-scale meteorological conditions to simulate the flooding event. Will use a dynamical downscaling approach and ensemble forecasting techniques to assess the probability of flooding.	**Completed**
Comment: Northern Kauaʻi experienced a catastrophic flood event during April 14-15, 2018, with the greatest 24-hour total being 49.69 inches (1,262 mm). This set a new U.S. 24-hour rainfall record and wreaked havoc on the local community for weeks. The objective of this project is to know whether this immense downpour can be simulated using a state-of-the-art high-resolution mesoscale numerical model through dynamical downscaling because the operational weather center was unable to foreshadow this extraordinary event with sufficient lead time. Other objectives are to understand key meteorological factors that are conducive to this intense flooding event so that better preparation and hazard mitigation can be made in the future. This project has been funded by FEMA since 2020 for a three-year duration. The numerical weather model used is the Weather Research and Forecast (WRF) version 4.2 developed by the National Center for Atmospheric Research in Boulder, Colorado. For initial and boundary conditions, the European ERA5 Reanalysis data set at 31 km horizontal resolution and six hourly intervals is used to drive the WRF. Because of the small study area, a dynamical downscaling approach is applied to reproduce local weather at very fine-scale resolutions. The simulation is conducted with one-way nesting for three meshes of 12 km (domain 1), 4 km (domain 2), and 1.3 km (domain 3) horizontal grid spacing. That is, the WRF model will be able to simulate weather variables (e.g., rainfall, wind) at high-resolution (1.3 km) over the entire island of Kauaʻi. The model configuration includes longwave and shortwave radiation schemes, boundary-layer scheme, cumulus parameterization scheme, cloud microphysics scheme, and a land surface model. The simulation period is April 13 to April 15, 2018. In the past two years, we rigorously conducted a suite of numerical experiments using five different cumulus schemes and eight different cloud microphysics schemes, and compared simulation results with observations from rain gauges, radar images, and satellite products. The purpose is to determine which pair of cumulus parametrization-cloud microphysics schemes most closely resembles the observations. The comparison focused on three episodes based on hourly and 15-min rainfall records at Waipa Garden near the epic center in northern Kauaʻi. The first episode occurred from 1-7 pm on April 14 with a total of 20 inches of rainfall. The second episode ran from 12 am to 5 am on April 15 with 18 inches of rainfall. This is followed by the third episode which ran from 10:30 am to 12:45 pm on April 15 with eight inches rainfall. For five cumulus schemes, Grell-Freitas ensemble and Modified Tiedtke are better than the other three schemes in simulating hourly rainfall spatial distribution during episodes 2 and 3 when used in combination with WSM 6-class graupel (mp_physics=6) cloud microphysics scheme. Both cumulus schemes clearly simulate the eastward movement of the rainstorm, and a southward expansion of the convective system, as observed in the corresponding radar reflectivity images. Although the Grell-Freitas ensemble scheme can realistically simulate the northeast-southwest tilting of the rain-band, the intensity of rain rate is weaker, and the storm center is slightly to the east compared to observations. For instance, during the true 24-h period of peak rainfall (12:45 pm April 14 to 12:45 pm April 15), the simulated rainfall from Grell-Freitas ensemble scheme is ~400 mm, relative to >1,000 mm from the Modified Tiedtke scheme. Northern Kauaʻi features complex terrain with Mount Waiʻaleʻale in central Kauaʻi reaching an elevation of 1,569 m. Elevated terrains provide orographic uplift that enhances convection and convective rainfall along the northern slopes of Kauaʻi. This may provide a key mechanism for enhancing the record-breaking rainfall. Our current effort is to reduce the terrain of Kauai using modeling techniques to investigate how the terrain may affect the development of thunderstorms.	
Lead Agency: Hawaiʻi State Climate Office	
Funding Source: FEMA HMGP (Hazard Mitigation Grant Program)	

Action Item from Previous Plan	Status and/or New Action Number
Action: State-2018-037 - Estimating return periods of Extreme Rainfall Events for Kauaʻi, Hawaiʻi: Collect and process high-frequency (hourly if available) rainfall data; quality control of raw rainfall data; use the extreme value distribution to compute extreme rainfall corresponding to different return periods (e.g., 20-yr, 50-yr); spatial analysis of extreme rainfall events defined by return values Reference: Chu, P.-S., coauthors, 2009: Extreme rainfall events in the Hawaiian Islands. Journal of Applied Meteorology and Climatology, 48, 502-516.	**Completed**
Comment: Historical hourly rainfall data for Kauaʻi were obtained from diverse federal, state, and private sectors (Huang et al., 2022). The majority of data comes from the National Weather Service and the USGS. Initially, there were 41 rain gauges available from Kauaʻi. After screening using an automated and manual quality control process, and to keep homogeneity and consistency in analyses, 20 stations were finally selected for the study. To estimate return periods of extreme rainfall events, a generalized extreme value (GEV) distribution is used. The GEV distribution is often found to be a good approximation for the statistics of the maxima of random variables. The probability density function of GEV can be integrated analytically to yield the cumulative distribution function (CDF), which can be inverted to yield an explicit formula of the quantile function. This makes GEV very appealing because once its distribution parameters are known, its extreme value corresponding to any desired return period (e.g., 50 or 100-yr) can be easily determined. This extreme value is known as the "return level", which is expressed as the same unit as rainfall, mm, and exceeded by the annual maximum value in any particular year with probability p. Results indicate that windward Kauaʻi exhibits high return levels with rainfall intensity ranging from 40 mm/hr (2-yr return period) to 100 mm/hr (100-yr return period) (Gayte, 2022). In comparison, sites in leeward Kauaʻi show lower return levels, varying from 30 mm/hr (2-yr return period) to 70 mm/hr (100-yr return period). A nonparametric rank-based Mann-Kendall test and Sen's method are applied to analyze whether the trends in return levels are statistically significant during 1990-2020 (Chen and Chu, 2014). Spatial analysis of trends in return levels indicates rather different patterns across Kauaʻi. That is, rain gauges located on the northern coast are characterized by a downward trend while gauges on the eastern Kauai have a positive trend. *References* Chen, Y.R., and P.-S. Chu, 2014: Trends in precipitation extremes and return levels in the Hawaiian Islands under a changing climate. International Journal of Climatology, 34, 3913-3925. Huang and Coauthors, 2022: Hourly rainfall data from rain gauge networks and weather radar up to 2020 across the Hawaiian Islands: Scientific data. In review. Gayte, M., 2022: Characterizing rainfall regimes changes and estimating the timing of high streamflow events across the five main Hawaiian Islands. M.S. thesis, Department of Natural Resources and Environmental Management, University of Hawaii-Manoa, 97 pp.	
Lead Agency: UH	
Funding Source: FEMA HMGP (Hazard Mitigation Grant Program)	

Action Item from Previous Plan	Status and/or New Action Number
Action: State-2018-038 - Model Resources for Streamlined and Resilient Disaster Reconstruction in Hawaiʻi: This Guidance is intended to help State and County agencies, communities, and other stakeholders: •Expand and support the institution of reconstruction guidelines and policies that will balance regulatory control and recovery speed, protect sensitive environmental and cultural resources, and incorporate mitigation and adaptation strategies throughout the process to increase resilience for future hazards; •Support Hawaiʻi Sea Grant in conducting reconstruction and resilience workshops to inform development of guidelines, ordinances, and policies; •Bring planners and emergency managers to a common understanding how their fields interact after a disaster; and •Inform the Climate Commission of guidelines and model resources for improving resilience to coastal flooding-related disaster events, building on the recommendations of the State SLR Report. Model resources developed through the project will include recovery preparedness plan outline, State-level emergency proclamation including considerations of resilient recover, model reconstruction ordinance, and model communication between agencies and community. The project is building on previous work by Maui County and Hawaiʻi Sea Grant.	**Completed**
Comment: This was published in July 2019. Guidance for Disaster Recovery Preparedness in Hawaiʻi: https://seagrant.soest.hawaii.edu/guidance-for-disaster-recovery-preparedness-in-hawaii/ Through a National Oceanic and Atmospheric Administration (NOAA) Regional Coastal Resilience Grant, the Hawaiʻi Sea Grant College Program together with the State of Hawaiʻi Department of Land and Natural Resources (DLNR), Office of Planning, and Tetra Tech, Inc., developed statewide guidance documents and tools to improve community resilience to coastal hazards and sea level rise, building on the work of the 2017 Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report. This guidance document, with recommended practices and model resources, was developed with State and County government in Hawaiʻi to assist them in establishing resilience-focused recovery practices before a disaster event to enable communities to recover quickly while also protecting sensitive coastal environments. Guidance and model resources include three potential outputs of disaster recovery preparedness: disaster recovery ordinance, disaster recovery framework, and disaster reconstruction ordinance.	
Lead Agency: UH Sea Grant in partnership with State DLNR and OP through grant and cooperative agreement with NOAA.	
Funding Source: (NOAA) Regional Coastal Resilience Grant 2017	

Action Item from Previous Plan	Status and/or New Action Number
Action: State-2018-039 - Guidance for Addressing Sea Level Rise in Community Planning: This Guidance is intended to help State and County agencies, communities, and other stakeholders: •Use the best available science and tools in community planning for sea level rise. •Apply the State's climate adaptation priority guidelines to enhance coastal resilience through planning. •Integrate policies, strategies, and actions in community-level plans to address existing and future chronic coastal flooding with sea level rise. •Identify ways to promote horizontal and vertical policy consistency. •Define a process for monitoring, evaluation, and learning to support adaptive management needed with evolving climate science and under changing conditions.	**Completed**
Comment: https://seagrant.soest.hawaii.edu/guidance-for-addressing-slr-in-community-planning-in-hi-2/ Through a National Oceanic and Atmospheric Administration (NOAA) Regional Coastal Resilience Grant, the Hawaiʻi Sea Grant College Program together with the State of Hawaiʻi Department of Land and Natural Resources (DLNR), Office of Planning, and Tetra Tech, Inc., developed statewide guidance documents and tools to improve community resilience to coastal hazards and sea level rise effects, building on the work of the State of Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report. This Guidance for Addressing Sea Level Rise in Community Planning in Hawaiʻi is intended to assist County planners to build upon and improve existing efforts to address sea level rise and includes recommended practices, examples, and resources, to assist County government in addressing sea level rise and coastal hazards as part of County planning and implementation framework. Developed through extensive input from the County planning departments and based on Hawaii's existing planning context, this guidance is organized under four key topics: vulnerability assessment, land use and development alternatives, plan and policy alignment, and adaptive management.	
Lead Agency: UH Sea Grant in partnership with State DLNR and OP through grant and cooperative agreement with NOAA.	
Funding Source: NOAA Regional Coastal Resilience Grant	
Action: State-2018-040 - Hawaiʻi Sea Level Rise Viewer: Viewer has been built and released. Developed and hosted by PacIOOS. hawaiisealevelriseviewer.org Ongoing actions include trainings and demonstrations of utility of viewer, utilizing viewer in community planning. Project is part of larger Hawaiʻi Sea Grant –led program "Building Resilience to Coastal Hazards and Sea Level Rise in Hawaii" (see funding NOAA funding info, below). Viewer was accepted along with State SLR Report by State Interagency Climate Change Mitigation and Adaptation Commission.	**Completed**
Comment: The Hawaiʻi Sea Level Rise Viewer was completed and publicly released in December 2017: www.hawaiisealevelriseviewer.org This Viewer provides localized and property scale maps of potential future exposure to sea level rise from high tide and high wave flooding and coastal erosion. The significance of the viewer is that it provides a tangible basis for planning and policy discussions. The SLR Viewer and the information it provides very quickly became part of household conversations and is becoming institutionalized as the basis of plans, policies, and decisions. As a result, it is now part of State and County Hazard Mitigation Plans, it is being incorporated into community plans that direct land use for the next 30 years, it is the basis of ongoing vulnerability assessments at the local level for capital improvement decisions, and as the basis for proposed shoreline development setbacks.	
Lead Agency: UH Sea Grant in partnership with State DLNR and OP through grant and cooperative agreement with NOAA. Viewer was developed by PacIOOS at UH.	
Funding Source: NOAA Regional Coastal Resilience Grant	

Action Item from Previous Plan	Status and/or New Action Number
Action: State-2018-041 - Comprehensive Education/Outreach Plan for State: 2017 HB-571 – Require Comprehensive Education and Outreach Plan –Team with US Sea Grant to implement strategies to reach all individuals and all organizations. For 2022-2023, under the HMGP Program, this is being addressed with the Project Aloha Safe Homes - Community Behavior - which targets Unreceptive or difficult to reach citizens.	**In Progress** **2023 Action:** 2023-2018-041
Comment: A Communication Plan to Reach the Whole Community was submitted to the legislature in 2020. See: https://seagrant.soest.hawaii.edu/wp-content/uploads/2020/09/Communication-Strategy-Outreach-Plan-V.1.pdf - Minor elements of the Plan have been completed - about 5%. A major portion of the plan can be implemented with HMGP 4510 - Aloha Safe Homes Community Behavior, to be submitted in January of 2023. Education and Outreach for the entire community is a continuing task for preparation. This is already in the 2018 SHMP. Of the 84 action items in the Plan, this received the highest score of 59, along with two other items, one being the Companion to this Project - Aloha Safe Homes - Education and Outreach. The need for Education and Outreach should be further strengthened in the 2023 Plan. It was the top priority in the FEMA, ACOE, HI-EMA Hurricane Behavioral Study (2018).	
Lead Agency: UH Sea Grant	
Action: State-2018-042 - Homeowners Handbook to Prepare for Natural Hazards: Update homeowners handbook for hazard events, obtain funding to reprint, and incorporate lessons learned such as from Hurricane Ida in Louisiana.	**In Progress** **2023 Action:** 2023-2018-042
Comment: The Homeowner's Handbook has been informing citizens since 2007. The book is currently in the 4th Edition. This is an ongoing project with updating required for recent hazard events as well as new mitigation measures (e.g., damage assessed for Hurricane Ida in Louisiana). This is being funded with HMGP for 2022/2023 which calls for update of the book, printing 20,000 copies, and conducting 60 outreach and education events in the State of Hawaiʻi.	
Lead Agency: UH Sea Grant	
Action: State-2018-043 - Comprehensive Wastewater Management Plan: Implement statewide wastewater management program with funding to inventory and maintain database of on-site systems. Implement statewide code that requires maintenance contracts. Develop robust education and outreach program.	**In Progress** **2023 Action:** 2023-2018-043
Comment: DOH has an inventory of cesspools and other on-site systems that still needs to be validated. There are over 130,000 on-site systems in Hawaiʻi that will need to be validated. DOH is currently researching ways of how this validation will be done. DOH currently requires maintenance contracts for aerobic treatment units. The DOH has plans of amending the Hawaiʻi Administrative Rules to include the requirement of having maintenance contracts for septic systems. DOH with the assistance of the University of Hawaiʻi Water Resources Research Center has developed a geographic information system that is a Hazard Assessment and Prioritization Tool that includes sea level rise zones for on-site systems. This tool identifies areas in the State of Hawaiʻi that have on-site systems that are vulnerable to sea level rise. DOH is currently administering a Cesspool Conversion Working Group that is tasked to develop a long-term plan to address cesspool replacements by 2050. Education and outreach will be developed after the long-term plan is completed in December 2022.	
Lead Agency: DOH	

Action Item from Previous Plan	Status and/or New Action Number
Action: State-2018-044 - Building Code Amendments to Reduce Existing and Future Stock Vulnerability to Coastal Hazards & Climate Impacts in the City & County of Honolulu, Hawaiʻi: Report was produced for the City and County of Honolulu to implement as useful.	**Completed**
Comment: The state of Hawaiʻi and the County of Honolulu have adopted the 2015 International Residential Code and International Building code, both of which included improvements to improving existing and future stock vulnerability to coastal hazards. Undergoing final editorial revisions.	
Lead Agency: Hawaiʻi State Energy Office	
Funding Source: In kind	
Action: State-2018-045 - Building Code Amendments to Reduce Existing and Future Stock Vulnerability to Coastal Hazards & Climate Impacts for the Counties of Hawaiʻi, Maui and Kauaʻi, State of Hawaiʻi: Report to be produced for the Counties to implement as useful.	**In Progress** **2023 Action:** 2023-2018-045
Comment: The state of Hawaiʻi and the Counties of Hawaiʻi, Maui and Kauaʻi have adopted the 2015 International Residential Code and International Building code, both of which included improvements to improving existing and future stock vulnerability to coastal hazards Undergoing final editorial revisions.	
Lead Agency: State of Hawaiʻi DBEDT	
Action: State-2018-046 - Green Infrastructure Study and Plan: 1. Identify green infrastructure opportunities in the State, including any related costs and savings. 2. Identify green infrastructure planning and development best practices in the State for potential application, including financing and community engagement practices. 3. Complete a plan that details how the State can move forward to cost effectively take advantage of identified opportunities, including related costs and savings. 4. Identify any legal or regulatory Changes that will be needed to execute the completed plan.	**No Progress** **2023 Action:** 2023-2018-046
Comment: There was no measurable progress due to a lack of capacity. This action is still considered viable and will be carried over to the plan update.	
Lead Agency: State of Hawaiʻi DBEDT	
Action: State-2018-047 - Report Assessing the Feasibility and Implications of Managed Retreat Strategies for Vulnerable Coastal Areas in Hawaiʻi: Information gathered will feed into a report covering the potential for and feasibility of a managed retreat framework in the state. This report will summarize the complex systems affected by potential managed retreat and provide a solid basis to inform future legislation for the State, under which funding and requirements for a managed retreat framework would occur.	**Completed**
Comment: This report was completed in February 2019. The final report can be found here: https://planning.hawaii.gov/czm/ormp/ormp-action-team-project-on-the-feasibility-of-managed-retreat-for-hawaii/	
Lead Agency: State of Hawaiʻi DBEDT	
Funding Source: NOAA CZM funds	
Action: State-2018-048 - Develop criteria to rank infrastructure most threatened by chronic coastal flooding, climate change, and sea level rise, develop mitigation strategy to either retreat threatened infrastructure or nature-based engineering solution to harden, if retreat is not possible, and retreat or harden infrastructure.	**No Progress** **2023 Action:** 2023-2018-048
Comment: There was no measurable progress on this action specifically, but progress was made on related projects that would inform pilot projects/methodology for this action.	
Lead Agency: State of Hawaiʻi DBEDT	

Action Item from Previous Plan	Status and/or New Action Number
Action: State-2018-049 - Development of Comprehensive High-Resolution Probabilistic Tsunami Design Zone Maps Compatible with ASCE 7-16 for the Island of Oʻahu, State of Hawaiʻi: This project is Phase I / Years 1 and 2 of a multi-phase and -year endeavor described as follows: Phase I /Year 1 • Develop Phase I project work plan. • Conduct modeling/mapping of the City & County of Honolulu (Urban core south coast and Haleʻiwa) Phase I /Year 2. • Complete modeling/mapping for entire City & County of Honolulu Island of Oʻahu. • Conduct independent technical review to ensure compliance with the ASCE 7-16 Chapter 6 Probabilistic Tsunami Hazard Analysis mapping criteria. • Draft proposed language for the Honolulu City Council to consider amending the City & County of Honolulu Building Code to adopt the probabilistic Tsunami Design Zone maps/model data developed pursuant to this project along with styles of maps appropriate for use in the City & County of Honolulu Building Code and the ASCETsunami Design Geodatabase.	**In Progress** **2023 Action:** 2023-2018-049
Comment: Phase 1, year 1 of this action has been started but has not made significant progress. It is still a priority for the State and will be included in the updated action plan.	
Lead Agency: State of Hawaiʻi DBEDT	

Action Item from Previous Plan	Status and/or New Action Number
Action: State-2018-050 - Development of Comprehensive High-Resolution Probabilistic Tsunami Design Zone Maps Compatible with ASCE 7-16 for the Counties of Hawaiʻi, Maui, and Kauaʻi, State of Hawaiʻi: Phase I / Year 1 • Develop Phase I project work plan. • Conduct modeling/mapping of City & County of Honolulu (Urban core south coast and Haleʻiwa). • Conduct independent technical review to ensure compliance with ASCE 7 criteria. Phase I / Year 2 • Complete modeling/mapping for entire City & County of Honolulu Island of Oʻahu. • Conduct independent technical review to ensure compliance with ASCE 7 criteria. • Draft proposed language for the Honolulu City Council to consider amending the City & County of Honolulu Building Code to adopt the probabilistic Tsunami Design Zone maps / model data developed pursuant to this project along with styles of maps appropriate to the City & County of Honolulu Building Code and the ASCE Tsunami Design Geodatabase. Phase I / Year 3 • Initiate modeling/mapping for Hawaiʻi, Maui, and Kauaʻi Counties. Phase(s) I & II/ Year 4 • Complete modeling/mapping for Hawaiʻi, Maui, and Kauaʻi Counties. • Conduct independent technical review to ensure compliance with ASCE 7 criteria. • Draft proposed language for County Councils of Hawaiʻi, Maui, and Kauaʻi to consider amending their building codes to adopt the probabilistic Tsunami Design Zone maps / model data developed pursuant to this project along with styles of maps appropriate for use in their respective County building codes and the ASCE Tsunami Design Geodatabase. Phase II/ Year 5 • Complete drafting proposed language for County Councils of Hawaiʻi, Maui, and Kauaʻi to consider amending their building codes to adopt the probabilistic Tsunami Design Zone maps / model data developed pursuant to this project along with styles of maps appropriate for use in their respective County building codes and the ASCE Tsunami Design Geodatabase. • Draft proposed language to adopt the probabilistic Tsunami Design Zone maps / model data developed pursuant to this project along with style of maps appropriate for use in State of Hawaiʻi Building Code. • Present building code amendments for State Building Code Council (SBCC) review and approval. • Conduct rulemaking in accordance with HRS Chapter 91.	**In Progress** **2023 Action:** 2023-2018-050
Comment: Phase I is in progress. Probabilistic Tsunami Design Zone Mapping of Hawaii, Maui, and Kauai Counties (Phase II) will occur after Probabilistic Tsunami Design Zone Mapping of Oʻahu (Phase I) is completed.	
Lead Agency: State of Hawaiʻi DBEDT	

Action Item from Previous Plan	Status and/or New Action Number
Action: State-2018-051 - Flood Engineering Analysis of Waimanalo Watershed: 1. Form workgroup of affected State and County agencies, affected land owners, and stakeholders. 2. Develop a public information campaign including public service announcements, fact sheets, and other forms of communication on the types of insurance and the need to purchase flood insurance. 3. Measure Change in the number of active flood insurance policies compared to baseline levels. As of February 2018, there are 60,423 active flood insurance policies statewide.	**In Progress** **2023 Action:** 2023-2018-051
Comment: 1. Workgroup task was not handed over to current leadership in October 2021. Status unknown. 2. External Affairs Branch has incorporated messaging on the value of flood insurance and the need to consult with insurers about flood and wind insurance as part of its social media, news releases, and other outreach products, particularly the campaign around the start of the annual hurricane season in May and June. 3. As of Sept. 2, 2022, 55,244 NFIP flood insurance policies were active in the State of Hawaii, per the State's NFIP coordinator at DLNR. Assuming the baseline figure of 60,423 active policies in February 2018 also is based on NFIP policies, that reflects a decline of about 11.2%. However, there are complicating factors, as private flood insurance has become more widely available and there is currently no reliable routine source of data on private flood policies covering Hawaiʻi properties. The trend analysis is also complicated by the economic strain of the COVID-19 pandemic beginning in March 2020, and the rate of inflation in 2022, both of which created economic strains for households which may have dropped flood coverage to make more of their income available for food/shelter/etc.	
Lead Agency: HI-EMA	
Action: State-2018-052 - Include Climate Change in North Shore Coastal Flooding Restudy: 1. Coordinate with FEMA Region IX Risk Map staff to develop scope of work for north shore restudy, including climate change analysis.	**Discontinued**
Comment: Discontinue as currently written. This action no longer under the State's jurisdiction. This task is under the City and County of Honolulu purview.	
Lead Agency: HI-EMA	
Action: State-2018-053 - Coordinate the compilation of projected development to assist with future local and State HMPs: HI-EMA will work with other departments at the State and local levels, to coordinate the compilation of projected development in a spatial format to enable a more comprehensive analysis to identify problems and exposure prior to construction. This information will be included in the future update of local and State Hazard Mitigation Plans; and be available to all entities for planning use.	**No Progress** **2023 Action:** 2023-2018-053
Comment: No progress due to lack of staffing. This mitigation action will be developed by HI-EMA GIS staff in coordination with OPSD in the future.	
Lead Agency: HI-EMA	
Action: State-2018-054 - Reduce number of repetitive loss properties: The State of Hawaiʻi Department of Land and Natural Resources (DLNR), HI-EMA and the four County Governments will continue to work together to reduce the number of properties remaining on the repetitive loss list. The State Hazard Mitigation Forum will provide technical and scientific assistance. Mitigation measures to be considered for each property are: acquisition, relocation, elevation, or small flood control project.	**Ongoing** **2023 Action:** 2023-2018-054
Comment: There is no measurable progress on this project, but it is an ongoing goal to reduce repetitive loss properties. This project will continue to be developed.	
Lead Agency: HI-EMA	

Action Item from Previous Plan	Status and/or New Action Number
Action: State-2018-055 - Reduce and/or convert hazardous fuels along roadsides: Roadways, portions of highways, and private streets shall be cleared of combustible vegetation and other combustible growth. Certain ground covers shall be permitted to be exempt provided that they do not form a means of readily transmitting fire. Keep invasive, fire-prone grasses, and shrubs short. Monitor vegetative regrowth due to year-round growing season and invasive, fire-prone grasses that grow back quickly. **Comment:** Routine maintenance is performed on an ongoing basis to reduce fuels along roadsides. **Lead Agency:** State HDOT	**Ongoing** **2023 Action:** 2023-2018-055
Action: State-2018-056 - Collaborate with partners and the State Hazard Mitigation Forum to evaluate and update the State Hazard Mitigation Plan on an annual basis. **Comment:** Measurable progress was made over the past five years, including adding four new mitigation actions to the plan and evaluating funding opportunities to implement mitigation actions. **Lead Agency:** HI-EMA	**In Progress** **2023 Action:** 2023-2018-056
Action: State-2018-057 - Coordinate access to Hawai`i State Historic Preservation Division maintained cultural resource information: HI-EMA to work with the Department in order to access to cultural resource information for inclusion in future State Hazard Mitigation Plan updates. **Comment:** Outreach and coordination with the Hawai`i State Historic Preservation Division has taken place to coordinate how GIS coordinates will be presented in public facing materials in order to share critical location information. This data is an exact copy of the SHPD GIS data derived from with the exception that all descriptive information has been removed, future planners can contact the SHPD GIS Specialist for updates. This database was used to update the vulnerability assessment in the 2023 SHMP. **Lead Agency:** HI-EMA	**In Progress** **2023 Action:** 2023-2018-057
Action: State-2018-058 - Implement recommendations of the Statewide Highway Shoreline Protection Study: Implement the mitigation measures as outlined in State Highway Shoreline Protection Study: Final Report of Preliminary Field Investigation, Rankings and Recommendations; August 2019. The study has recommendations for next steps and has prioritized the roadways that require attention. **Comment:** Some of the shoreline erosion mitigation projects that have been initiated over the past five years include: • Kamehameha Highway at Kanenelu – Short-term • Kamehameha Highway at Kaaawa Elementary School - Short-term • Kamehameha Highway in the vicinity of Kualoa, Kaaawa, Punaluu, and Hauula – Mid-term • Kamehameha Highway at Hauula – Short-term • Sandsaver Pilot at Wailua Beach • Sandsaver Pilot at Kualoa and Waimanalo • Kamehameha IV Highway in the vicinity of Niaupala Fishpond Short-term • Kamehameha IV Highway in the vicinity of Niaupala Fishpond and Kupeke Fishpond -Mid-term **Lead Agency:** State of Hawai'i DOT	**In Progress** **2023 Action:** 2023-2018-058
Action: State-2018-2013-001 - By 2028, update the design standards for new high-occupancy public buildings that can provide enhanced hurricane protective areas and consider Mass Care Working Group recommendations. **Comment:** Staffing shortfalls prevented progress on this action. Coordination will continue with the State Building Code Council (SBCC) and revitalized Mass Care Working Group. Legislative bill submitted to add HI-EMA to the SBCC. Building code changes are slow to be adopted. **Lead Agency:** HI-EMA	**No Progress** **2023 Action:** 2023-2013-001

<table>
<tr><th>Action Item from Previous Plan</th><th>Status and/or New Action Number</th></tr>
<tr><td>Action: State-2018-2013-002 - Evaluate vulnerability of critical infrastructure systems in the storm surge inundation zone (power, water, fuel, communications, ports, airports) and identify protective measures or backup resources to the most practical extent.</td><td rowspan="3">In Progress

2023 Action: 2023-2013-002</td></tr>
<tr><td>Comment: This is an ongoing study that is 40% complete.</td></tr>
<tr><td>Lead Agency: HI-EMA</td></tr>
<tr><td>Action: State-2018-2013-004 - Improve Building Codes to the most current standards. Adopt wind design standards for the installation of photovoltaic panels, power walls, and other alternative energy sources on residential/commercial buildings.</td><td rowspan="3">In Progress

2023 Action: 2023-2013-004</td></tr>
<tr><td>Comment: This is an ongoing action that is slow to be implemented due, in part, to the limitations of volunteer staffing at the SBCC. The 2018 International Building Code, including design standards for roof-top solar panels, was adopted by the state on April 20, 2021.</td></tr>
<tr><td>Lead Agency: HI-EMA</td></tr>
<tr><td>Action: State-2018-2013-005 - When Hazus is updated to represent State of Hawaiʻi specific building types (anticipated late 2018), develop building geodatabase and incorporate into Hazus MH Hurricane loss estimation module, and make model adjustments to enable reasonable hurricane scenario loss estimates.</td><td rowspan="3">Discontinued</td></tr>
<tr><td>Comment: This action has been discontinued due to a lack of staffing capacity in the lead agency and the ability to manage the action. However, Hazus was used to model the hurricane hazard for the 2023 SHMP Update.</td></tr>
<tr><td>Lead Agency: PDC</td></tr>
<tr><td>Action: State-2018-2013-006 - Develop hurricane shelter capacity estimates and identify alternative hurricane evacuation/sheltering policies prioritizing the most vulnerable population areas.</td><td rowspan="3">Discontinued</td></tr>
<tr><td>Comment: This action is no longer under the State's jurisdiction. This falls under the individual counties' purview and may be added to local hazard mitigation plan updates.</td></tr>
<tr><td>Lead Agency: HI-EMA</td></tr>
<tr><td>Action: State-2018-2013-007 - Identify the types of buildings that can function as temporary refuges and create a voluntary program for certifying “storm-ready” private facilities through a standardized procedure. Determine the number of low vulnerability buildings available for refuge in the private sector.</td><td rowspan="3">Discontinued</td></tr>
<tr><td>Comment: This is no longer the State's jurisdiction. This is under the counties' purview and may be added to local hazard mitigation plan updates.</td></tr>
<tr><td>Lead Agency: HI-EMA</td></tr>
<tr><td>Action: State-2018-2013-009 - Develop State of Hawaiʻi Hurricane Relief Fund standards for hurricane retrofits and debris protection, to enable insurance premium credits. Develop a post & pier/single wall hurricane retrofit Expert Tool Graphical User Interface, similar to earthquake retrofits.</td><td rowspan="3">Discontinued</td></tr>
<tr><td>Comment:
This mitigation action is no longer continued because the Hawaiʻi Hurricane Relief Fund is no longer active. The Fund has also been removed from the list of state capabilities.</td></tr>
<tr><td>Lead Agency: DCCA</td></tr>
</table>

Action Item from Previous Plan	Status and/or New Action Number
Action: State-2018-2013-018 - Continue to support the Counties in the evaluation of existing policies for the use of buildings for vertical evacuation and update as necessary. Develop a standard procedure for evaluating existing multi-story buildings as tsunami (and hurricane) refuge structures. This continues to be a priority for HETAC, and we did some work with the City and County of Honolulu who completed pilot studies of several buildings.	**In Progress** **2023 Action:** 2023-2013-018
Comment: Minimal progress was made on this action due to staffing shortfalls. HETAC worked with the City and County of Honolulu contractor to review selected buildings in Honolulu, but a report has not been produced yet. A review of the report will determine next steps for this project. FEMA Region IX will be engaged to initiate the vulnerability analysis and to develop priorities.	
Lead Agency: HETAC	
Action: State-2018-2013-021 - Develop maps of probabilistic tsunami inundation and runup for use in designing or retrofitting critical infrastructure facilities, including bridges, major multi-story buildings and vertical evacuation refuge buildings (required ASCE-7 implementation). Adopt tsunami-resistant design provisions. Enable "tsunami-ready" designation for risk Category III and IV structures.	**In Progress** **2023 Action:** 2023-2013-021
Comment: Project for the Development of Comprehensive High-Resolution Probabilistic Tsunami Design Zone Maps Compatible with ASCE 7-16 for the Island of Oʻahu, State of Hawaiʻi is currently in the solicitation stage.	
Lead Agency: DBEDT	
Action: State-2018-2013-024 - Conduct all hazard evaluations and develop cost-effective seismic retrofits for priority facilities in the Counties of Hawaiʻi and Maui.	**In Progress** **2023 Action:** 2023-2013-024
Comment: Minimal progress was made on this action due to staffing shortfalls, but new work has begun that includes planning for home retrofit programs that can be supported by this initiative. FEMA Region IX will be engaged to initiate the vulnerability analysis and to develop priorities. The Hawaiʻi building code status needs to improve to increase eligibility for BRIC funding that will facilitate implementation of this project in the future.	
Lead Agency: HETAC	
Action: State-2018-2013-025 - Provide public outreach on how to retrofit and establish anchorage of post & pier foundations of Hawaiʻi light-frame housing. New work has begun planning for home retrofit programs that can be supported by this initiative. Working with other State partners to implement.	**In Progress** **2023 Action:** 2023-2013-025
Comment: Minimal progress was made on this action due to staffing shortfalls, but new work has begun planning for home retrofit programs that can be supported by this initiative. HETAC is working with other State partners to implement the project. FEMA Region IX will be engaged to initiate the vulnerability analysis and to develop priorities. HETAC is considering tax incentives and encouraging retrofit of the entire load path.	
Lead Agency: HETAC	
Action: State-2018-2013-026 - Require implementation of seismic bracing requirements for equipment and ceiling systems in renovation and post-disaster repairs of schools, hospitals, and assisted living facilities.	**In Progress** **2023 Action:** 2023-2013-026
Comment: No measurable progress was made on this action due to staffing shortfalls. FEMA Region IX will be engaged to initiate vulnerability analysis and to develop priorities.	
Lead Agency: State Building Code Council	
Action: State-2018-2013-028 - Compile detailed County of Maui bridge seismic retrofit performance objective information from HDOT for 50-60 bridges, and update Hazus inventory to reflect more accurate expected bridge loss estimates in data products.	**No progress** **2023 Action:** 2023-2013-028
Comment: No measurable progress was made on this action due to a lack of capacity.	
Lead Agency: State of Hawaiʻi DOT	

Action Item from Previous Plan	Status and/or New Action Number
Action: State-2018-2013-030 - Confirm Seismic Rating Criteria for Shelters in Counties of Hawaiʻi and Maui.	**Discontinued**
Comment: This action is no longer under the State's jurisdiction. This is now under the counties' purview and may be included in updates to their local hazard mitigation plans.	
Lead Agency: HI-EMA	
Action: State-2018-2013-033 - Conduct Testing of the Performance of current and future assets for the promotion of life-saving measures (Single Wall Construction, pillar and post-construction, and post-disaster housing) when subjected to major earthquakes and hurricanes.	**In Progress** **2023 Action:** 2023-2013-033
Comment: Minimal progress has been made, but this action is still a priority and aligns with State goals, innovation, and development of new assets and could potentially take place at HI-EMA facilities.	
Lead Agency: HI-EMA	
Action: State-2018-2013-034 - Track and evaluate current development of Earthquake Early Warning systems.	**In Progress** **2023 Action:** 2023-2013-034
Comment: HETAC is monitoring the development of these systems. HETAC has coordinated with UH scientists working on the development of these systems globally and is promoting local Hawaiʻi and subduction zone deployments that could significantly benefit data collection and early warning. This action was reworded slightly for the 2023 action plan to better meet the goals of the State.	
Lead Agency: HETAC	
Action: State-2018-2013-035 - Generate ShakeMaps that incorporate soil conditions and the new seismic hazard model information for Hawai'i.	**No Progress** **2023 Action:** 2023-2013-035
Comment: The action is still a priority and aligns with State goals; however, due to funding constraints and/or competing priorities but it is not underway with the USGS.	
Lead Agency: HETAC	
Action: State-2018-2013-061 - Develop Zones of Required Special Investigations near hillsides. If mandated by the State Legislature, use these zones to define as a duty to notify during real estate transactions.	**No Progress** **2023 Action:** 2023-2013-061
Comment: The action is still a priority and aligns with State goals; however, due to funding constraints and/or competing priorities, it has not seen measurable progress over the past five years.	
Lead Agency: UH	
Action: State-2018-2013-070 - Develop clear Standard Operating Procedures for Medical Reserve Corps activation and deployment.	**Completed**
Comment: This project was needed to standardize the activation and deployment of the Medical Reserve Corps. It was completed in 2020 with clear Standard Operating Procedures established and shared with stakeholders.	
Lead Agency: DOH	
Funding Source: State General Funds	
Action: State-2018-2013-071 - Develop a pre-incident mission-ready package (MRP) for EMAC requests (Emergency Mutual Aid Compact) for licensed healthcare professionals. DOH OPHP has established a plan for responding to EMAC requests when needed.	**Ongoing** **2023 Action:** 2023-2013-071
Comment: With Hawaiʻi being a small and remote state, we are more likely to request assistance from other states rather than provide it. A plan has been developed for Department of Health Office of Public Health Preparedness Planners to handle EMAC requests as the need arises. This is an ongoing action that is being carried forward in the plan update.	
Lead Agency: DOH	

Action Item from Previous Plan	Status and/or New Action Number
Action: State-2018-2013-072 - DOH to develop standard operating procedures for sharing information across agencies.	**Ongoing** **2023 Action:** 2023-2013-072
Comment: As documented in DOH's Emergency Operations Plan, sharing information across agencies occurs mainly occur via WebEOC, veoci, various data and reports from lab/disease investigation/GIS, etc. DOH maintains network communication infrastructure, including landline phones, computers, email, video conferencing, and fax. Satellite phones and 800 MHZ two-way radios are backup devices for communication. This is an ongoing action that is being carried forward in the plan update.	
Lead Agency: DOH	
Action: State-2018-2013-078 - Develop templates for public health emergency messaging.	**Ongoing** **2023 Action:** 2023-2013-078
Comment: DOH developed templates for various public health emergencies that could be modified depending on the situation. DOH continues to build capacity to provide just-in-time messaging and incorporate relevant templates from other sources like those found on ready.gov. This is an ongoing action that is being carried over to the plan update.	
Lead Agency: DOH	
Action: State-2018-2013-086 - Investigate how to warehouse supplies to account for supply chain disruption. Continue preparedness messaging to residents to have commodities on-hand for 14 days.	**In Progress** **2023 Action:** 2023-2013-086
Comment: HI-EMA is currently investigating how to warehouse needed supplies. Preparedness messaging to residents to have food and water on-hand has been revised and increased to 14 days. Cost of project implementation changed to >$100,000 because of the resources required to execute this mitigation action.	
Lead Agency: HI-EMA	
Action: State-2018-2013-088 - Using the "Hurricane Shelter Retrofit Procedural Guide" HI-EMA will continue to retrofit public shelter buildings to increase capacity and decrease the statewide sheltering deficit. These shelter-hardening actions will result in EHPA-rated hurricane shelters. The goal of the program is to use federal HMGP funds, along with State CIP funds, in order to increase the overall fund amount available for the shelter-hardening actions needed to achieve Category 3 hurricane protection.	**In Progress** **2023 Action:** 2023-2013-088
Comment: $3 million in annual State CIP funding has been allocated for hurricane retrofits of State or county-owned facilities.	
Lead Agency: HI-EMA	
Action: State-2018-2013-095 - Augment and expand education and outreach for earthquake and tsunami hazard reduction activities.	**In Progress** **2023 Action:** 2023-2013-095
Comment: Tsunami outreach activities are ongoing with HETAC members. A USGS cooperative agreement is being leveraged to support outreach activities on the Big Island with a 1/2 full-time equivalent for all hazards. As of March 2023, seven communities have reached recognition level in the Hazards Awareness and Resilience Program (HHARP) and another six communities are on the verge of program recognition. This program won the 2016 National Award in Excellence for Educational Outreach to the General Public from the Western States Seismic Policy Council.	
Lead Agency: HETAC	

Action Item from Previous Plan	Status and/or New Action Number
Action: State-2018-2013-116 - Continue to develop Operational Support Plans to account for adequacy of critical marine/ground transportation to address supply chain and alternate port operations plan. Future considerations may include Natural Systems Protection (NSP) elements.	**In Progress** **2023 Action:** 2023-2013-116
Comment: This action is still a priority and aligned with State goals; however, due to staffing and funding limitations, it has not been completed. Work on this effort is ongoing. Regional Resiliency Assessment Program (RRAP) was completed by Cybersecurity & Infrastructure Security Agency (CISA). The review of marine transportation systems is in progress and this mitigation action is 20% complete.	
Lead Agency: HI-EMA	
Action: State-2018-2013-121 - Continue to develop harbor maps to define regimes of currents and timeframes for several scenarios of tsunami to estimate necessary period of ship evacuation.	**In Progress** **2023 Action:** 2023-2013-121
Comment: This action is considered to be 80% complete. Honolulu harbor maps were completed by HETAC; other harbor map development is in progress.	
Lead Agency: HI-EMA	
Action: State-2020-001 - Modernization and Hardening of the State Emergency Operations Center: 1. Acquire suitable land. 2. Acquire funds for design and engineering to include environmental assessment. 3. Acquire funding for construction.	**In Progress** **2023 Action:** 2023-2020-001
Comment: In 2022, HI-EMA received $1M in federal funds to start the design phase of this project.	
Lead Agency: HI-EMA	
Action: State-2020-002 - Warning Systems and Outreach Programs: High-risk areas will be evaluated by subject matter experts to include governmental agencies having statutory responsibility for those activities.	**In Progress** **2023 Action:** 2023-2020-002
Comment: HI-EMA has been conducting ongoing maintenance of Siren Program. Results of these assessments are pending.	
Lead Agency: HI-EMA	
Action: State-2020-003 - Hardening/Retrofit/Protection of Food and Agriculture Facilities which involve production, storage, distribution, and research functions: 1. Structural Analysis of priority facilities 2. Acquire funds for design and engineering 3. Acquire funds for construction	**In Progress** **2023 Action:** 2023-2020-003
Comment: The Lanakila Pacific Wind Retrofit project was funded under HMGP DR-4395, and the Komohana Research and Extension Center Wind Retrofit (at the UH College of Tropical Agriculture and Human Resources) project was funded under HMGP DR-4366. Both projects are ongoing.	
Lead Agency: HI-EMA	
Action: State-2020-004 - American Red Cross (ARC) Hawaiʻi Chapter will conduct Disaster Emergency Life Safety Sheltering and Outreach training programs throughout the state to increase the number of trained volunteers capable of responding and providing emergency support services at public shelter during a disaster.	**In Progress** **2023 Action:** 2023-2020-004
Comment: No progress has been made due to a lack of grant funding. Other funding options are being explored.	
Lead Agency: HI-EMA	

Action Item from Previous Plan	Status and/or New Action Number
Action: Hawaiʻi-2018-001 - Damage Assessment Software Licenses & Field Data Collection Equipment: 1. Purchase licenses and tablets 2. Install application software on tablets 3. Test software in the field 4. Conduct training 5. Be Mission-ready for Recovery Phase damage assessment operations	**In Progress** **County-responsibility actions will be tracked in their respective local HMPs**
Comment: Alternatives and a demo of the ArcGIS Collector program have been researched.	
Lead Agency: Hawaiʻi County Civil Defense Agency	
Action: Hawaiʻi-2018-002 - Waimea Operations Facility Emergency Power System Hardening: 1. Gain proper approval for project and funding; execute agreements, as required. 2. Execute professional services contract and obtain materials required for construction permit and solicitation. 3. Solicit bids and award construction contract. 4. Order materials, complete construction, and close out construction and professional services contracts. 5. Close out with HI-EMA and FEMA, as required.	**No Progress** **County-responsibility actions will be tracked in their respective local HMPs**
Comment: No progress, preparing to secure funding.	
Lead Agency: Department of Water Supply	
Action: Hawaiʻi-2018-003 - Hilo Operations Facility Hardening and Improvements: Gain proper approval for project and funding; execute agreements, as required. <u>Phase 1</u> • Execute professional services contract and obtain materials required for construction permit and solicitation. <u>Phase 2</u> • Solicit bids and award construction contract. • Order materials, complete construction, and close out construction and professional services contracts. Close out with HI-EMA and FEMA, as required.	**No Progress** **County-responsibility actions will be tracked in their respective local HMPs**
Comment: No progress, preparing to secure funding.	
Lead Agency: Department of Water Supply	
Action: Hawaiʻi-2018-004 - Kona Operations Facility Emergency Power System Hardening: 1. Gain proper approval for project and funding; execute agreements, as required. 2. Execute professional services contract and obtain materials required for construction permit and solicitation. 3. Solicit bids and award construction contract. 4. Order materials, complete construction, and close out construction and professional services contracts. 5. Close out with HI-EMA and FEMA, as required.	**No Progress** **County-responsibility actions will be tracked in their respective local HMPs**
Comment: No progress, preparing to secure funding.	
Lead Agency: Department of Water Supply	

Action Item from Previous Plan	Status and/or New Action Number
Action: Hawaiʻi-2018-005 - Kona Operations Facility Hardening and Improvements: Gain proper approval for project and funding; execute agreements, as required. Phase 1 • Execute professional services contract and obtain materials required for construction permit and solicitation. Phase 2 • Solicit bids and award construction contract. • Order materials, complete construction, and close out construction and professional services contracts.	**No Progress** **County-responsibility actions will be tracked in their respective local HMPs**
Comment: No progress, preparing to secure funding.	
Lead Agency: Department of Water Supply	
Action: Hawaiʻi-2018-006 - Community-based 2-way Radio Communications Repeater Equipment: 1. Purchase repeater equipment. 2. Train local licensed amateur radio licensed operators in handling emergency traffic of Emergency Alert Messaging (EAM), Situational Reporting (SitRep), Requests for Assistance (RFA), and Requests for Information (RFI). 3. Program repeater equipment. 4. Register repeater equipment with FCC and Frequency Controller. 5. Install repeater equipment. 6. Implement new capability and be Mission-Ready to standup Emergency Communications Operations.	**In Progress** **County-responsibility actions will be tracked in their respective local HMPs**
Comment: Equipment is purchased. Installation sites have been selected. Amateur Radio training is ongoing. Installing equipment is waiting for contracting and permitting.	
Lead Agency: Hawaiʻi County Civil Defense Agency	
Action: Hawaiʻi-2018-007 - Hardening of the Parker No. 2, Waiaha and Keonepoko Nui Water Well: 1. Gain project funding approval and execute agreements, as required. 2. Execute professional services contract and obtain materials required for construction permit. 3. Generate bid documents, solicit bids, and award contract. 4. Order materials, complete construction, and close out contract. 5. Close out with HI-EMA and FEMA, as required.	**In Progress** **County-responsibility actions will be tracked in their respective local HMPs**
Comment: Funding secured (HMGP & DWS funds). Professional engineer working on the project design and plans.	
Lead Agency: Department of Water Supply	
Action: Hawaiʻi-2018-008 - Furnishing two (2) Water Hauling Tankers to Harden the Potable Water System: 1. Gain proper approval for project and funding; execute agreements, as required. 2. Generate bid documents, solicit bids, and award contract. 3. Receive tankers and close out project. 4. Close out with HI-EMA and FEMA, as required.	**No Progress** **County-responsibility actions will be tracked in their respective local HMPs**
Comment: No progress, preparing to secure funding.	
Lead Agency: Department of Water Supply	

Action Item from Previous Plan	Status and/or New Action Number
Action: Hawaiʻi-2018-009 - Waimea Operations Facility Hardening and Improvements: Gain proper approval for project and funding; execute agreements, as required. Phase 1 • Execute professional services contract and obtain materials required for construction permit and solicitation. Phase 2 • Solicit bids and award construction contract. • Order materials, complete construction, and close out construction and professional services contracts. Close out with HI-EMA and FEMA, as required. **Comment:** No progress, preparing to secure funding. **Lead Agency:** Department of Water Supply	**No Progress** **County-responsibility actions will be tracked in their respective local HMPs**
Action: Honolulu-2018-001 - Long-term Recovery and Adaptation Plan: - Hire a Planner to develop the Long-term Recovery & Adaptation Plan. - Work with C & County + State Stakeholders to develop the plan, including development of specific recovery and adaptation projects to address the long-term impacts of climate change. **Comment:** The City was awarded mitigation grant funding to develop a long-term recovery plan and has a position within the City's Climate Change and Resiliency Office who will work with the contractor on the long-term recovery strategy. Planning work is set to begin late 2022 and into 2023. **Lead Agency:** City and County of Honolulu Department of Emergency Management	**In Progress** **County-responsibility actions will be tracked in their respective local HMPs**
Action: Honolulu-2018-002 - Lualualei Navy Lands Drainage Improvements: The Navy should coordinate with DOH and the watershed coordinator to identify depressions or relatively flat areas along stream channels to construct small detention ponds and/or check dams to reduce peak flood flows. These are easier to construct than a full sediment basin and will help reduce some of the sediment load and peak flows, potentially reducing flooding downstream. **Comment:** No progress by the City and County of Honolulu due to lack of capacity. This action is supported by Department of Health Clean Water Branch and will be led by DOH in the SHMP update. **Lead Agency:** City and County of Honolulu Department of Design and Construction	**No Progress** **2023 Action:** 2023-001
Action: Honolulu-2018-003 - Makiki Stream Flood Mitigation Project: - Develop design specifics for flooding problem that are compatible with developed, urban areas along Makiki and Kanaha streams - Channel improvements from Ala Wai Canal to King Street to handle a design flow of 5,600 cfs - Channel improvements for Kanaha Stream makai of Roosevelt High School - Accommodate multiple purposes in flood control features, including ecosystem improvements, recreational activities & maintenance activities **Comment:** No progress due to a lack of capacity. **Lead Agency:** City and County of Honolulu Department of Design and Construction	**No Progress** **County-responsibility actions will be tracked in their respective local HMPs**
Action: Honolulu-2018-004 - Hardening of Critical Facilities, Utilities, and Port Facilities: 1. Prioritize facilities for hardening. 2. Seek funding for drawing up hardening plans. 3. Draw up plans for hardening. 4. Seek funding for hardening retrofits. **Comment:** The City does not have jurisdiction over ports, so the action will be reworded. No progress to report on other listed hazards due to a lack of capacity. **Lead Agency:** City and County of Honolulu Department of Emergency Management	**No Progress** **County-responsibility actions will be tracked in their respective local HMPs**

Action Item from Previous Plan	Status and/or New Action Number
Action: Honolulu-2018-005 - Long-Term Congregate Care Shelters: Create long-term congregate care shelters at public parks and recreation centers and gymnasiums. This will require hardening and retrofitting these facilities.	**In Progress** **County-responsibility actions will be tracked in their respective local HMPs**
Comment: The City plans to conduct structural assessments of Parks facilities in 2022 and 2023 as the initial step towards identifying City-owned facilities suitable for retrofit as these are the facilities most likely to be utilized for post-impact sheltering. The City has also prioritized buildings for retrofit using State CIP funding to focus on facilities that are most suitable for both evacuation and post-impact sheltering. The City is in the final stages of populating a recently created shelter database that will support the identification and analysis of facilities for post-impact sheltering.	
Lead Agency: City and County of Honolulu Department of Emergency Management	
Action: Honolulu-2018-006 - Post-Disaster Staging Areas: The City and County of Honolulu would like to build new staging facilities as opportunities allow and to harden existing staging facilities to create between 5 and 8 (optimal) disaster response staging areas.	**Discontinued** **County-responsibility actions will be tracked in their respective local HMPs**
Comment: This action as currently described is not a current priority and should be revised. The construction of new staging facilities is not an action that is being pursued. As staging facilities are located at existing critical government facilities, it is not clear this should be a standalone action as the purpose would not be to harden those types of facilities just for the purpose of serving as a staging area. The hardening of those facilities is captured under other mitigation actions.	
Lead Agency: City and County Department of Emergency Management	
Action: Honolulu-2018-007 - Temporary Electrical Charging Stations for Oʻahu Post-Disaster: Outfit staging areas and congregate care shelters with solar powered, battery-operated charging systems.	**Discontinued** **County-responsibility actions will be tracked in their respective local HMPs**
Comment: Discontinued as written. This action needs to be re-evaluated and expanded to include State agencies as lead or supporting this effort given the number of facilities the City owns that would be used for post-impact sheltering is very small. Would also recommend expanding this action to be more generalized to the temporary power needs at shelters. Microgrid project at one DOE facility is ongoing.	
Lead Agency: City and County of Honolulu Department of Emergency Management	
Action: Honolulu-2018-008 - Tsunami Evacuation Signage: The City & County of Honolulu has purchased signs to demarcate Tsunami Evacuation Routes, but does not currently have the funding to install them. Project requests funds for installing the signs, and also using templates to indicate evacuation lines and routes on the streets/ sidewalks under our jurisdiction.	**In Progress** **County-responsibility actions will be tracked in their respective local HMPs**
Comment: In 2022, the City was awarded HMGP funding to install tsunami signs around the island. This project includes installation of signs at State and City beach parks with instructions for actions to take in the event of a tsunami warning, as well as Hazard Area signs along roadways to increase public awareness of Oahu's two evacuation zones.	
Lead Agency: City and County of Honolulu Department of Emergency Management	
Action: Honolulu-2018-009 - Micro Grids for Critical Health Infrastructure Support: Install micro grids to support medical facilities such as hospitals and dialysis centers in the event that the island's primary power grid goes down.	**No Progress** **2023 Action:** 2023-002
Comment: No measurable progress on this action. This action has been re-assigned to the Department of Health and included in the SHMP update. While DEM supports this action and its importance, it is not the appropriate agency to lead its implementation.	
Lead Agency: City and County of Honolulu Department of Emergency Management	

Action Item from Previous Plan	Status and/or New Action Number
Action: Honolulu-2018-010 - Structural Retrofitting of Existing Buildings and Construction of Safe Rooms: Working with DDC engineers, the City would harden windows, doors, and roofs of identified facilities and/or install an interior safe room within or adjacent to the identified facilities. The goal is to create 15 such facilities that are retrofitted or constructed with a safe room. **Comment:** No action taken to date due to a lack of capacity. **Lead Agency:** City and County Department of Emergency Management	**No Progress** **County-responsibility actions will be tracked in their respective local HMPs**
Action: Honolulu-2018-011 - Lualualei Drainage Improvements: As outlined in the Lualualei Flood Study, there are multiple culverts in residential areas in need of repair or replacement. The Army Corps of Engineers should coordinate with the City & County of Honolulu to implement the upgrades identified in the flood study (2). $740,000 estimated in Lualualei Flood Study for all necessary replacements. **Comment:** No action taken to date due to a lack of capacity. **Lead Agency:** City and County of Honolulu Department of Design and Construction	**No Progress** **County-responsibility actions will be tracked in their respective local HMPs**
Action: Kauaʻi-2018-001 - Wildfire Suppression Procurement of Water Tanker- included as mitigation action 2018-027 for the State as well: Procure new 4,000-gallon capacity water truck to assist in providing the public with potable water as well as assist other State and County agency efforts in disaster management activities. Vehicle will provide DLNR with a water truck capability of handling various incidents and addressing health and safety issues. **Comment:** State DLNR-DOFAW has procured the 4,000-gallon capacity water truck and it is standing by, ready for use. **Lead Agency:** DLNR-DOFAW **Funding Source:** State DLNR Funding	**Completed**
Action: Kauaʻi-2018-002 - Hawaiʻi Wide Interoperable Network (HWIN) Compliant Equipment & Structures: Replace existing equipment and structures that do not meet new FCC compliance standards to be included in the Hawaii-wide interoperable network. **Comment:** DLNR-DOFAW reports the project is about 75% complete. The remaining actions (25%) will take some time. **Lead Agency:** County of Kauaʻi	**In Progress** **County-responsibility actions will be tracked in their respective local HMPs**
Action: Kauaʻi-2018-003 - Hardening of the Kīlauea Gymnasium for Hurricane Shelter Purpose - included as mitigation action 2018-003 for the State as well: Install a hurricane shutter system to protect existing louver windows to allow the gymnasium to serve as an emergency shelter during natural disaster evacuations. **Comment:** The engineering consultant for the County of Kauai Department of Parks and Recreation completed the engineering analysis and determined additional funding is necessary to complete the retrofit. **Lead Agency**: County of Kauaʻi Department of Parks and Recreation	**In Progress** **County-responsibility actions will be tracked in their respective local HMPs**
Action: Kauaʻi-2018-004 - Hardening of the Kauaʻi War Memorial Convention Hall (KWMCH) – included as mitigation action 2018-012 for the State as well: Install a hurricane shutter system to protect all exhibit hall windows and glass doors to allow use of the hall as a disaster shelter during evacuations. **Comment:** After a bumpy start due to County issues with Act 12/35/9 (State disaster recovery assistance to the County) funding that delayed the project initiation, the Department of Parks and Recreation has begun procurement of an engineering firm to assess the KWMCH (Phase 1). **Lead Agency:** County of Kauaʻi Department of Parks and Recreation	**In Progress** **County-responsibility actions will be tracked in their respective local HMPs**
Action: Kauaʻi-2018-005 - Fire Protection System Retrofit: Upgrade fire alarm system throughout campus and retrofit existing fire sprinkler systems in buildings designated as emergency shelters. **Comment:** The Kauai Community College (KCC) POC reports that this retrofit is scheduled to begin in 2024. **Lead Agency:** County of Kauaʻi	**In Progress** **County-responsibility actions will be tracked in their respective local HMPs**

Action Item from Previous Plan	Status and/or New Action Number
Action: Kauaʻi-2018-006 - Emergency Communication System Installation: Install public address system to ensure effective emergency communications to the campus and surrounding area. **Comment:** The Kauai Community College (KCC) POC reports this project is scheduled to begin in 2024 together with the Fire Suppression Retrofit project (Kauai-2018-005). **Lead Agency:** County of Kauaʻi	**In Progress** **County-responsibility actions will be tracked in their respective local HMPs**
Action: Kauaʻi-2018-007 - Generators for Emergency Shelter Facilities: Purchase five diesel generators and install generator tie-ins to the electrical system for five shelter facilities. **Comment:** The Kauai Community College (KCC) POC reports that KCC is not planning on purchasing generators for emergency shelter facilities. **Lead Agency:** County of Kauaʻi	**Discontinued**
Action: Kauaʻi-2018-008 - Līhuʻe Airport Electrical Distribution Hardening: Provide alternate distribution feed to the Lihue Airport with the installation of auto transfer switchgear, and underground conduits and cables. Project will be designated to be integrated into Kauai Island Utility Coop smart grid and Lihue Hardening Plan, increasing reliability and hardening electrical service to critical and essential facilities in the Lihue Area. **Comment:** The Kauai Island Utility Cooperative (KIUC) withdrew this project, for a variety reasons, primarily because the work will be overtaken by future development at the site. **Lead Agency:** Kauaʻi Island Utility Coop	**Discontinued**
Action: Kauaʻi-2018-009 - Church of the Pacific United Church of Christ: 1. Survey facility – completed 11/20/2009 2. Shelter agreement – signed 7/12/2010 3. Work with the American Red Cross to have the Church of Pacific United Church of Christ serve as a shelter for flooding and fire, and post-impact shelter when possible for large disaster when people in Koloa an Poipu area are displaced. **Comment:** Confirmed with Red Cross POC that they completed their survey of the Church of the Pacific (COP) building to potentially be used as a shelter. **Lead Agency:** County of Kauaʻi **Funding Source:** American Red Cross	**Completed**
Action: Kauaʻi-2018-010 - Kauaʻi Christian Fellowship: 1. Survey facility – completed 7/8/14 **2.** Shelter agreement – signed 8/27/18 3. Work with the American Red Cross to have the Kauai Christian Fellowship serve as a shelter for flooding and fire, and post-impact shelter when possible for large disaster when people in Koloa an Poipu area are displaced. **Comment:** Confirmed with Red Cross POC, that the Kauai Christian Fellowship (KCF) building could potentially serve as a shelter for Poipu & Koloa residents. **Lead Agency:** County of Kauaʻi **Funding Source:** American Red Cross	**Completed**

Action Item from Previous Plan	Status and/or New Action Number
Action: Kauaʻi-2018-011 - Kauaʻi Veteran's Center: 1. Survey facility – completed 8/5/13 2. Obtain shelter agreement – signed 2/24/14 3. Add private facility to serve as a disaster shelter with Red Cross to serve as an evacuation shelter for flooding and fire, and post-impact shelter when possible for large disaster when people in Kola and Poipu are area displaced.	**Completed**
Comment: Confirmed with Red Cross POC that Kauai Veterans Center (KVC) in potentially available as shelter for Līhuʻe residents.	
Lead Agency: County of Kauaʻi	
Funding Source: American Red Cross	
Action: Maui-2018-001 - Dam Inundation - Public Awareness Campaign: Develop a public outreach awareness campaign targeting residents located within a dam inundation area. Include information about what to do in an emergency, community questions and answers, and where to receive information.	**Completed**
Comment: This action has become a capability. DLNR will publish Dam Inundation Maps. MEMA will work on the public messaging campaign to complement the publication.	
Lead Agency: DLNR	
Funding Source: N/A	
Action: Maui-2018-002 - Emergency Barge and Ferry Service: Make contact with each barge/ferry company and work toward formalizing agreements for prioritized shipments.	**No Progress** **County-responsibility actions will be tracked in their respective local HMPs**
Comment: Progress has yet to be made on this action due to a lack of capacity.	
Lead Agency: Maui Emergency Management Agency	
Action: Maui-2018-003 - Realign Honoapiʻilani Highway: Realign Honoapiʻilani Highway outside of coastal hazard area – Initiate a planning process with HDOT; Document planning process steps and timeline; Develop environmental documents showing alternative alignments; Acquire/purchase any additional land needed for realignment; Implement construction for realignment.	**In Progress** **County-responsibility actions will be tracked in their respective local HMPs**
Comment: A West Maui Transportation Working Group was established and will strategize possible solutions. County of Maui land purchase along Honoapiʻilani Highway. The Honoapiʻilani Highway Realignment project was identified in the Hele Mai Maui Long-Range Transportation Plan 2040, exemplifying how such investments can foster new ways of improving resilience in the transportation network.	
Lead Agency: Maui County Mayors Office	
Action: Maui-2018-004 - Retrofit Shelter Facilities: Harden emergency shelters throughout the planning area to ensure that they are able to withstand Category 3 hurricane-force wind speeds.	**In Progress** **County-responsibility actions will be tracked in their respective local HMPs**
Comment: MEMA submitted ranked emergency shelters throughout Maui County for State of Hawaiʻi Hurricane Sheltering Retrofit Program. Molokaʻi High School is currently funded for retrofit.	
Lead Agency: Maui Emergency Management Agency	

G.3 2023 State Action Plan

G.3.1 2023 MITIGATION ACTIONS BY HAZARD

Table G-3 summarizes the State 2023 mitigation actions and the hazards of concern each addresses.

Table G-3. 2023 SHMP Update State of Hawaiʻi Actions and Hazards of Concern Addressed

Action Number	Hazard(s) of Concern Addressed															
	All Hazards	Climate Change and Sea Level Rise	Cyber Threat	Drought	Earthquake	Flood	Hazardous Materials	Health Risks	Hurricane	Infrastructure Failure	Landslide/ Rockfall	Terrorism	Tsunami	Volcanic Hazards	Wildfire	Windstorm
2023-001						◆										
2023-002					◆	◆			◆	◆	◆	◆	◆		◆	◆
2023-003										◆						
2023-004	◆															
2023-005		◆				◆										
2023-006						◆										
2023-007		◆														
2023-008		◆		◆		◆										
2023-009		◆				◆			◆				◆			
2023-010																
2023-011																
2023-012																
2023-013																
2023-014																
2023-015																
2023-016																
2023-017																
2023-018																
2023-019															◆	
2023-2020-001	◆															
2023-2020-002					◆	◆			◆	◆	◆		◆	◆	◆	◆
2023-2020-003		◆			◆	◆			◆	◆	◆		◆	◆	◆	◆
2023-2020-004	◆															
2023-2018-001					◆											
2023-2018-002					◆	◆			◆							◆
2023-2018-004	◆															
2023-2018-005													◆	◆		
2023-2018-006	◆															
2023-2018-007																
2023-2018-009	◆															
2023-2018-011					◆	◆			◆							◆
2023-2018-012									◆							◆
2023-2018-013									◆							◆
2023-2018-016																
2023-2018-017				◆												
2023-2018-018				◆												

Action Number	All Hazards	Climate Change and Sea Level Rise	Cyber Threat	Drought	Earthquake	Flood	Hazardous Materials	Health Risks	Hurricane	Infrastructure Failure	Landslide/ Rockfall	Terrorism	Tsunami	Volcanic Hazards	Wildfire	Windstorm
	Hazard(s) of Concern Addressed															
2023-2018-019				◆											◆	
2023-2018-021				◆											◆	
2023-2018-022		◆				◆			◆				◆			◆
2023-2018-023		◆				◆							◆			
2023-2018-024															◆	
2023-2018-025															◆	
2023-2018-026															◆	
2023-2018-027				◆											◆	
2023-2018-028				◆											◆	
2023-2018-029															◆	
2023-2018-030									◆						◆	
2023-2018-031									◆						◆	
2023-2018-032				◆		◆			◆					◆	◆	
2023-2018-033		◆			◆	◆	◆	◆					◆			
2023-2018-034	◆						◆	◆								◆
2023-2018-041	◆								◆				◆		◆	◆
2023-2018-042	◆	◆							◆				◆		◆	◆
2023-2018-043		◆				◆		◆								
2023-2018-045		◆			◆	◆			◆	◆	◆			◆	◆	◆
2023-2018-046		◆		◆		◆		◆			◆					
2023-2018-048		◆				◆			◆				◆			
2023-2018-049									◆				◆			
2023-2018-050													◆			
2023-2018-051						◆			◆							
2023-2018-053	◆															
2023-2018-054		◆				◆							◆			
2023-2018-055															◆	
2023-2018-056	◆								◆							
2023-2018-057	◆								◆							
2023-2018-058		◆				◆			◆							
2023-2013-001									◆							
2023-2013-002									◆							
2023-2013-004					◆				◆							◆
2023-2013-018									◆				◆			
2023-2013-021													◆			
2023-2013-024	◆															
2023-2013-025					◆	◆			◆				◆			

Action Number	Hazard(s) of Concern Addressed															
	All Hazards	Climate Change and Sea Level Rise	Cyber Threat	Drought	Earthquake	Flood	Hazardous Materials	Health Risks	Hurricane	Infrastructure Failure	Landslide/ Rockfall	Terrorism	Tsunami	Volcanic Hazards	Wildfire	Windstorm
2023-2013-026					◆											
2023-2013-028					◆											
2023-2013-033					◆				◆							
2023-2013-034					◆											
2023-2013-035					◆											
2023-2013-061											◆					
2023-2013-071					◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆
2023-2013-072	◆															
2023-2013-078	◆															
2023-2013-086	◆															
2023-2013-088					◆				◆							
2023-2013-095	◆															
2023-2013-116					◆	◆	◆		◆				◆	◆		
2023-2013-121													◆			

G.3.2 ACTION PLAN PRIORITIZATION

As discussed in Section 6.4 (Mitigation Strategy - Action Plan Prioritization), all 2023 State mitigation actions were prioritized utilizing the established prioritization schema. Table G-4 summarizes the prioritization of the State mitigation actions.

Table G-4. 2023 SHMP Update State of Hawaiʻi Action Plan Prioritization

Action Number	Criteria															Priority
	Life Safety	Property Protection	Cost-effective	Technically Feasible	Climate Change	Legal Authority	Funding Available	Environmental Impact	Social Vulnerability	Administrative Capability	Multi-Hazard	Timeline	Local Champion	Other Objectives or Policies	Total Score	
2023-001	0	3	3	3	3	3	1	3	3	1	0	0	1	3	27	Medium
2023-002	3	3	3	3	3	3	1	1	3	1	3	1	1	3	32	High
2023-003	1	1	3	3	1	3	3	3	3	1	0	3	1	1	33	High
2023-004	0	0	3	3	0	3	1	0	3	1	3	3	3	3	26	Medium
2023-005	1	1	3	3	3	3	1	3	3	3	3	3	3	3	36	High
2023-006	0	3	3	3	3	3	1	3	3	1	3	3	3	1	33	High
2023-007	1	0	3	3	3	3	1	3	3	1	3	1	3	3	31	High

Action Number	Criteria														Priority
	Life Safety	Property Protection	Cost-effective	Technically Feasible	Climate Change	Legal Authority	Funding Available	Environmental Impact	Social Vulnerability	Administrative Capability	Multi-Hazard	Timeline	Local Champion	Other Objectives or Policies	Total Score	
2023-008	1	3	3	3	3	3	1	3	1	1	3	1	3	3	32	High
2023-009	1	3	3	3	3	3	3	3	3	3	3	1	3	3	38	High
2023-010	1	1	3	3	0	3	1	1	3	1	3	3	3	3	29	Medium
2023-011	3	3	3	3	3	3	1	1	3	1	3	1	3	3	34	High
2023-012	0	0	3	3	0	3	1	1	3	3	3	1	3	3	27	Medium
2023-013	0	0	3	3	0	3	1	1	3	3	3	3	3	3	29	Medium
2023-014	0	3	1	3	3	3	1	1	3	1	3	1	3	3	29	Medium
2023-015	0	0	3	3	1	3	1	0	1	1	3	3	3	3	22	Medium
2023-016	0	0	3	3	3	3	1	1	1	1	3	1	3	3	26	Medium
2023-017	1	0	3	3	1	3	1	1	3	1	1	3	3	1	25	Medium
2023-018	0	0	3	3	3	3	1	1	3	3	3	3	3	3	32	High
2023-019	3	3	3	3	3	3	3	3	3	3	3	3	3	3	42	High
2023-2020-001	3	3	3	3	1	3	1	1	3	1	3	0	3	3	31	High
2023-2020-002	3	3	3	3	0	3	1	1	3	1	3	3	3	3	33	High
2023-2020-003	1	3	1	3	3	3	1	0	3	1	3	3	3	3	29	Medium
2023-2020-004	3	0	3	3	1	3	1	0	3	1	3	3	3	3	30	Medium
2023-2018-001	3	3	3	3	3	3	1	1	3	3	3	1	3	1	34	High
2023-2018-002	1	3	3	3	3	3	1	1	3	3	3	3	3	1	34	High
2023-2018-004	1	0	3	3	3	3	3	0	3	3	3	0	3	0	28	Medium
2023-2018-005	3	3	3	3	0	3	0	3	3	3	3	3	3	3	33	High
2023-2018-006	3	3	1	1	1	1	1	1	3	1	3	3	1	3	26	Medium
2023-2018-007	3	3	3	3	3	3	1	3	3	3	3	3	3	3	40	High
2023-2018-009	3	1	3	3	1	3	1	1	3	3	1	3	3	3	32	High
2023-2018-011	3	3	3	3	3	3	1	1	3	3	3	3	3	1	36	High
2023-2018-012	3	3	3	3	3	3	3	1	3	3	3	3	3	1	38	High
2023-2018-013	3	3	3	3	3	3	1	1	3	3	3	3	3	1	36	High
2023-2018-016	3	3	3	3	1	3	1	1	3	3	3	3	3	3	36	High
2023-2018-017	3	1	1	3	3	3	0	0	3	1	3	3	3	1	28	Medium
2023-2018-018	3	0	0	3	3	1	0	3	3	1	3	1	3	3	27	Medium
2023-2018-019	3	0	1	3	3	3	1	3	3	3	3	1	3	3	33	High
2023-2018-021	3	0	1	1	3	3	1	0	3	1	0	3	3	3	25	Medium
2023-2018-022	3	3	3	3	3	3	3	0	3	3	3	3	3	1	37	High
2023-2018-023	3	3	3	1	3	3	0	3	3	3	3	3	3	1	35	High
2023-2018-024	1	1	3	3	3	3	3	3	3	3	0	3	1	3	33	High
2023-2018-025	1	1	3	3	3	3	1	3	3	3	0	3	0	3	30	Medium
2023-2018-026	1	3	3	3	3	3	1	3	1	3	0	1	3	3	31	High
2023-2018-027	1	3	3	3	3	3	1	3	3	3	3	1	3	3	36	High
2023-2018-028	1	3	3	3	3	3	3	3	3	3	3	3	3	3	40	High
2023-2018-029	1	3	3	3	3	3	3	3	3	3	3	3	3	3	37	High

Action Number	Criteria														Priority
	Life Safety	Property Protection	Cost-effective	Technically Feasible	Climate Change	Legal Authority	Funding Available	Environmental Impact	Social Vulnerability	Administrative Capability	Multi-Hazard	Timeline	Local Champion	Other Objectives or Policies	Total Score	
2023-2018-030	1	3	3	3	3	3	3	3	3	3	3	3	3	3	37	High
2023-2018-031	1	3	3	3	3	3	3	0	3	3	3	3	1	3	35	High
2023-2018-032	1	1	3	3	3	3	3	3	3	3	3	3	3	3	38	High
2023-2018-033	1	0	3	3	3	0	0	3	3	0	3	0	3	3	25	Medium
2023-2018-034	3	3	3	3	3	3	0	1	1	3	3	1	3	3	33	High
2023-2018-041	3	3	3	3	3	3	1	3	3	3	3	3	3	3	40	High
2023-2018-042	3	3	3	3	3	3	1	3	3	3	3	3	3	3	40	High
2023-2018-043	3	3	3	1	3	1	0	3	3	0	3	0	3	3	29	Medium
2023-2018-045	3	3	3	3	3	3	1	3	1	1	3	3	1	3	34	High
2023-2018-046	1	1	3	3	3	3	0	3	3	3	3	3	3	3	35	High
2023-2018-048	3	3	1	1	3	2	1	2	3	2	3	1	1	3	29	Medium
2023-2018-049	3	3	1	3	1	1	1	1	3	1	0	1	3	3	25	Medium
2023-2018-050	3	3	1	3	1	1	1	1	3	1	0	1	3	3	25	Medium
2023-2018-051	3	3	1	1	3	1	1	0	3	1	3	3	1	3	27	Medium
2023-2018-053	1	3	3	3	3	3	0	0	3	0	3	3	3	3	31	High
2023-2018-054	3	3	3	3	3	3	0	0	3	0	3	3	3	3	33	High
2023-2018-055	1	1	3	3	3	3	3	3	3	3	0	3	3	3	35	High
2023-2018-056	3	3	3	3	1	3	3	1	1	3	3	3	3	3	36	High
2023-2018-057	1	3	3	3	3	1	3	3	3	3	3	3	3	3	38	High
2023-2018-058	1	3	3	3	3	3	1	1	3	1	3	1	3	3	32	High
2023-2013-001	3	3	1	3	3	1	0	0	3	3	3	3	3	3	32	High
2023-2013-002	3	3	3	3	3	3	0	0	3	3	3	0	3	3	33	High
2023-2013-004	3	3	3	3	3	3	3	0	3	3	3	3	3	3	39	High
2023-2013-018	3	0	0	1	3	3	1	1	3	1	3	3	1	3	26	Medium
2023-2013-021	1	3	3	3	1	3	0	0	3	3	3	3	3	3	32	High
2023-2013-024	3	3	3	3	3	3	0	0	3	3	3	3	3	3	36	High
2023-2013-025	3	3	1	3	3	3	0	3	3	3	3	3	3	3	37	High
2023-2013-026	3	3	3	3	1	3	0	0	3	3	3	3	3	3	34	High
2023-2013-028	3	1	3	3	1	3	0	0	3	1	0	3	3	3	27	Medium
2023-2013-033	1	3	3	1	3	3	0	0	3	0	3	0	3	3	26	Medium
2023-2013-034	1	1	1	3	1	3	0	0	3	0	3	3	1	3	23	Medium
2023-2013-035	1	1	1	3	0	3	0	0	3	0	3	3	2	3	23	Medium
2023-2013-061	1	1	3	1	3	3	0	0	3	0	3	0	3	3	24	Medium
2023-2013-071	2	0	1	3	0	3	1	0	3	3	3	1	3	1	22	Medium
2023-2013-072	1	0	3	1	0	3	1	0	3	1	3	1	3	3	23	Medium
2023-2013-078	1	0	1	3	0	3	1	0	3	1	3	1	3	3	23	Medium
2023-2013-086	3	1	3	1	3	3	1	1	3	1	3	3	3	3	32	High
2023-2013-088	3	3	3	1	3	1	0	0	3	1	3	0	3	3	27	Medium
2023-2013-095	1	1	1	3	0	0	1	0	3	0	3	3	3	3	22	Medium

Action Number	Criteria															Priority
	Life Safety	Property Protection	Cost-effective	Technically Feasible	Climate Change	Legal Authority	Funding Available	Environmental Impact	Social Vulnerability	Administrative Capability	Multi-Hazard	Timeline	Local Champion	Other Objectives or Policies	Total Score	
2023-2013-116	1	3	1	1	3	3	0	0	3	0	3	1	3	3	25	Medium
2023-2013-121	1	3	1	1	0	3	0	1	3	0	0	1	1	1	16	Medium

G.4 Mitigation Funding

Cost share percentages across FEMA mitigation funding streams are detailed in Table G-5. Eligible activities under the HMGP, BRIC, FMA, and HHPD grant programs are listed in Table G-6.

Table G-5. FEMA Hazard Mitigation Assistance Grant Program Cost Share

Programs	Mitigation Activity (Percent of Federal/Non-Federal Share)	Recipient Management Costs (Percent of Federal/Non- Federal Share)	Subrecipient Management Costs (Percent of Federal/Non-Federal Share)
HMGP	75/25	100/0	–/–[a]
BRIC	75/25	75/25	75/25
BRIC – subrecipient is small and impoverished community	90/10	100/0	90/10
PDM	75/25	95/5	95/5
PDM – subrecipient is small and impoverished community	90/10	95/5	95/5
FMA – insured properties and planning grants	75/25	75/25	75/25
FMA – repetitive loss property	90/10	90/10	90/10
FMA – severe repetitive loss property [b]	100/0	100/0	100/0

a. *Subapplicants should consult their State Hazard Mitigation Officer (SHMO) for the amount or percentage of HMGP subrecipient management cost funding their State has determined to be passed through to subrecipients.*
b. *To be eligible for an increased Federal cost share, a FEMA-approved State or Tribal (Standard or Enhanced) Mitigation Plan that addresses RL properties must be in effect at the time of award, and the property that is being submitted for consideration must be a RL property.*

Table G-6. FEMA Hazard Mitigation Grant Program Eligible Activities

Eligible Activities	HMGP	BRIC	FMA	HHPD
Property Acquisition and Structure Demolition	√	√	√	
Property Acquisition and Structure Relocation	√	√	√	
Structure Elevation	√	√	√	
Mitigation Reconstruction	√	√	√	√
Dry Floodproofing of Historic Residential Structures	√	√	√	
Dry Floodproofing of Non-residential Structures	√	√	√	
Generators	√	√		
Localized Flood Risk Reduction Projects	√	√	√	
Non-Localized Flood Risk Reduction Projects	√	√		

Eligible Activities	HMGP	BRIC	FMA	HHPD
Structural Retrofitting of Existing Buildings	√	√	√	
Non-structural Retrofitting of Existing Buildings and Facilities	√	√	√	
Safe Room Construction	√	√		
Wind Retrofit for One- and Two-Family Residences	√	√		
Infrastructure Retrofit	√	√	√	
Soil Stabilization	√	√	√	√
Wildland Fire Mitigation	√	√		
Post-Disaster Code Enforcement	√			
Advance Assistance	√			
5 Percent Initiative Projects*	√			
Aquifer and Storage Recovery**	√	√	√	
Flood Diversion and Storage**	√	√	√	
Floodplain and Stream Restoration**	√	√	√	
Green Infrastructure**	√	√	√	
Miscellaneous/Other**	√	√	√	
Hazard Mitigation Planning	√	√	√	√
Technical Assistance			√	√
Management Costs	√	√	√	

** FEMA allows increasing the 5% Initiative amount up to 10% for a Presidential major disaster declaration under HMGP. The additional 5% Initiative funding can be used for activities that promote disaster-resistant codes for all hazards. As a condition of the award, either a disaster-resistant building code must be adopted or an improved Building Code Effectiveness Grading Schedule is required.*

***Indicates that any proposed action will be evaluated on its own merit against program requirements. Eligible projects will be approved provided funding is available.*

Note: Eligible activities for the PDM Grant Program will be listed in future updates.

Appendix H. 2023 SHMP Annual Progress Reports

CONTENTS

[1] *Section Cover Photo: ʻĪao Valley State Monument, Maui. Photo courtesy of DLNR*

APPENDIX H. ANNUAL PROGRESS REPORTS

This appendix will serve as the location in the plan where annual plan reviews, updates, and progress reports will be included. Each year, the annual review progress report will be added, and the updated appendix posted on the HI-EMA website. A summary of each FEMA annual consultation throughout the plan performance period will be included as well. Below are placeholder pages for the anticipated annual review reports and FEMA annual consultations between 2023 and 2027.

H.1 2023 FEMA Consultation Report

H.2 2023 SHMP Update Annual Review Report

H.3 2024 FEMA Consultation Report

H.4 2024 SHMP Update Annual Review Report

H.5 2025 FEMA Consultation Report

H.6 2025 SHMP Update Annual Review Report

H.7 2026 FEMA Consultation Report

H.8 2026 SHMP Update Annual Review Report

H.9 2027 FEMA Consultation Report

H.10 2027 SHMP Update Annual Review Report

Appendix I. FEMA State Mitigation Plan Review Tool

CONTENTS

[1] *Section Cover Photo: View of Waikīkī and Honolulu from Diamond Head State Monument. Photo courtesy of DLNR*

APPENDIX I. STATE MITIGATION PLAN REVIEW TOOL

The State Mitigation Plan Review Tool (Plan Review Tool) demonstrates and documents how the state mitigation plan meets the regulations set forth in 44 CFR Part 201 and offers FEMA mitigation planners an opportunity to provide feedback to the state.

The Regulation Checklist must be completed by FEMA. The FEMA Plan Approver must reference the State Mitigation Planning Policy Guide when completing the Plan Review Tool. The purpose of the checklist is to identify the location of relevant or applicable content in the plan by element/sub- element and to determine if each requirement has been "Met" or "Not Met."

The Required Revisions summary at the bottom of each element must clearly explain the revisions that are required for plan approval. Required revisions must be explained for each plan sub-element that is "Not Met." Sub-elements should be referenced by the appropriate number, where applicable (e.g., S2-a, S2-b). Requirements for each element and sub-element are described in detail in Sections 3 and 4 of the State Mitigation Planning Policy Guide.

The HHPD section and FMAG sub-elements only need to be completed if the state is pursuing eligibility for those grant programs.

The Plan Assessment must be completed by FEMA. This assessment provides more comprehensive feedback to the state to acknowledge where the plan exceeds minimum requirements and provides suggestions for improvements. FEMA will describe the strengths that are demonstrated and highlight examples of best practices. FEMA's suggestions for improvement are not required to be made for plan approval.

For greater clarification of the elements in the regulation checklist, please see Sections 3 and 4 in the State Mitigation Planning Policy Guide. This document defines terms and phrases used within this review tool.

I.1 Plan and Review Information

I.2 Standard State Mitigation Plan Regulation Checklist

I.3 Plan Assessment

I.4 Standard State Mitigation Plan Requirements

I.5 Enhanced State Mitigation Plan Requirements