Resolution

No. 25-174

RECOGNIZING THE 2025 UPDATE TO
THE COUNTY OF MAUI HAZARD MITIGATION PLAN

WHEREAS, the County of Maui is subject to the effects of natural hazards that pose threats to life and property; and

WHEREAS, the County desires to mitigate the impact of known hazard risks; and

WHEREAS, the County of Maui Hazard Mitigation Plan represents the County's commitment to reduce risks from natural hazards and serves as a guide for decision makers in committing resources in the effort to reduce the effects of natural hazards; and

WHEREAS, in accordance with the federal Robert T. Stafford Disaster Relief and Emergency Assistance Act, as enacted by Section 104 of the Disaster Mitigation Act of 2000, Public Law 106-390, the County of Maui Hazard Mitigation Plan must be updated every five years; and

WHEREAS, in accordance with Title 44 of the Code of Federal Regulations, Section 201.6(c)(5), the County of Maui Hazard Mitigation Plan and any updates thereto must be formally adopted by the governing body of the jurisdiction; and

WHEREAS, the Maui Emergency Management Agency is responsible for advising all County departments and agencies on the County of Maui Hazard Mitigation Plan's implementation and has completed a comprehensive update, dated August 2025, attached as Exhibit "1"; and

WHEREAS, the Federal Emergency Management Agency completed a review of the 2025 Hazard Mitigation Plan Update on August 22, 2025, and has determined that it is eligible for final approval pending adoption by the Maui County Council; now, therefore,

Resolution No. 25-174

BE IT RESOLVED by the Council of the County of Maui:

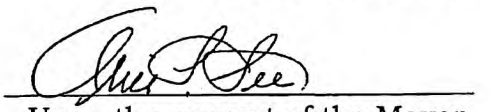
1. That it formally adopts the 2025 County of Maui Hazard Mitigation Plan dated August 2025, as described in Exhibit "1,"; and

2. That a certified copy of this resolution be transmitted to the Mayor and the Administrator of the Maui Emergency Management Agency.

APPROVED AS TO FORM AND
LEGALITY

CALEB P. ROWE
Department of the Corporation
Counsel
County of Maui
2025-1460

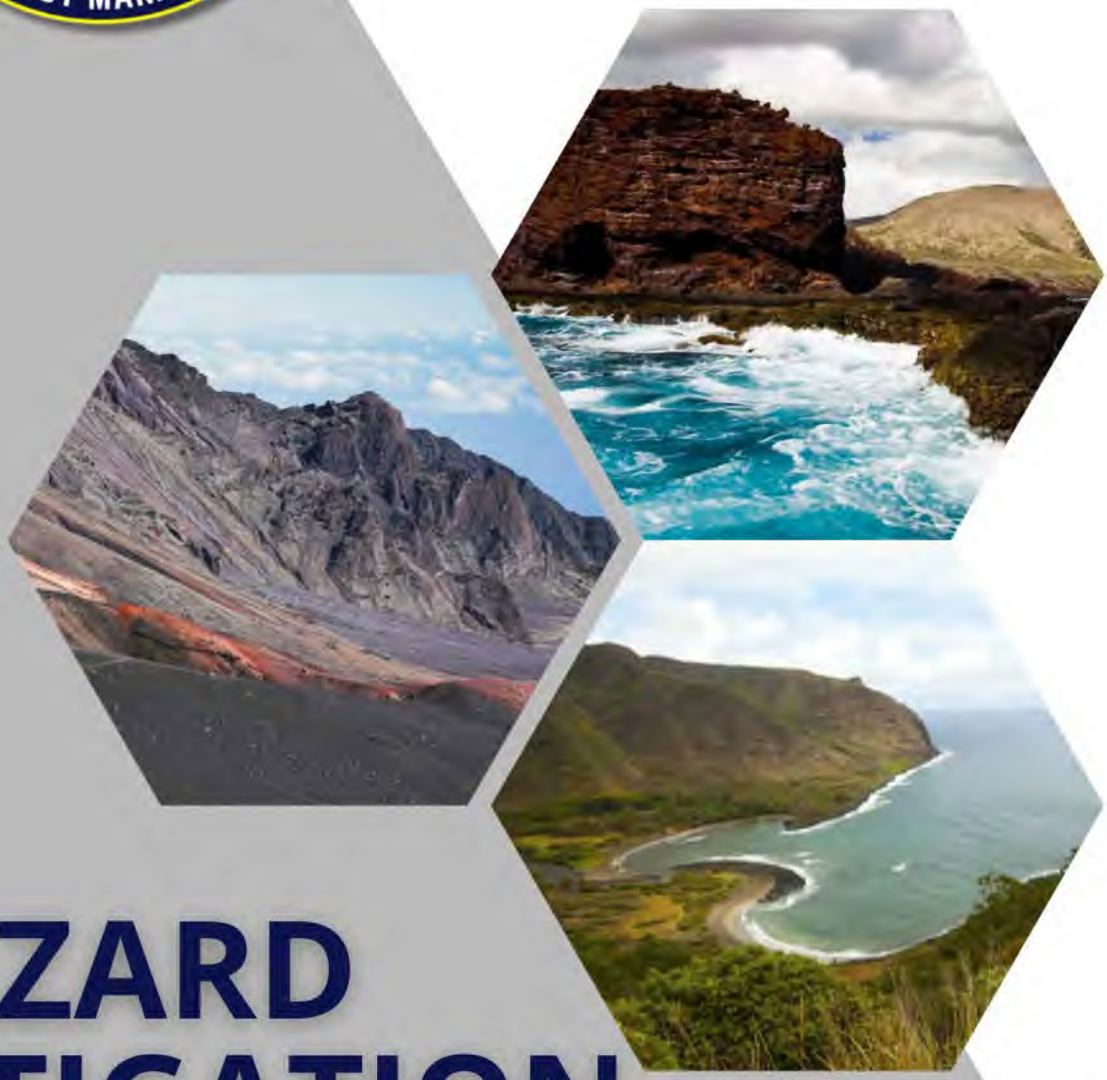
INTRODUCED BY:



Upon the request of the Mayor.

EXHIBIT 1

MAUI EMERGENCY MANAGEMENT AGENCY



HAZARD MITIGATION PLAN

FEMA Review Draft
August 2025

County of Maui 2025 Hazard Mitigation Plan

August 2025
#105S045057

PREPARED FOR

County of Maui Emergency Management Agency
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EXECUTIVE SUMMARY

Hazard Mitigation Overview

Mitigation is the effort to reduce loss of life and property by lessening the impacts of disasters. It creates safer communities and helps maintain the quality of life. Effective mitigation requires an understanding of all the risks that a community faces and the implementation of short- and long-term strategies to address those risks before the next disaster.

Mitigation planning is the process of identifying the hazards that impact a community, analyzing the risks that those hazards pose, identifying actions to reduce losses from the hazards, and establishing a process to implement the actions. Maui County has developed a hazard mitigation plan (HMP) to reduce risks from disasters to the people, property, economy, and environment within the County. This HMP updates the 2020 Maui County HMP. It includes countywide assessment of hazards, risk, and capabilities. The HMP complies with federal and state hazard mitigation planning requirements to establish the County's eligibility for funding under Federal Emergency Management Agency (FEMA) grant programs.

The Planning Process

Overall Approach

The foundation of all mitigation plans is an inclusive, well-documented planning process with community buy-in. A successful process brings diverse partners together. They will discuss the community's experience with natural hazards and how to meet local risk reduction needs.

To support the planning process, the County accomplished the following:

- Developed a Hazard Mitigation Working Group consisting of key stakeholders, county agencies, and other regional partners
- Involved a wide range of stakeholders and the public in the plan update process
- Reviewed the 2020 Maui County HMP and 2023 State HMP
- Identified hazards of concern to the County to be included in the update
- Profiled the hazards of concern
- Estimated the inventory at risk and potential losses associated with these hazards
- Reviewed and updated the mitigation goals
- Reviewed mitigation strategy and actions outlined in the 2020 HMP to indicate progress
- Developed new mitigation actions to reduce the vulnerability of assets from hazards of concern
- Developed mitigation plan maintenance procedures to be executed after obtaining approval of the plan from the Hawai'i Emergency Management Agency (HI-EMA) and Federal Emergency Management Agency (FEMA)

Multiple Agency Support for Hazard Mitigation

Primary responsibility for hazard mitigation lies with local governments. Partners at the regional, state, and federal levels are available to assist local communities with their mitigation strategies. FEMA provides grants, tools, guidance, and training to support mitigation planning.

Under the project management of the Maui Emergency Management Agency (MEMA), the Maui County Hazard Mitigation Working Group provided oversight for the preparation of this plan. The Hazard Mitigation Working Group includes representatives from the following:

- Hawai'i Community Foundation
- Hawai'i Emergency Management Agency
- Hawai'i Health Care Emergency Management
- Hawai'i Search and Rescue Conference
- Hawai'i Voluntary Organizations Active in Disaster
- Hawai'i Wildfire Management Organization
- Hawaiian Electric
- Home Innovation
- Imua Onipaa
- Kula Watershed Alliance
- Lahaina Strong
- Lāna'i Airport Fire Station
- Malama Kula
- Maui County Council
- Maui County GIS
- Maui Department of Agriculture
- Maui Department of Environmental Management
- Maui Department of Housing and Community Development
- Maui Department of Human Concerns
- Maui Department of Parks and Recreation
- Maui Department of Planning
- Maui Department of Public Works
- Maui Department of Water Supply
- Maui Emergency Management Agency
- Maui Lani Community Association
- Maui Memorial Medical Center
- Maui United Way
- Maui Visitors Bureau
- Mayor's Office
- Mayor's Office of Communications
- Mayor's Office of Innovation and Sustainability
- Mayor's Office of Recovery
- Maui Police Department
- Na Hale o Maui
- Native Hawaiian Legal Corporation
- Pacific Disaster Center
- Papakea Resort
- Pūlama Lāna'i
- Rebuild Maui
- Surfrider Foundation
- University of Hawai'i at Manoa

Outreach and Engagement Strategy

An important benefit of the mitigation planning process is that it promotes awareness of risks and elevates the conversation about making a safer, more resilient community. A plan that accurately

reflects the community's values and priorities will generate more community support. That support will lead to success in carrying out mitigation actions and projects that reduce risk. Federal regulations for mitigation plan approval require that stakeholders and the general public be given opportunities to be involved in the plan's development process. Input from community members can strengthen the content and outcomes of the mitigation plan. Stakeholders and members of the public can meaningfully contribute to the plan update.

Goals of the outreach and engagement activities for this HMP update included the following:

- Identify the right outreach methods.
- Develop clear and consistent messages that align with community values.
- Evaluate and incorporate feedback from outreach activities.
- Inform and educate about hazards and risks.
- Provide for two-way sharing of information to improve the quality and accuracy of the plan.
- Maximize chances to carry out the plan through greater agreement and acceptance.

Outreach and engagement activities included the following:

- A public website (https://www.mauicounty.gov/1832/Hazard-Mitigation) that contains hazard mitigation information, County contact information, access to HMP surveys, and sections of the HMP for public review and comment.
- In-person outreach at the 2025 Maui Disaster Preparedness Expo, Taro Festival, and Moloka'i Resource Fair.
- Hazard mitigation materials and HMP updates posted in public spaces, such as libraries and community bulletin boards.
- Public meetings designed to provide the public with an opportunity to participate in the planning process.
- Surveys for the public, local stakeholders, and business owners living and working in Maui County.

Risk Assessment for Local Hazards of Concern

The Hazard Mitigation Working Group evaluated the County's risk and vulnerability to each identified hazard of concern for Maui County, based on past events, past and predicted future losses, and the expected probability of future occurrence. From these evaluations, hazards were ranked as high, medium, or low. The hazard rankings were used to focus and prioritize mitigation actions. Summary overall hazard rankings for all of Maui County are as follows:

- Coastal Erosion – Low
- Dam and reservoir failure – Low
- Drought – Medium
- Earthquake – Low-High
- Flood – Low
- High windstorms – Medium
- Hurricane – Low
- Landslide – Low
- Tsunamis – Low
- Volcanic hazards – Low
- Wildfire – High

All of the hazards addressed in this plan pose a threat to Maui County's assets and populations. Factors that influence vulnerability include building construction type, date of construction, social vulnerability, time of occurrence, location, and capacity to respond. The hazard of concern that is most likely to cause significant damage to the people, structures, economy, and environment of Maui County is wildfire.

Based on the risk and vulnerability assessment and input from the community, the following are key findings for each hazard:

- Coastal Erosion:
  - High tides and annual high surf exacerbate coastal erosion, especially in areas with structures and infrastructure located at sea level. Potential solutions include moving roads inland, raising roadways, or providing shoreline protection; however, all of these options come with a significant cost to the County.
  - Critical facilities located along the shore are not flood-proofed to prevent water damage from flooding or the ocean. These facilities will eventually need to be relocated to a higher elevation.
  - 87 percent of public survey respondents indicated that they are concerned about coastal erosion but solutions are handicapped by funding gaps, state and local laws, and negative public perception of available solutions.
- Dam and Reservoir Failure:
  - Dam and reservoir failure was the hazard that survey respondents were least concerned about; 54 percent of public respondents were not concerned about this hazard. This could indicate that the public is unaware of the risk posed by dams and reservoirs.
  - New homes are being built in the areas downstream of dams and reservoirs, which puts them at risk in the event of a dam failure.
  - A significant number of dams and reservoirs in Maui County have no hydrologic and hydraulic modeling or the modeling is based on old information. These need to be updated to provide the downstream community with an accurate risk of inundation.
- Drought:
  - Drought creates conditions that increase the frequency, severity, and intensity of wildfires; there is a need for water storage infrastructure in areas prone to wildfires and drought.
  - While drought mitigation is recommended in many state and County planning documents; project implementation is difficult due to a lack of funding options.

- Earthquake:
  - While stakeholders seem aware of facilities at risk from wildfire or coastal erosion, they did not report their facilities being at risk from earthquakes, despite the analysis demonstrating that all of Maui County is at risk from earthquakes. In addition, the public rated earthquakes as the hazard they are third-least concerned about. This could indicate that residents are unaware of the hazard posed by earthquakes.
  - Maui County has more than 18,000 residential buildings on NEHRP Class D soil. However, in the event of a major earthquake, the County does not have the engineering staff needed to complete damage assessments on these properties.
  - The structural integrity of buildings can be damaged during an earthquake, including facilities identified as emergency shelters.
- Flood:
  - Repetitive loss properties are not limited to the Special Flood Hazard Area and flooding losses can occur in areas not identified on flood maps.
  - Rainfall intensity is expected to increase, straining existing drainage and stormwater infrastructure, potentially leading to flooding damage if these systems fail.
  - Wildfire burn scars are at risk of post-fire debris flows and flash floods.
  - There is a gap in knowledge about flood risk and the County floodplain management program among county staff, elected officials, and the public.
  - County infrastructure and critical facilities are located within the Special Flood Hazard Area and at risk from flooding.
- High Windstorm

  Much of the electrical power infrastructure of Maui County is above ground, which makes it vulnerable to high winds. Telecommunication services often run parallel to power lines.
  - Downed trees and power lines pose a risk to human life and safety and can prevent emergency vehicles from reaching people in need of their services.
  - Strong winds can exacerbate wildfires, as exemplified by the 2023 Wildfires on Maui.
- Hurricane (including Kona storms)
  - Considering that the County has been in a period of drought for the past five years, an extreme rainfall event associated with a hurricane could overload existing drainage and stormwater systems. Heavy rainfall resulting from a hurricane can block culverts, damage bridges, overtop reservoirs, and trigger landslides, potentially affecting homes, businesses, infrastructure, and transportation networks.
  - Storm surge from a hurricane could exacerbate existing coastal erosion issues and damage critical infrastructure located along the County's coasts.
  - Older homes are at risk of wind-damaged roofs and structural collapse during hurricanes from wind pushing homes off their foundations.
  - Existing hurricane shelters are not built to withstand a major hurricane.
- Landslide

  - Landslides have a history of closing roads to isolated communities, rendering them unreachable by first responders, especially when the soil becomes saturated during a period of high rainfall.
  - A major landslide on roadway arteries, such as the Pali, would be disastrous for residents because more than 30,000 vehicles per day use that road. The alternative route (Kahakuloa) doesn't have the capacity to serve West Maui's traffic needs. West Maui would be (for the most part) cut off from the major harbor, airport, and hospital until the road is reopened.
  - County engineers do not have GIS layers that identify landslide hazard areas and historic landslide events.
- Tsunami
  - Tsunami is one the deadliest hazards to threat Maui County. 29.5 percent of the County's critical infrastructure and community lifeline facilities are located within a tsunami inundation zone.
  - More than 20 percent of Maui County's residents live in a tsunami inundation zone.
- Volcanic hazards
  - There is a general perception among residents that Haleakalā is a dormant volcano.
  - There are no structural mitigation measures that can protect structures or infrastructure from lava flow.
  - Air quality measurements and historical data are not available to track vog. The Hazard Mitigation Working Group was unaware of any sulfur dioxide sensors in Maui County and the Hawai'i Department of Health has only two particulate (PM2.5) sensors.
- Wildfire
  - Steep slopes, rough terrain, strong winds, and a large percentage of highly ignitable invasive grasses characterize much of the County's landscape.
  - More than half of the County's population lives in a wildfire hazard area.
  - More than 25,000 building are located in a wildfire hazard area.

Capability Assessment and Plan Integration into Other Local Mechanisms

Effective mitigation is achieved when hazard awareness and risk management become integral parts of public activities and decision-making. Maui County has many plans and programs that support hazard risk management. This HMP integrates, complements, and references those plans and programs to the extent practical in order for it to be a comprehensive resource for hazard mitigation.

The HMP includes a capability assessment to review relevant local mechanisms for implementing hazard mitigation. This assessment identifies where the County is currently able to implement hazard mitigation measures and where it would benefit from improved capabilities for such measures. The capability assessment also provides a summary and description of the existing plans, programs, and regulatory mechanisms at all levels of government (federal, state, and county) that support hazard mitigation in the County.

Mitigation Strategy

Goals

The HMP includes goals for reducing or avoiding long-term vulnerabilities to the identified hazards of concern. The planning process included a review and update of previous mitigation goals. The goals were updated based on the updated risk assessment, discussions, research, and input from plan participants and stakeholders. The goal development process considered the goals expressed in the Hawai'i State Hazard Mitigation Plan, and in relevant County planning documents.

2025 Maui County HMP Goals

Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors.

Goal 2: Promote the long-term resilience of the County's economic, environmental, historical and cultural resources.

Goal 3: Protect and adapt property and infrastructure from the impacts of natural hazards and climate change.

Goal 4: Improve awareness and mitigation of risks associated with natural hazards and climate change.

Goal 5: Enhance the implementation of this hazard mitigation plan through active involvement and plan integration across all County departments.

Implementation of the 2020 Plan

The status of the mitigation projects identified in the 2020 HMP was reviewed for this HMP. Numerous projects and programs have been implemented to reduce hazard vulnerability of assets in the planning area. Uncompleted projects that remain feasible and in keeping with the current mitigation goals have been evaluated, modified as necessary, and incorporated into this plan. Plan maintenance procedures have been developed to encourage thorough integration with local decisions and processes and regular review of implementation progress.

2025 Mitigation Strategy

The County identified seven agencies to implement 51 actions in the mitigation strategy, with numerous supporting agencies and community-based organizations identified to support completion of the projects. The actions were prioritized based on cost, benefits, alignment with goals, and the time frame for completion.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

PART 1: THE PLANNING PROCESS AND PLANNING AREA

1. INTRODUCTION

Maui County has developed this hazard mitigation plan (HMP) to reduce risks from disasters to the people, property, economy, and environment within the County. This HMP updates the 2020 Maui County HMP. The updated 2025 HMP includes countywide analysis and assessment of hazards, risks, and local capabilities. The planning area includes the entirety of Maui County, with a limited focus on the uninhabited Island of Kahoʻolawe. Concurrently, the Maui Emergency Management Agency (MEMA) is updating its preparedness and response plans.

1.1 OVERVIEW OF HAZARD MITIGATION PLANNING

1.1.1 What Is Hazard Mitigation?

Mitigation is the effort to reduce loss of life and property by lessening the impacts of disasters. It creates safer communities and helps maintain the quality of life. Effective mitigation requires an understanding of all the risks that a community faces and the implementation of short- and long-term strategies to address those risks before the next disaster.

Mitigation planning is the process of identifying the hazards that impact a community, analyzing the risks that those hazards pose, identifying actions to reduce losses from the hazards, and establishing a process to implement the actions. It helps people, organizations, and government agencies to better prepare for and respond when disasters occur. Mitigation planning also allows local governments to remain eligible for Federal Emergency Management Agency (FEMA) grant funding for projects that will reduce the impact of future disaster events. The long-term benefits of mitigation planning and implementation include the following:

- An increased understanding of hazards faced by local communities
- A more sustainable and disaster-resistant community
- Financial savings through partnerships that support planning and mitigation efforts
- Focused use of limited resources on hazards that have the biggest impact on the community
- Reduced long-term impacts and damage to human health and structures
- Reduced costs associated with response and recovery efforts, including repairs

1.1.2 Regulatory Framework

Federal policy regarding disasters encourages communities to assess their vulnerability to hazards before disaster strikes and then take action to reduce potential risks. A disaster-resistant community can rebound more quickly and cost-effectively from a natural disaster, with less human injury or loss of property. This minimizes other losses associated with disasters, such as the time lost from productive activity by businesses and industries.

The federal Disaster Mitigation Act of 2000 (DMA) encourages hazard mitigation planning by states, tribes, and local governments. Under the DMA, communities seeking certain hazard-related federal funding must have an HMP to prepare for and reduce the potential impacts of natural hazards. Regulations that establish minimum requirements for HMPs are included in Title 44 of the Code of Federal Regulations, Section 201 (44 CFR 201). Table 1-1 summarizes the 44 CFR 201 requirements for local hazard mitigation plans and where each is addressed in this HMP.

The **Federal Emergency Management Agency** (FEMA) estimates that for every dollar spent on damage prevention (mitigation), twice that amount is saved by not having to perform post-disaster repairs.

Table 1-1. FEMA Local Mitigation Plan Review Crosswalk

Plan Criteria	Primary Location in the 2024 Maui HMP
Prerequisites	
Adoption by the Local Governing Body: §201.6(c)(5)	Section 2.7; Appendix A
Planning Process	
Documentation of the Planning Process: §201.6(b) and §201.6(c)(1)	Chapter 2
Risk Assessment	
Identifying Hazards: §201.6(c)(2)(i)	Chapter 5
Profiling Hazards: §201.6(c)(2)(i)	Chapters 6-16
Assessing Vulnerability: Overview: §201.6(c)(2)(ii)	Chapter 4
Assessing Vulnerability: Identifying Structures: §201.6(c)(2)(ii)(A)	Chapter 4; Chapters 6-16
Assessing Vulnerability: Estimating Potential Losses: §201.6(c)(2)(ii)(B)	Chapter 4; Chapters 6-16
Assessing Vulnerability: Analyzing Development Trends: §201.6(c)(2)(ii)(C)	Chapter 3.9; Chapters 6-16
Mitigation Strategy	
Local Hazard Mitigation Goals: §201.6(c)(3)(i)	Chapter 19.1
Identification and Analysis of Mitigation Actions: §201.6(c)(3)(ii)	Chapter 19.2.2
Implementation of Mitigation Actions: §201.6(c)(3)(iii)	Chapter 0
Multi-Jurisdictional Mitigation Actions: §201.6(c)(3)(iv)	N/A
Plan Maintenance Process	
Monitoring, Evaluating, and Updating the Plan: §201.6(c)(4)(i)	Chapter 20.2
Incorporation into Existing Planning Mechanisms: §201.6(c)(4)(ii)	Chapter 20.2.2
Continued Public Involvement: §201.6(c)(4)(iii)	Chapter 20.2.6

1.2 HISTORY OF HAZARD MITIGATION PLANNING IN MAUI COUNTY

1.2.1 Previous Maui County HMPs

Maui County has been included in 38 federal disaster declarations (major disaster, fire management, and emergency) since 1954. The County adopted its first HMP in 2005. Federal regulations require that states and local governments update HMPs on a 5-year basis. Maui County adopted updates to its

HMP in 2010, 2015, and 2020. The original HMP and all updates cover the single jurisdiction of Maui County; there are no municipalities within the County.

The most recent update to Maui County's HMP (2020) identified the following as the hazards of concern:

- Coastal erosion
- Dam and reservoir failure
- Drought
- Earthquake
- Extreme cold
- Extreme heat
- Flood
- High windstorms
- Hazardous materials
- Health risks
- Hurricane
- Landslides
- Tsunamis
- Volcanic hazards
- Wildfire

Updates to the 2020 HMP's 50 mitigation actions are provided in Section 19.2.1.

1.2.2 Key Changes in the Current Update

The following are the most significant changes made between the previous County HMP (2020) and the current (2025) update:

- The following hazards of concern from the 2020 HMP were omitted from this update:
  - Health risk was removed as a hazard of concern as that topic will be fully addressed in the new County Public Health and Medical Plan.
  - Hazardous material release was removed as a hazard of concern because it will be addressed in the County's new Comprehensive Emergency Management Plan.
  - Extreme heat and cold were removed as hazards of concern because the temperature in the county does not experience the extreme levels of heat and cold that impact human health and safety or infrastructure integrity; this was demonstrated by the fact that only one mitigation action from the 2020 HMP addressed extreme temperatures.
- Maui County will face major impacts on its people, infrastructure, economy, and environment as the frequency, intensity, and severity of sea level rise and warming ocean temperatures increase. As a result, each hazard of concern is analyzed within the context of climate change impacts on vulnerability and future frequency of occurrence.
- The 2023 Lahaina Wildfire response and recovery demonstrated that community organizations are critical to the success of adequately supporting survivors after a disaster. As a result, the Capability Assessment (Chapter 18) captures both county government capabilities and community organization capabilities to accurately reflect the resources and tools available to emergency managers.
- The 2023 wildfire left a lasting impact on the people of Maui County, and efforts to integrate best practices and lessons learned from the wildfire are contained throughout this HMP.

1.3 SPECIALIZED TERMS AND CONCEPTS

Like any technical field, hazard mitigation has developed over the years its own set of terms and concepts with particular meanings within the hazard mitigation practice. A full glossary and list of acronyms is provided in Appendix B. The list below provides a quick reference for specialized terms whose use is especially prominent in this hazard mitigation plan:

- **Adaptive capacity**—the ability of a human or natural system to adjust to climate change by moderating potential damage, taking advantage of opportunities, or coping with the consequences (EPA 2023)
- **Asset**—anything that is important to the character and function of a community (e.g., people, structures, community lifelines, the economy, and natural, historic, and cultural resources) (FEMA 2023)
- **Capability assessment**—an evaluation of which authorities, policies, programs, funding, and resources a participant has to accomplish hazard mitigation (FEMA 2023)
- **Cascading hazards**—a primary event, such as heavy rainfall, seismic activity, or rapid snowmelt, followed by a chain of consequences that may range from modest (less than the original event) to substantial (National Academies of Sciences, Engineering, and Medicine 2022)
- **Community lifelines**—the most fundamental services in a community that, when stabilized, enable all other aspects of society to function (FEMA 2023)
- **Extent**—the range of anticipated intensities of the identified hazards within a community, most commonly expressed using various scientific scales (FEMA 2022)
- **Hazard profile**—a description of a hazard's location, extent, previous occurrences, and probability of future events within a community (FEMA 2023)
- **Hazard ranking**—the process of identifying the hazards that pose the greatest risk to a community, based on how likely the hazard is to occur, the potential consequences if the hazard does occur, and other relevant local factors
- **Impact**—the consequences or effects of a hazard on a community's assets identified in the vulnerability assessment. (FEMA 2023)
- **Integration**—the inclusion of hazard mitigation principles, vulnerability information, and mitigation actions into other existing community planning to leverage activities that have co-benefits, reduce risk and increase resilience (FEMA 2022)
- **Mitigation action**—measures, projects, plans, or activities proposed to reduce the current and future vulnerabilities identified in the risk assessment (FEMA 2023)
- **Mitigation strategy**— the long-term blueprint for reducing the potential hazard-related losses identified in the risk assessment; the strategy consists of mitigation goals, mitigation actions, and a plan for implementing the actions (FEMA 2023)
- **Natural hazard**—a source of harm or difficulty created by a meteorological, environmental, or geological event (FEMA 2023)

- **Plan maintenance**—monitoring and updating a hazard mitigation plan as warranted by changing conditions, availability of new information, and progress on the proposed mitigation actions (FEMA 2023)
- **Planning process**—the procedures used to develop a hazard mitigation plan with broad acceptance across the community
- **Risk**—the potential for damage or loss when natural hazards interact with people or assets (FEMA 2023)
- **Risk assessment**—a data-driven analysis to find where a community is vulnerable to hazards (FEMA 2023)
- **Social vulnerability**—the potential for loss within an individual or social group, as affected by traits that influence an individual's or group's resilience, which is their ability to prepare, respond, cope, or recover from an event (FEMA 2023)
- **Stakeholder**—individuals or groups that a mitigation action or policy affects, including businesses, private organizations, and residents (FEMA 2023)
- **Vulnerability**—a description of which assets within locations identified to be hazard-prone are at risk from the effects of the hazard (FEMA 2023)

1.4 PLAN ORGANIZATION

The Maui County HMP includes a description of the County, a summary of the mitigation planning process, a risk assessment, a capability assessment, the mitigation strategy, and an outline of steps for implementing and maintaining the mitigation plan. It includes the following chapters:

- Part 1. The Planning Process and Planning Area
  - Chapter 1: Introduction
  - Chapter 2: Planning Process—A description of the plan development process, participants' roles and activities, and how the plan will be incorporated into existing programs. Information regarding the adoption of the plan by the County.
  - Chapter 3: County Profile—An overview of Maui County, including general information and physical conditions, land use patterns and trends, population and demographics, economy, general building stock inventory, community lifelines, and natural, historic, and cultural resources
- Part 2. Risk Assessment
  - Chapter 4: Methodology—Description of the methodology used to assess hazard risk and the data used for the assessment.
  - Chapter 5: Hazards of Concern Identification—Documentation of the process of identifying the natural hazards of concern for further profiling and evaluation.
  - Chapters 6– 16—Hazard profiles and findings of the risk assessment (estimates of the impact of hazard events on life, safety, and health; general building stock; critical facilities; the economy; and natural, historic, and cultural resources).
  - Chapter 17: Hazard Ranking—Description of the hazard ranking process and results.

- Part 3. Capability Assessment
  - Chapter 18: Capability Assessment—A description of the plans, programs, and regulatory mechanisms at all levels of government (federal, state, county, local) that support hazard mitigation within the County.
- Part 4. Mitigation Strategy
  - Chapter 19: Mitigation Strategy—Description of the mitigation goals identified for this HMP, the process by which the County mitigation strategy was developed, and identification of the actions recommended for the strategy.
- Part 5. Plan Maintenance
  - Chapter 20: Plan Maintenance Procedures—A system to continue to monitor, evaluate, maintain, and update the plan.

Appendices include supplementary information and documentation related to various components of the main HMP document.

2. PLANNING PROCESS

This chapter describes the planning process used to update the Maui County HMP. Maui County was awarded a planning grant under the Hazard Mitigation Grant Program, which supported the development of this HMP. Grant administration was the responsibility of the Maui Emergency Management Agency (MEMA).

2.1 GENERAL MITIGATION PLANNING APPROACH

FEMA provides hazard mitigation planning support to local communities through guidance, resources, and plan reviews. This HMP was prepared in accordance with the following regulations and guidance:

- DMA 2000 (Public Law 106-390, October 30, 2000)
- 44 CFR 201 and 206 (including: Feb. 26, 2002, Oct. 1, 2002, Oct. 28, 2003, and Sept. 13, 2004, Interim Final Rules)
- Mitigation Planning How-to Series (FEMA 386-1 through 4, 2002)
- Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards (FEMA, January 2013)
- Integrating Hazard Mitigation into Local Planning (FEMA, March 1, 2013)
- Plan Integration: Linking Local Planning Efforts (FEMA, July 2015)
- Local Mitigation Planning Policy Guide (FEMA, April 19, 2022)
- Local Mitigation Planning Handbook (FEMA, May 2023)
- State of Hawai'i 2023 Hazard Mitigation Plan

The plan was developed following FEMA regulations and prevailing FEMA and state guidance in order to ensure that all requirements are met and to facilitate state and federal review of the plan. The process used for this HMP also meets the criteria for the National Flood Insurance Program (NFIP) Community Rating System (CRS) and the Flood Mitigation Assistance (FMA) program.

2.2 ORGANIZATION OF PLANNING PROCESS

2.2.1 Planning Process Participants

Project Management and Planning Consultant

Project management was the responsibility of MEMA. A contract planning consultant (Tetra Tech) was tasked with the following:

- Assisting with the organization of a Hazard Mitigation Working Group
- Assisting with the development and implementation of a public and stakeholder outreach program
- Data collection

- Facilitation and attendance at meetings (Hazard Mitigation Working Group, stakeholders, public, and others)
- Review and update of the hazards of concern, and hazard profiling and risk assessment
- Assistance with the review of mitigation planning goals
- Assistance with the review of past mitigation strategy progress
- Assistance with the screening of mitigation actions and the identification of appropriate actions
- Assistance with the prioritization of mitigation actions
- Authoring of the draft and final HMP documents

Communication with this group included virtual conference calls, emails, and in-person meetings.

Hazard Mitigation Working Group

Maui County developed a Hazard Mitigation Working Group (HMWG) to provide guidance and direction to the HMP update effort and to ensure that the resulting document will be embraced by local government leaders and all who live and work within the planning area. HMWG members were charged with the following:

- Providing guidance and oversight of the planning process
- Attending and participating in HMWG meetings
- Supporting and promoting the public involvement process
- Reporting on the progress of mitigation actions identified in prior or existing HMPs, as applicable
- Identifying, developing, and prioritizing appropriate mitigation actions
- Reporting on the progress of the integration of prior or existing HMPs into other planning processes and County operations
- Reviewing, amending, and approving all sections of the plan update
- Adopting, implementing, and maintaining the plan update
- Assisting with the development and completion of planning elements, including the following:
  - Reviewing and updating the hazards of concern
  - Developing a public and stakeholder outreach program
  - Ensuring that the data and information used in the plan update process is the best available
  - Reviewing and updating the hazard mitigation goals
  - Identifying and screening appropriate mitigation actions
- Reviewing and commenting on plan documents before submission to the Hawai‘i Emergency Management Agency (HI-EMA) and FEMA.

The HMWG provided guidance, leadership, and oversight of the planning process and acted as the point of contact for interest groups in the planning area. Table 2-1 lists the members of the HMWG. (Participation Matrix) identifies how each individual who participated in the planning effort contributed to the planning process. Communication with this group was through email, Teams messages, virtual conference calls, and in-person meetings.

Table 2-1. Maui County HMWG Members

Organization	Participant	Position	Community Lifeline Category	CRS Participant Category
Hawai'i Community Foundation	Keanu Lau Hee Kehau Meyer	Senior Director Senior Program Officer	N/A	Stakeholder
Hawai'i Emergency Management Agency	Manuel Soco	Hazard Mitigation Specialist	Safety and Security	N/A
Hawai'i Health care Emergency Management	Aiko Holmberg Matthew Nishimura	Program Coordinator Health care Emergency Management Specialist	Health and Medical	Stakeholder
Hawai'i Search and Rescue Conference	Rosemarie Johnson	Director	Safety and Security	Stakeholder
Hawai'i Voluntary Organizations Active in Disaster	Andrea Finkelstein	Secretary	Food, Hydration, Shelter	Stakeholder
Hawai'i Wildfire Management Organization	Cassandra Smith Elizabeth Pickett	Firewise Program Co-Executive Director	Safety and Security	Stakeholder
Hawaiian Electric	Lydia Mertyris	Emergency Preparedness Manager	Energy	Stakeholder
Home Innovation	Elina Thapa	N/A	N/A	Public
Imua Onipaa	Gary Albitz	Managing Director	N/A	Public
Kelea Foundation	Jackie Keefe	Inclusive Recovery Specialist	N/A	Stakeholder
Kula Watershed Alliance	Sara Tekula	Director	Water Systems	Stakeholder
Lahaina Strong	Lauryn Rego	Strategic Advisor	N/A	Stakeholder
Lāna'i Airport Fire Station	Rainui R Faatau	Airport Firefighter	Safety and Security	N/A
Malama Kula	Kyle Ellison	President/Executive Director	N/A	Stakeholder
Maui County Council	Michele McLean	Executive Assistant	N/A	County Council
Maui County GIS	Kristana Erickson Michael Napier	GIS Supervisor GIS Analyst V	N/A	N/A
Maui Department of Agriculture	Jeffery Jurickovich	Maintenance Specialist	Food, Hydration, Shelter	N/A
Maui Department of Environmental Management	Shayne Agawa	Director	Water Systems	Environmental Protection/Public Health
Maui Department of Housing	Saumalu Mataafa Antonette Eaton	Deputy Director Housing Specialist	Food, Housing, Shelter	Housing/Community Development
Maui Department of Human Concerns	Jessica Crouse Dionne Carvalho	Deputy Director Aging Care Manager	N/A	N/A

Organization	Participant	Position	Community Lifeline Category	CRS Participant Category
Maui Department of Parks and Recreation	Wesley Bradshaw	Planner	N/A	Parks/Recreation
Maui Department of Planning	Ana Lillis James (Jim) Buika Sybil Lopez	Division Chief Coastal Resources Planner Moloka'i Planner	N/A	Land Use Planning/Zoning
Maui Department of Public Works	Paul Barany Berry Ueoka Lance Nakamura	Deputy Director Floodplain Manager Assistant Development Services Administrator	N/A	Public Works; Engineering; Building Department/Code Enforcement
Maui Department of Water Supply	Eva Blumenstein Geovanna Torres	Planning Program Manager Water Resources Senior Planner	Water Systems	N/A
Maui Emergency Management Agency	Amos Lonokailua-Hewett Tara Sabado	Administrator Planning Division Chief	Safety and Security	Emergency Management/Public Safety
Maui Lani Community Association	Leiane Paci	President	N/A	Public
Maui Memorial Medical Center	Jeremy Cooke	Safety Project Manager	Health and Medical	Stakeholder
Maui United Way	Jason Economou	President	N/A	Stakeholder
Maui Visitors Bureau	Janet Kuwahara	Senior Manager of Operations	Safety and Security	Stakeholder
Mayor's Office	Zeke Kalua	Special Assistant to the Mayor	N/A	N/A
Mayor's Office of Communications	Lois Leinani Whitney	Deputy Director, Communications & Gov't. Affairs	Communications	Public Information
Mayor's Office of Innovation and Sustainability	Joshua Cooper	Sustainability Specialist	N/A	N/A
Mayor's Office of Recovery	Kaiea Medeiros	Agricultural Advocate	Food, Hydration, Shelter	N/A
Maui Police Department	Bryan Manlapao	Sergeant	Safety and Security	N/A
Na Hale o Maui	Carrie DeMott	Executive Director	N/A	Stakeholder
Native Hawaiian Legal Corporation	Devon Haia	Equal Justice Works Disaster Resilience Fellow	N/A	Stakeholder
Pacific Disaster Center	Sharon Meilbrecht Annie Collopy	Hazard Mitigation Specialist Senior Disaster Services Analyst	N/A	Stakeholder
Papakea Resort	Cindy Amano	N/A	N/A	Public

Organization	Participant	Position	Community Lifeline Category	CRS Participant Category
Pūlama Lānaʻi	Keiki-Pua Dancil	Senior Vice President of Government Affairs & Strategic Planning	N/A	Stakeholder
Rebuild Maui	Alfy Basurto	CEO	N/A	Stakeholder
Surfrider Foundation	Maureen Brock	Chair	N/A	Stakeholder
University of Hawaiʻi – Sea Grant	Tara Owens	Coastal Hazards Specialist	N/A	Stakeholder

2.2.1.1 Planning Activities

Members of the HMWG, as well as key stakeholders, met and communicated as needed to share information. This included workshops to identify hazards, assess risks, update inventories of critical facilities, and assist in updating mitigation goals and strategies. All members of the HMWG had the opportunity to review the draft plan, supported interaction with other stakeholders, and assisted with public involvement efforts.

Table 2-2 summarizes planning activities conducted during the development of the plan. It also identifies which 44 CFR 201 requirements each activity satisfies. Documentation of meetings may be found in Appendix C (Public Outreach). In addition to the activities listed in the table, there was a great deal of communication between HMWG members and the consultant through individual contacts.

Table 2-2. Summary of Mitigation Planning Activities

Date	44 CFR 201 Requirement[a]	Description of Activity	Participants
November 12, 2024	2	Project Startup Meeting: Discuss proposed planning process and scope of work including documenting participation, schedule, and public and stakeholder outreach and involvement.	MEMA, Tetra Tech
December 30, 2024	2, 3c	GIS data collection meeting	MEMA, Maui County GIS, Tetra Tech
Bi-Weekly	-	Bi-weekly project status meeting to discuss action items in support of the expedited planning process	MEMA, Tetra Tech
February 27, 2025	1b	Presented HMP update process to public and requested input and support. Encouraged the public to participate in planning process.	MEMA, Tetra Tech, Public
December 5, 2024	2	Public project website developed: https://www.mauicounty.gov/1832/Hazard-Mitigation	MEMA, Contract Planner
January 31, 2025	2	Online stakeholder hazard mitigation surveys developed and deployed	MEMA, Contract Planner
January 31, 2025	2	Online private sector mitigation survey developed and deployed	MEMA, Contract Planner
February 12, 2025	2	Online public hazard preparedness and mitigation survey developed and deployed	MEMA, Contract Planner

Date	44 CFR 201 Requirement[a]	Description of Activity	Participants
April 16, 2025	1b, 2, 3, 4, 5	HMWG Meeting: Plan maintenance, draft plan review	HMWG, Contract Planner
April 23, 2025	2	Draft plan posted to public project website	Public and Stakeholders
April 23-24, 2025	1b	Presented information about the HMP planning process to the public. Attendees were encouraged to review the draft plan.	Public and Stakeholders
April 23-May 8, 2025	1b, 2	Public and stakeholder comments to draft plan received and incorporated into final plan.	Public and Stakeholders
May 27, 2025	All requirements	Final plan submitted to HI-EMA and FEMA Region 9	HI-EMA, FEMA Region 9
Upon FEMA plan approval	1a	Plan adoption by resolution by the County's governing body	All plan participants

a. *Numbers in column 2 identify specific requirements of 44 CFR 201.6, as follows:*
1a – Prerequisite – Adoption by the Local Governing Body (201.6.a.1)
1b – Public Participation (201.6.b)
2 – Planning Process – Documentation of the Planning Process (201.6.c.1)
3a – Risk Assessment – Identifying Hazards (201.6.c.2.i)
3b – Risk Assessment – Profiling Hazard Events (201.6.c.2.i)
3c – Risk Assessment – Assessing Vulnerability: Identifying Assets (201.6.c.2.ii.A)
3d – Risk Assessment – Assessing Vulnerability: Estimating Potential Losses (201.6.c.2.ii.B)
3e – Risk Assessment – Assessing Vulnerability: Analyzing Development Trends (201.6.c.2.ii.C)
4a – Mitigation Strategy – Local Hazard Mitigation Goals (201.6.c.3.i)
4b – Mitigation Strategy – Identification and Analysis of Mitigation Measures (201.6.c.3.ii)
4c – Mitigation Strategy – Implementation of Mitigation Measures (201.6.c.3.iii)
5a – Plan Maintenance Procedures – Monitoring, Evaluating, and Updating the Plan (201.6.c.4.i)
5b – Plan Maintenance Procedures – Implementation through Existing Programs (201.6.c.4.ii)
5c – Plan Maintenance Procedures – Continued Public Involvement (201.6.c.4.iii)

2.3 STAKEHOLDER OUTREACH AND INVOLVEMENT

The Maui County HMP update was written using the best available information, collected throughout the HMP update process from County and regional agencies, stakeholders, federal and state agencies, and County residents. The HMWG solicited information from local agencies and individuals with specific knowledge of natural hazards and past historical events. In addition, the HMWG took into consideration planning and zoning codes, ordinances, and recent land use planning decisions.

To ensure broad regional, county, and local representation in this planning process, a comprehensive list of stakeholders was developed with the support of the HMWG and Planning Team. The stakeholders are the agencies, departments, non-profits, districts, authorities, and other entities that have a stake in managing hazard risk and mitigation. Information and input provided by these stakeholders have been included throughout this plan.

Key stakeholders were asked to participate in the HMWG. Stakeholder outreach, performed throughout the planning process, included mass media notifications and invitations to stakeholders to attend HMWG meetings, complete a stakeholder survey, and comment on the draft plan. The following

sections list the stakeholders who were invited to participate in the development of this plan and describe how they contributed to the plan. In addition to the summary information presented here, many stakeholders were aware of and/or contributed to this plan through formal and informal outreach efforts by the County.

Communication with the groups listed in this section included emails, surveys, telephone calls, and, at times, in-person meetings.

2.3.1 Surveys

The Planning Team developed a stakeholder survey and distributed it to local and regional agencies involved in hazard mitigation activities, agencies with authority to regulate development, neighboring communities, academic institutions, nonprofit organizations, community-based organizations, and other key stakeholders. The Planning Team also developed a business survey to capture the mitigation interests of the private sector and economic community. A summary of both survey results is provided later in this chapter. In addition, an example of the stakeholder surveys is presented in Appendix C.

2.3.2 Governmental Agencies

The federal and state agencies listed in Table 2-3 were contacted during the planning process. The county agencies listed in

Table 2-4 were invited to participate by attending HMWG meetings, contributing subject-matter expertise, completing the stakeholder survey, reviewing the draft plan, and submitting mitigation actions. The tables describe how each agency participated.

Table 2-3. Participation of Federal and State Agencies

Agency	Participation
• FEMA Region 9	Provided updated planning guidance; provided summary and detailed NFIP data for planning area; conducted plan review.
• National Centers for Environmental Information (NCEI) • National Hurricane Center (NHC) • National Oceanic and Atmospheric Administration (NOAA) • National Weather Service (NWS) • Storm Prediction Center (SPC) • U.S. Army Corps of Engineers (USACE) • U.S. Census Bureau • U.S. Geological Survey (USGS)	Information regarding hazard identification and the risk assessment for this HMP update was requested and received or incorporated by reference.
• Hawai'i Emergency Management Agency (HI-EMA)	Administered planning grant; facilitated FEMA review; deployed a mitigation specialist to support plan development; provided updated planning guidance; attended meetings; conducted review of draft and final plan.

Agency	Participation
• Hawai'i Department of Land and Natural Resources	Provided data and information on the number and locations of dams and the status of state drought projects; attended HMWG meetings; reviewed draft plan and provided feedback
• Hawai'i Department of Education • Hawai'i Department of Health	Attended HMWG meetings
• USACE Honolulu Office • USGS Hawaiian Volcano Observatory	Attended HMWG meetings; reviewed draft plan and provided feedback
• U.S. Small Business Administration	Provided information about homeowner and business loans following the 2023 Lahaina Fire.
• U.S. Natural Resource Conservation Services • U.S. Fish and Wildlife Service	Requested data and information related to the impact of natural hazards on Maui communities and agency activities that might affect flooding or properties in hazard areas.

Table 2-4. Participation of County Agencies

Agency	Attended HMWG Meetings	Completed Stakeholder Survey	Reviewed Draft Plan	Updated 2020 Mitigation Strategy
MEMA	☒	☐	☒	☒
Department of Planning	☒	☒	☒	☒
Department of Public Works	☒	☒	☒	☒
Office of the Mayor	☒	☐	☒	☒
Department of Human Concerns	☒	☒	☐	☐
Department of Parks and Recreation	☒	☒	☐	☐
Department of Housing	☒	☐	☐	☐
County Council	☒	☐	☒	☐
Department of Agriculture	☒	☐	☐	☐
Department of Water Supply	☒	☐	☒	☒
Department of Environmental Management	☒	☐	☒	☒
Department of Fire and Public Safety	☐	☐	☒	☒

2.3.3 Local and Regional Stakeholders

Community Lifeline Representatives

FEMA defines community lifelines as fundamental services in a community that, when stabilized, enable all other aspects of society. Following a disaster event, intervention is required to stabilize community lifelines. Maui County asked County agencies associated with community lifeline categories to complete a stakeholder survey. Table 2-5 lists other stakeholders involved with community lifelines

who were invited to participate in the planning process by attending HMWG meetings, contributing subject-matter expertise, completing a stakeholder survey, or reviewing the draft plan. The stakeholders are categorized by FEMA's designated community lifeline categories. More detailed information about community lifelines in the planning area is provided in Chapter 3.

Additional Stakeholder Groups

The following additional groups were invited to attend HMWG meetings, contribute subject-matter expertise, complete a stakeholder or business survey, and review the draft plan:

- Businesses, Academia, and Other Private Organizations
  - Building Industry Association Hawai'i
  - Hawai'i Society of Professional Engineers Maui Chapter
  - Maui Chamber of Commerce
  - Maui Visitors Bureau
  - Pacific Disaster Center
  - University of Hawai'i
- Organizations Working with Socially Vulnerable Groups and Underserved Communities
  - Hawai'i Community Foundation
  - Hawai'i Department of Hawaiian Homelands
  - Ka Hale a Ke Ola
  - Kelea Foundation
  - Kula Community Watershed Alliance
  - Maui Humane Society
  - Maui Office of Aging
  - Na Hale o Maui
  - Native Hawaiian Legal Corporation
  - Hawai'i Voluntary Organizations Active in Disaster
  - Lahaina Strong
  - Malama Kula
  - Maui United Way
  - Sustainable Moloka'i

Table 2-5. Local and Regional Stakeholders Involved with Community Lifelines

Community Lifeline Category	Stakeholders Contacted

Safety and Security	**Law Enforcement**
	• Hawai'i Search and Rescue Conference
	• Lāna'i Airport Fire Station
	• Maui Department of Fire and Public Safety
	• Maui Police Department
	• Hawai'i Wildfire Management Organization
	Dam Safety
	• Hawai'i Department of Land and Natural Resources; asked to provide the following:
	  • Information, data, or resources regarding the risk of dam failure as a result of deficiencies or exposure to hazards such as flooding, geologic impacts, and severe storms.
	  • Concerns with dam safety due to changing climate conditions
	  • Concerns with emergency action plan deficiencies including warning time, evacuation needs, etc.
	  • Completed or in progress repairs/improvements to dams
	  • Potential new mitigation actions that should be considered for inclusion in the HMP mitigation strategy

Food, Hydration, Shelter	• American Red Cross • Feed My Sheep • Habitat for Humanity Maui • Maui United Way
Health and Medical	• Hawai'i Health care Emergency Management • Maui Memorial Medical Center
Energy	• Hawai'i Gas • Maui Electric dba Hawaiian Electric
Communications	• Akaku • Hawai'i News Now
Transportation	• Maui Department of Public Works • Maui Department of Transportation • Maui Metropolitan Planning Organization
Hazardous Materials	• Lāna'i Airport Fire Station • Maui Department of Fire and Public Safety • Maui Fire Department • Maui Fire Protection Bureau
Water Systems	• Kula Watershed Alliance • Maui Soil and Water Conservation Districts • Maui Department of Environmental Management • Maui Department of Water Supply

2.3.4 Adjacent Jurisdictions

Maui County shares only one physical border with a neighboring jurisdiction—Kalawao County on the Island of Moloka'i. Kalawao is the smallest county in the 50 states by land area and the second

smallest county by population. The county encompasses the Kalaupāpā Peninsula and was home to 82 residents as of the 2020 Census. The county is isolated from the rest of Molokaʻi by cliffs over a quarter-mile high; the only land access is a mule trail. Due to the small population, Kalawao County does not have an elected government or county offices.

2.3.5 Floodplain Coordination with Communities and Other Agencies

The following agencies and organizations were contacted to determine if they had studies, plans, data, or information pertinent to the County's floodplain management efforts; to determine if their programs or initiatives may affect the community's program; and to see if they could support the HMP efforts by attending a meeting of the HMWG or commenting on the draft plan (copies of contact attempts are included in Appendix D):

- American Red Cross
- Kula Community Watershed Alliance,
- Maui Visitors Bureau
- Pacific Disaster Center
- U.S. Small Business Administration
- Habitat for Humanity
- United Way
- Hawaiʻi Community Foundation
- Sustainable Molokaʻi
- Haleakalā National Park
- Hawaiʻi Gas
- Maui Metropolitan Planning Organization
- Maui Humane Society
- NRCS Kahului
- Pacific Islands Fish and Wildlife Office
- USACE Honolulu Office
- Building Industry Association Hawaiʻi
- Na Hale o Maui
- Maui Chamber of Commerce
- Hawaiʻi Society of Professional Engineers Maui Chapter
- Hawaiʻi Department of Land and Natural Resources
- Maui Historical Society
- Realtors Association of Maui
- Maui Soil and Water Conservation District
- Hawaiʻi Department of Agriculture
- Hawaiʻi Department of Business, Economic Development and Tourism
- Hawaiʻi State Library System

In addition to contacting the above agencies, stakeholder coordination meetings were conducted with 4 agencies and organizations to discuss floods and other natural hazards. The meeting minutes are available in Appendix E.

- American Red Cross
- Pacific Disaster Center
- Sustainable Molokaʻi
- Hawaiian Electric Company

2.3.6 Stakeholder and Business Survey Summaries

This section summarizes the results and feedback received by those who completed the stakeholder and business surveys. Feedback was integrated where appropriate into the plan.

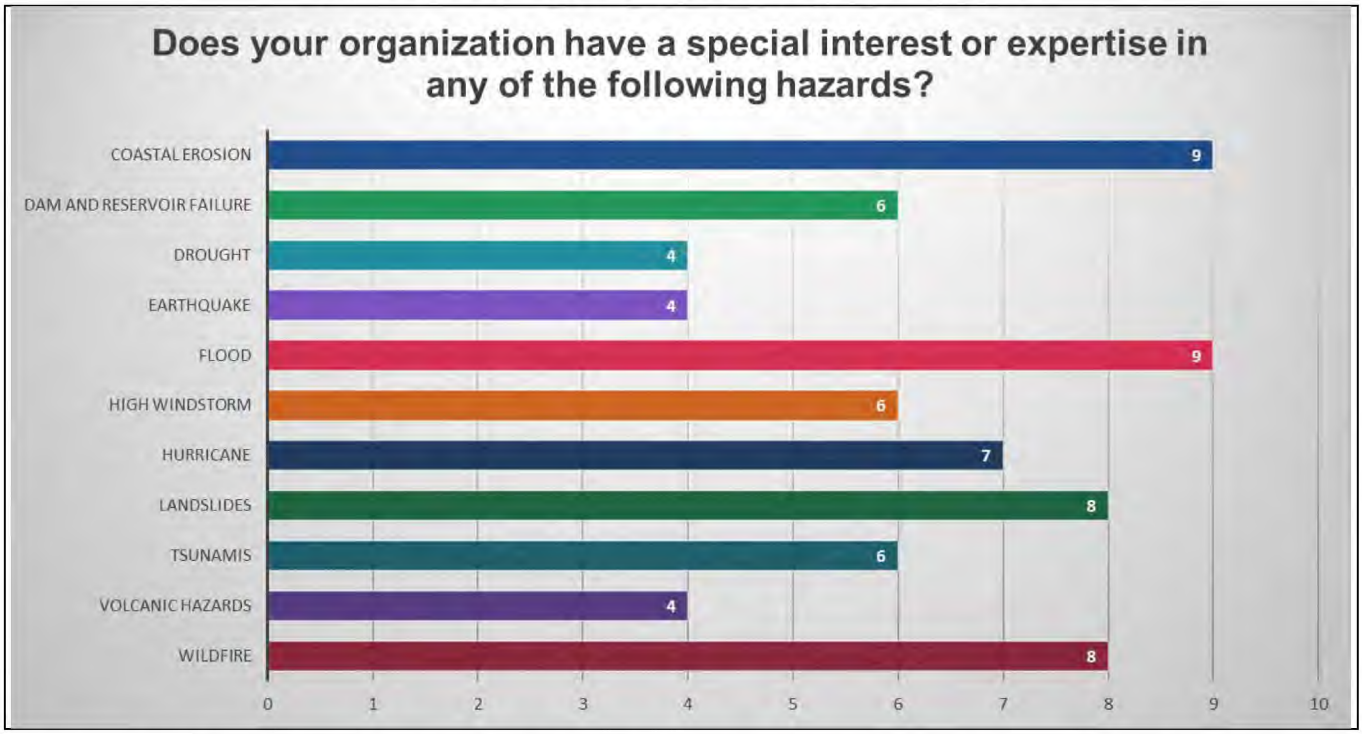
Stakeholder Survey

The stakeholder survey was designed to identify general needs for hazard mitigation and resiliency within Maui County from the perspective of stakeholders, as well as to identify specific projects that may be included in the mitigation plan. It was distributed to identified stakeholders, including county agencies, community-based organizations, and emergency response organizations.

Services Provided by Respondents' Organizations

As of March 13, 2025, 12 stakeholders completed the survey. Respondents represent the academic/research sector, emergency services sector, nonprofit sector, and local agencies with a variety of special interests and subject-matter expertise across the hazards of concern. Figure 2-1 illustrates the stakeholder responses about interest and expertise; most stakeholders indicated that they had interest or expertise across multiple hazards.

Figure 2-1. Stakeholder Special Interest or Expertise



Two-thirds of respondents said that they manage buildings, roads, bridges, stormwater, or other facility within their designated service area (see Figure 2-2). The remaining respondents noted a variety of work including human services, natural and cultural resources, emergency management, and land use and development.

Figure 2-2. Stakeholder Infrastructure Maintenance

Two-thirds of respondents noted that they work with socially vulnerable populations. Examples of this work included the following:

- Assisting financially challenged community members in keeping their pets
- Supporting disaster management professionals and NGOs serving these populations
- Installing smoke and fire alarm technology for blind, deaf, and elderly
- Providing housing and services to the homeless population
- Providing grant funding for social services

Hazard and Damage Identification

Two-thirds of respondents indicated that their organizations manage facilities located in a hazard area, specifically tsunami inundation zones, wildfire hazard areas, and coastal erosion zones. Slightly more than half of respondents (59 percent) indicated that their physical assets have been damaged by a natural hazard over the past five years (see Figure 2-3), including the following:

- The total destruction of a senior center
- $20 million in flooding damage, $10 million in landslide damage, and $5 million in coastal erosion damage
- Flooding at facilities
- Destruction of emergency supplies
- Loss of beach facilities to coastal erosion
- Roadway and bridge washouts from flooding

Figure 2-4 summarizes respondents' reported primary concerns regarding natural hazards. Specific concerns identified were as follows:

- Uncertainty as to whether facilities are prepared for withstanding natural disasters
- Need to prepare for future conditions in capital improvements and infrastructure management
- Long-range planning to mitigate, minimize, and adapt to hazards
- Recovery and resiliency resources, particularly within the food and medical lifelines.

Figure 2-3. Stakeholder Asset Damage Since 2020

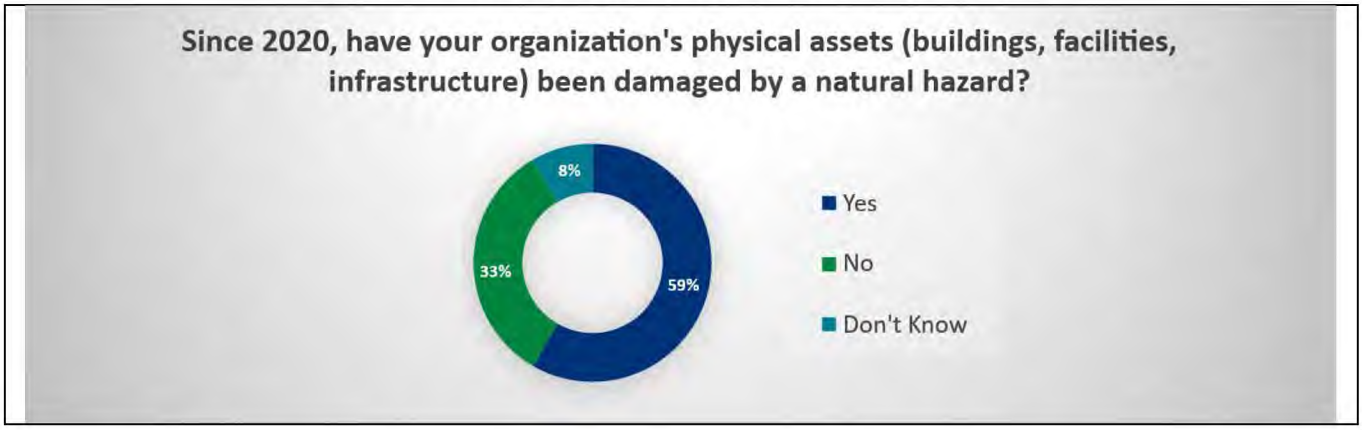
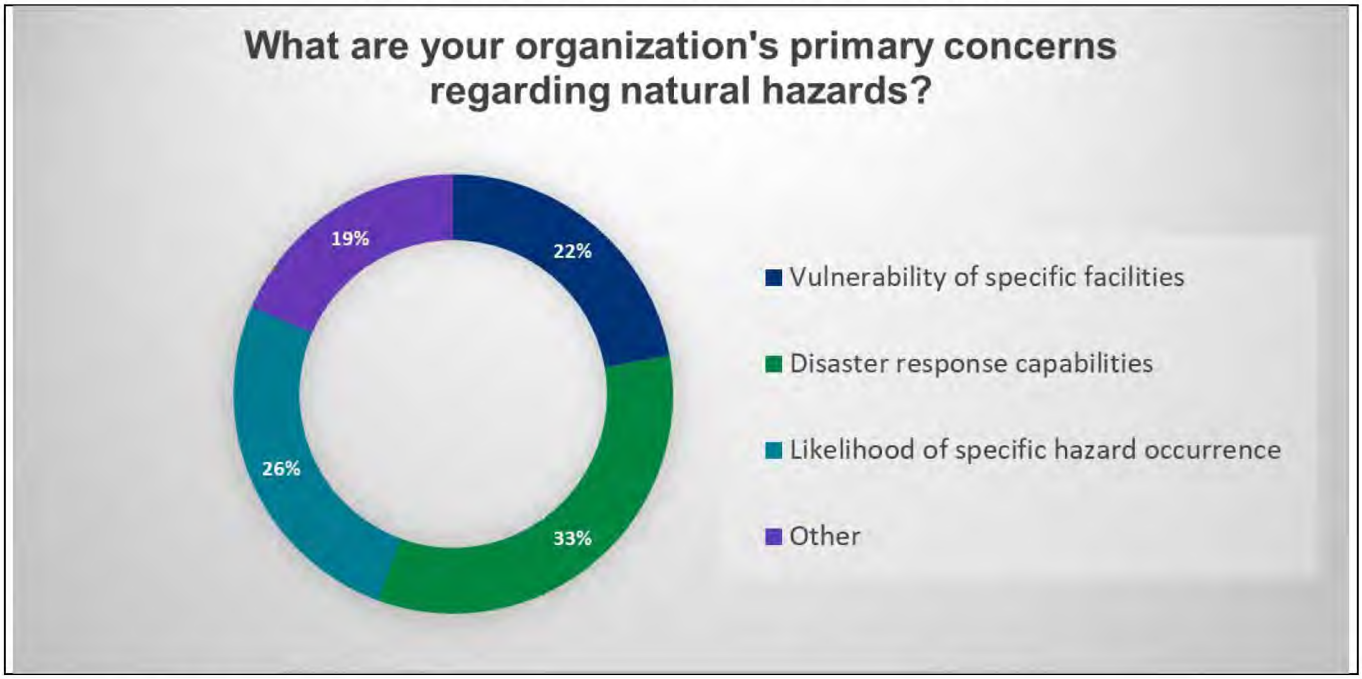


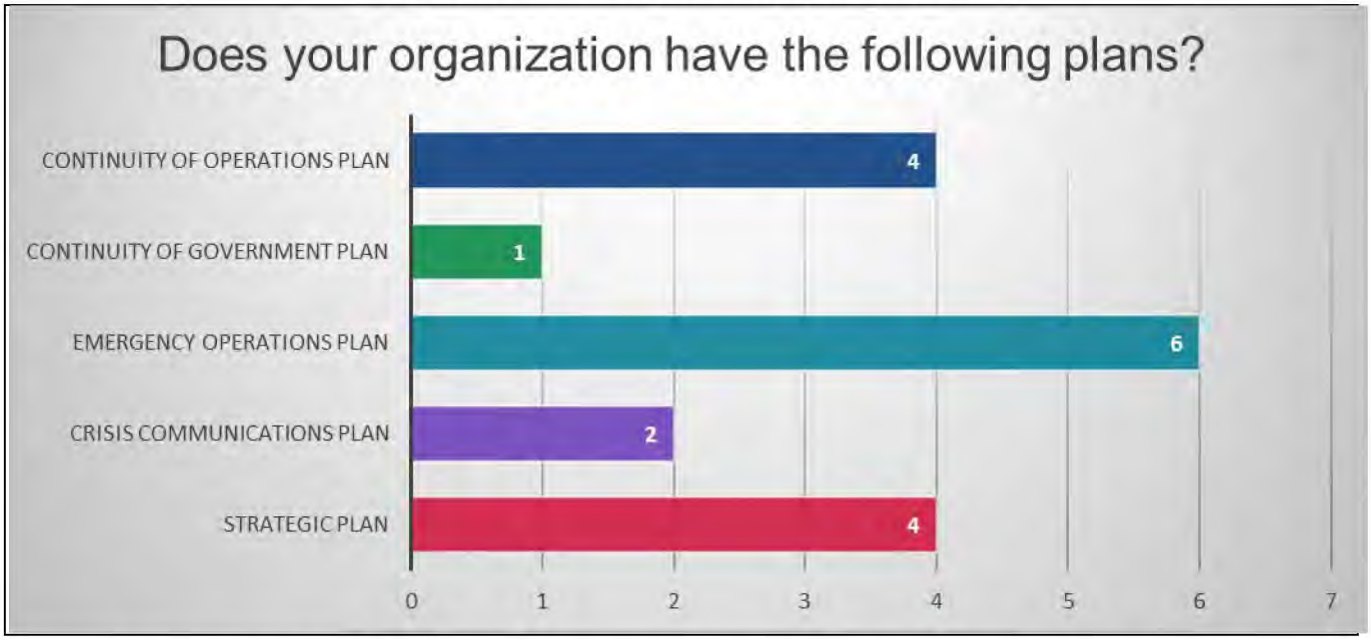
Figure 2-4. Stakeholder Natural Hazard Concerns



Organizational Preparedness

Regarding their organizations' preparedness measures, half of the respondents reported having an emergency operations plan in place. Fewer than half had continuity or communications plans in place. Figure 2-5 displays responses about preparedness planning efforts.

Figure 2-5. Stakeholder Emergency Plans



Respondents provided the following concerns related to challenges to reducing vulnerability to natural hazards:

- Expertise to know what the hazards are and to plan for budgeting and capital projects to address and mitigate the risks
- Lack of a fire break or fire break road
- Resources; being a remote island, logistics are uniquely challenging
- Changing administrative priorities, complexities of the challenges associated with future conditions, limited budgets, and the tendency for reactive responses rather than proactive
- Environmental permitting; community opposition to affordable mitigation
- To strategically place containers with supplies, private, county or state-owned parcels need permission to park containers or trailers and have access
- Financial limitations and private property rights
- Limited funding, not enough skilled workers, difficult permitting regulations, potential for encountering historic or cultural resources including iwi, effective collaboration across different agencies, and some physical limitations based on land availability and existing critical infrastructure that will eventually need to be relocated (such as roads)
- Permitting requirements, timely reviews of external and internal agencies, public perception or opposition to properly engineered solutions
- Critical infrastructure in flood zones; main highways in flood zones and experiencing damage from sea level rise; limited medical and emergency facilities/personnel/services; no certified evacuation shelters on the island

Respondents provided the following suggestions for potential mitigation projects that could reduce community vulnerability:

- Reduce wildfire fuels in former sugar cane land
- Firebreaks around critical facilities
- Dune restoration
- Long-term adaptation planning and implementation for roads and utilities
- Roadway extension
- Drainage improvements
- Shoreline hardening
- Bridge upgrades
- Dam and reservoir projects
- Create safe zones, staging areas, and resiliency facilities in isolated communities, such as Molokaʻi

Business Survey

The Business Survey was distributed to the small business, hospitality, and economic development networks of Maui County. The survey asked questions about natural hazards concerns, disaster preparedness measures, and resources needed to make Maui County's economy more resilient. As of March 13, 2025, four businesses completed the survey, with respondents coming from the real estate, restaurant, and healthcare sectors.

Natural Hazard Impacts on Business Operations

All respondents indicated that floods are a risk to their business operations, followed by coastal erosion, hurricane, tsunami, and wildfire, as displayed in Figure 2-6.

Two of the four respondents indicated that their business has closed at least once over the past five years due to a natural hazard. One respondent indicated that the Lahaina fire took three of their businesses and another reported that they lost 95 percent of their revenue during the first three months of the COVID-19 pandemic in 2020.

Disaster Preparedness Actions

Three businesses indicated that they have business interruption insurance and two businesses each indicated that they have property and flood insurance, as displayed in Figure 2-7. Two businesses indicated that they are not familiar with business continuity planning. Of the other two businesses, one indicated that they have a business continuity plan in place and the other indicated that they do not.

In the event of a disaster, three businesses indicated that they would check social media, the local news, and MEMA for information, as displayed in Figure 2-8

Figure 2-6. Hazard Risk to Business

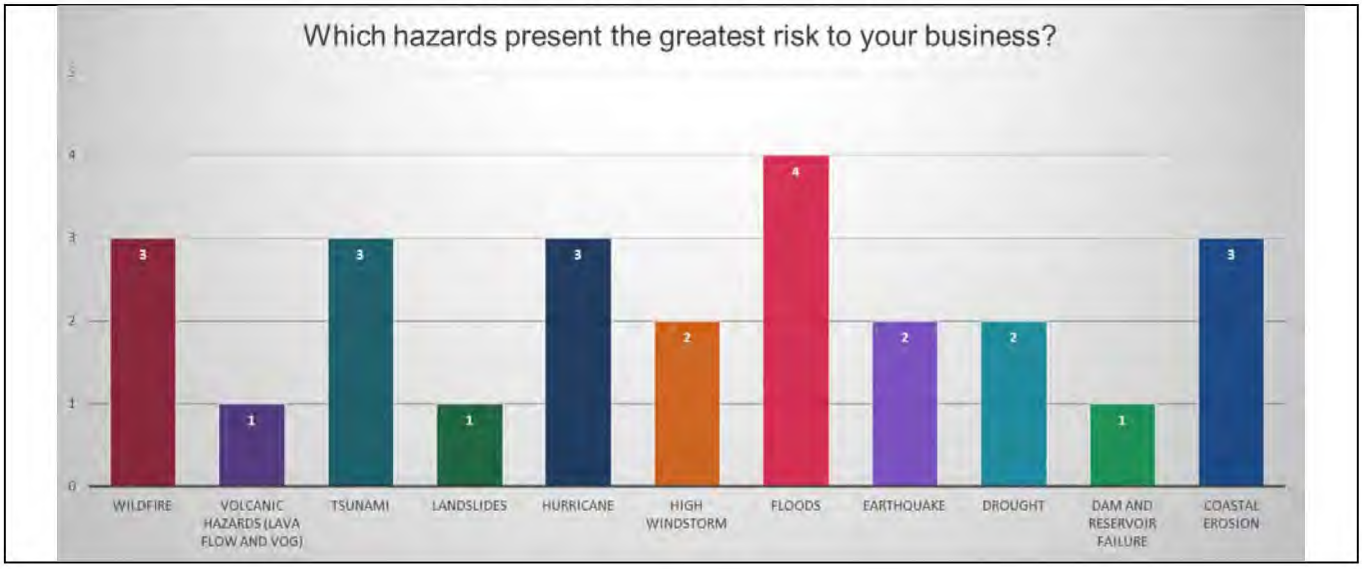


Figure 2-7. Business Insurance Types

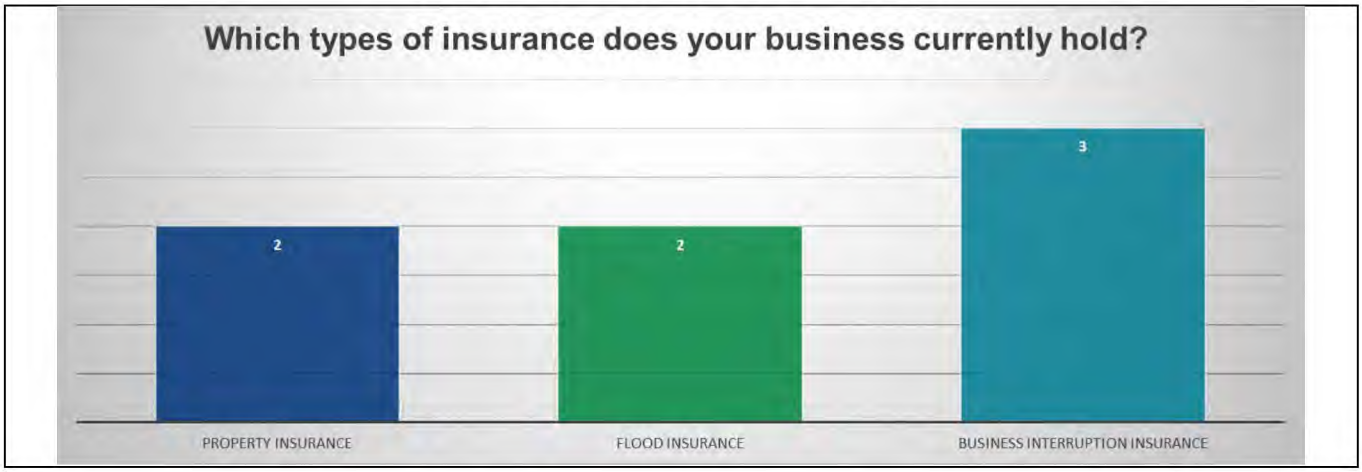
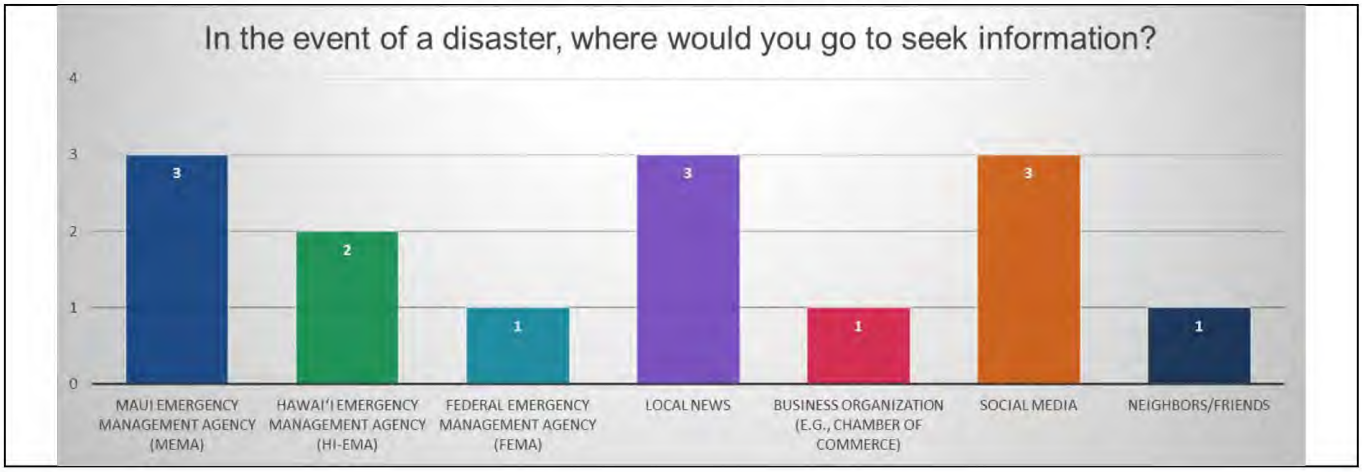


Figure 2-8. Disaster Information Sources



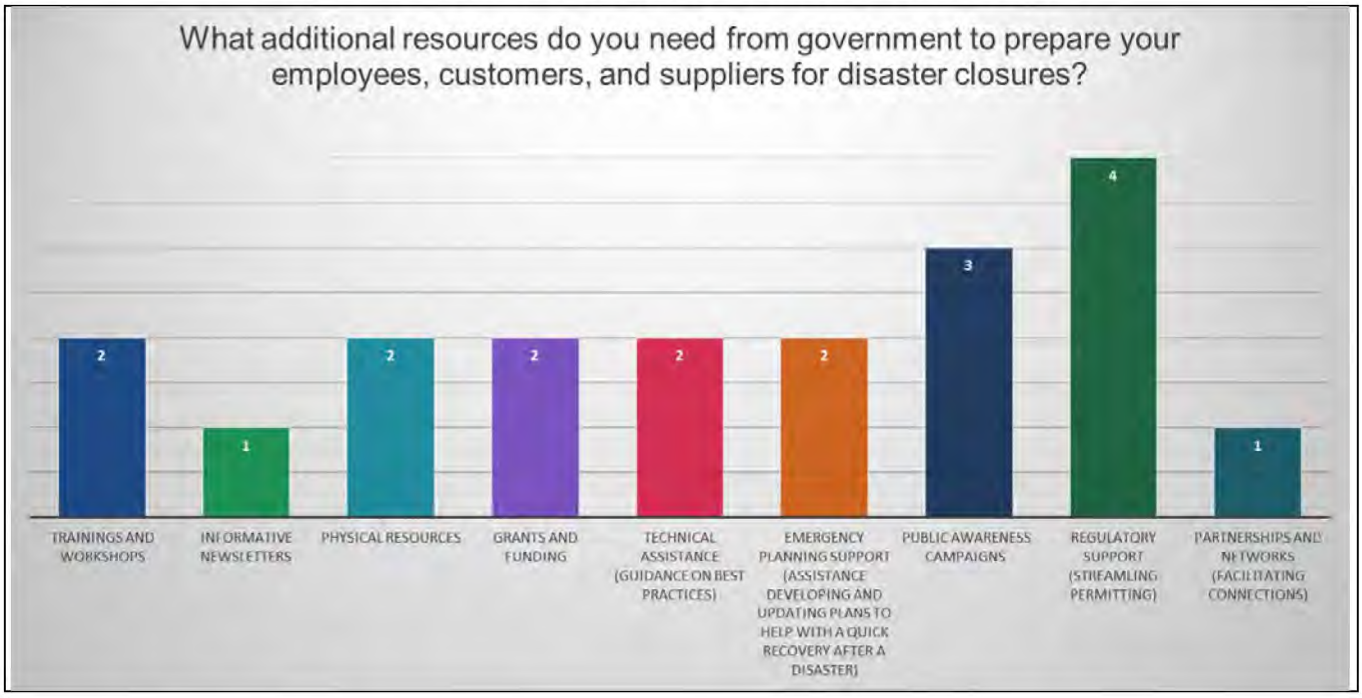
Challenges to Economic Resilience

When asked about potential impacts from natural hazards over the next five years, businesses indicated the following concerns:

- Price shifts
- Consumer behavior changes
- Weather
- Supply chain disruptions
- Inventory challenges

All respondents indicated that government assistance with regulatory support is needed. They also indicated that public awareness campaigns by the government are important. Figure 2-9 displays all government assistance types identified by respondents as needed.

Figure 2-9. Government Support for Business Preparedness



2.4 PUBLIC OUTREACH

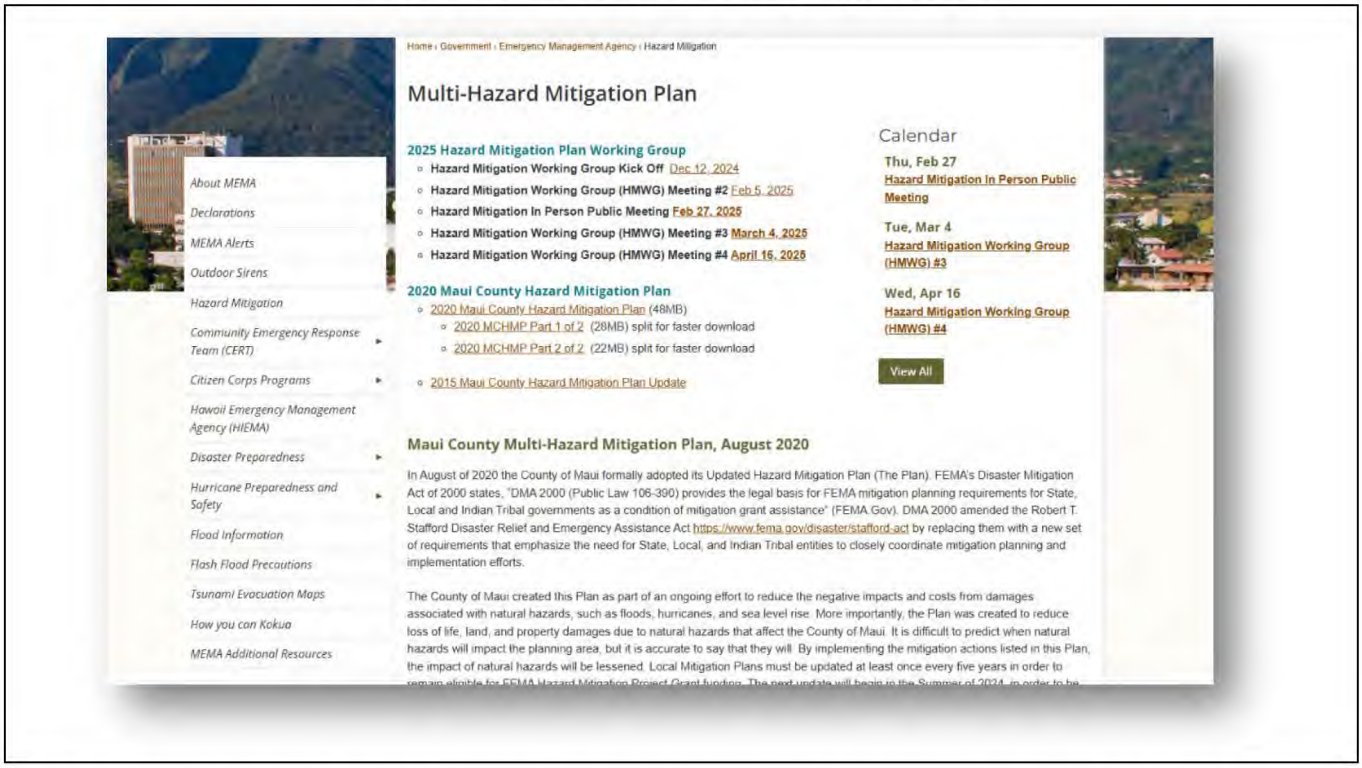
A series of public information activities were conducted throughout the planning process, as summarized below. Copies of all public information activities are available in Appendix C. Two in-person public meetings were held to allow the public an opportunity to learn about the HMP, participate in the planning process, and review the draft plan. Sign-in sheets and meeting materials are available in Appendix F. A public survey was developed to capture public sentiment about natural hazards and gauge personal preparedness. The full survey results are available in Appendix G.

Outreach activities included in-person meetings with both printed and electronic material, surveys, presentations with both electronic and printed material, surveys, and a website, among others.

2.4.1 Public Information Activities

A public website was established to facilitate communication between the HMWG, the public, and stakeholders (https://www.mauicounty.gov/1832/Hazard-Mitigation). The website (see Figure 2-10) contains a project overview, County contact information, access to the public survey and stakeholder surveys, and sections of the HMP for public review and comment.

Figure 2-10. MEMA Hazard Mitigation Website



On December 12, 2024, ahead of the first HMWG meeting on December 17, 2024, the public was informed of the start of the hazard mitigation planning effort through press releases, news articles, and social media posts (see Figure 2-11). The public was invited to attend the virtual meeting or to learn more about the plan at the MEMA hazard mitigation website.

Handout materials (see Figure 2-12) were developed for public spaces, in-person events, and to ensure that people who do not regularly use the internet could learn about the HMP process. MEMA developed a 2025 Hazard Mitigation Plan brochure and a handout. These materials were made available for residents at the following in-person events:

March 12, 2025: MEMA participated in a Community Public Meeting at the Kīhei Community Center where the Mayor, MEMA, Maui Fire Department, and Maui Police Department discussed emergency management updates. MEMA staff provided handouts about hazard mitigation and answered the public's questions about the Hazard Mitigation Plan update.

April 12, 2025: MEMA hosted the 2025 Disaster Preparedness Expo at the Queen Ka'ahumanu Center in Kahului. The free event featured informative speakers, community resources and participation from more than 30 local partner agencies. Held in conjunction with Tsunami Awareness Month, the expo was themed “Always Preparing, Stronger Together: Building a Resilient Maui Nui.” MEMA staff provided information about hazard mitigation and the Hazard Mitigation Plan at the event.

Figure 2-11. MEMA Hazard Mitigation Commencement Announcements

Home › News Flash

Press Releases

Posted on: December 12, 2024

Public invited to join virtual kickoff for Maui County Hazard Mitigation Plan Update working group

Maui Emergency Management Agency to host virtual meetings on risks and impacts, mitigation strategies

The Maui Emergency Management Agency (MEMA) invites residents to join the virtual kickoff meeting for the Maui County Hazard Mitigation Plan Update (HMPU) working group on Tuesday, Dec. 17, from noon to 1 p.m.

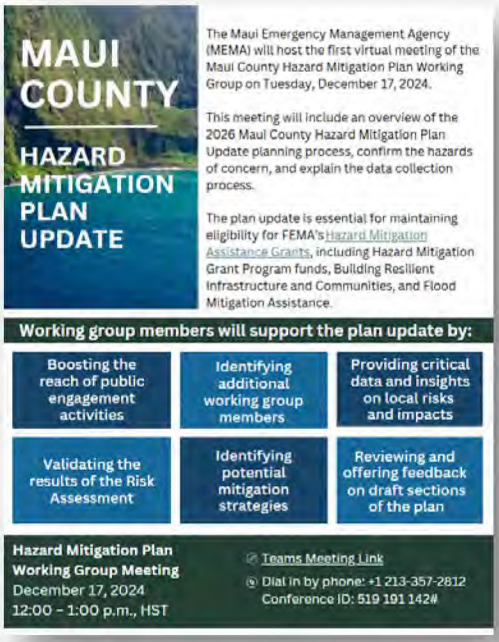
The HMPU update is essential for maintaining eligibility for FEMA's Hazard Mitigation Assistance grants, which providing funding for community needs including hazard mitigation funds, resilient infrastructure, post-fire needs and flood mitigation assistance.

Over the next eight months, HMPU working group members will conduct public engagement outreach, provide critical data and insights on local risks and impacts, recommend mitigation strategies, review and offer feedback on the draft plan, and identify additional stakeholders for plan review.

To join the online meeting at noon on Dec.17, visit https://tinyurl.com/HazardMitigationWGmeeting or join by phone by calling (213) 357-2812, and entering phone conference ID: 519 191 142#.

To learn more about Maui County's Multi-Hazard Mitigation Plan, visit www.mauicounty.gov/1832 or call MEMA at (808) 270-7285.

Click here to join kickoff mtg at noon on 12-17-24



MAUI COUNTY

HAZARD MITIGATION PLAN UPDATE

The Maui Emergency Management Agency (MEMA) will host the first virtual meeting of the Maui County Hazard Mitigation Plan Working Group on Tuesday, December 17, 2024.

This meeting will include an overview of the 2026 Maui County Hazard Mitigation Plan Update planning process, confirm the hazards of concern, and explain the data collection process.

The plan update is essential for maintaining eligibility for FEMA's Hazard Mitigation Assistance Grants, including Hazard Mitigation Grant Program funds, Building Resilient Infrastructure and Communities, and Flood Mitigation Assistance.

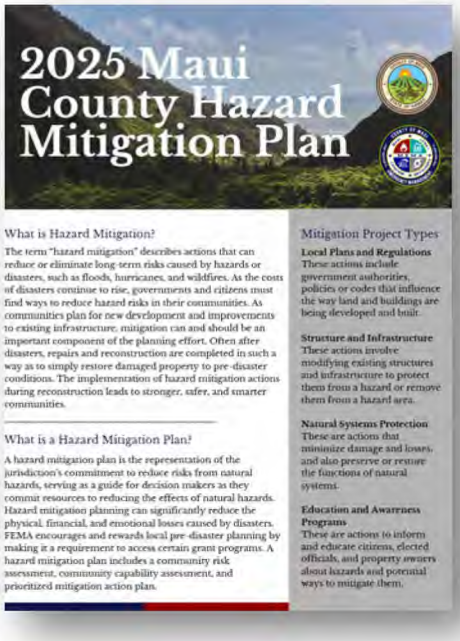
Working group members will support the plan update by:

- Boosting the reach of public engagement activities
- Identifying additional working group members
- Providing critical data and insights on local risks and impacts
- Validating the results of the Risk Assessment
- Identifying potential mitigation strategies
- Reviewing and offering feedback on draft sections of the plan

Hazard Mitigation Plan Working Group Meeting
December 17, 2024
12:00 – 1:00 p.m., HST

Teams Meeting Link
Dial in by phone: +1 213-357-2812
Conference ID: 519 191 142#

Figure 2-12. Hazard Mitigation Handouts



2025 Maui County Hazard Mitigation Plan

What is Hazard Mitigation?

The term "hazard mitigation" describes actions that can reduce or eliminate long-term risks caused by hazards or disasters, such as floods, hurricanes, and wildfires. As the costs of disasters continue to rise, governments and citizens must find ways to reduce hazard risks in their communities. As communities plan for new development and improvements to existing infrastructure, mitigation can and should be an important component of the planning effort. Often after disasters, repairs and reconstruction are completed in such a way as to simply restore damaged property to pre-disaster conditions. The implementation of hazard mitigation actions during reconstruction leads to stronger, safer, and smarter communities.

What is a Hazard Mitigation Plan?

A hazard mitigation plan is the representation of the jurisdiction's commitment to reduce risks from natural hazards, serving as a guide for decision makers as they commit resources to reducing the effects of natural hazards. Hazard mitigation planning can significantly reduce the physical, financial, and emotional losses caused by disasters. FEMA encourages and rewards local pre-disaster planning by making it a requirement to access certain grant programs. A hazard mitigation plan includes a community risk assessment, community capability assessment, and prioritized mitigation action plan.

Mitigation Project Types

Local Plans and Regulations
These actions include government authorities, policies or codes that influence the way land and buildings are being developed and built.

Structure and Infrastructure
These actions involve modifying existing structures and infrastructure to protect them from a hazard or remove them from a hazard area.

Natural Systems Protection
These are actions that minimize damage and losses, and also preserve or restore the functions of natural systems.

Education and Awareness Programs
These are actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them.

2025 MAUI COUNTY HAZARD MITIGATION PLAN

MEMA VISION STATEMENT:

MEMA envisions a resilient and unified Maui Nui, where all sectors of our community work together seamlessly to anticipate, prepare for, respond to, and recover from disasters.

MEMA MISSION STATEMENT:

MEMA's mission is to ensure the safety and resilience of Maui Nui through collaboration, planning, and coordinated responses.

MEMA INFO:

- MEMA Website
- Sign up for MEMA Alerts
- Siren information
- CoMaui_MEMA
- MauiEMA
- Maui_EMA

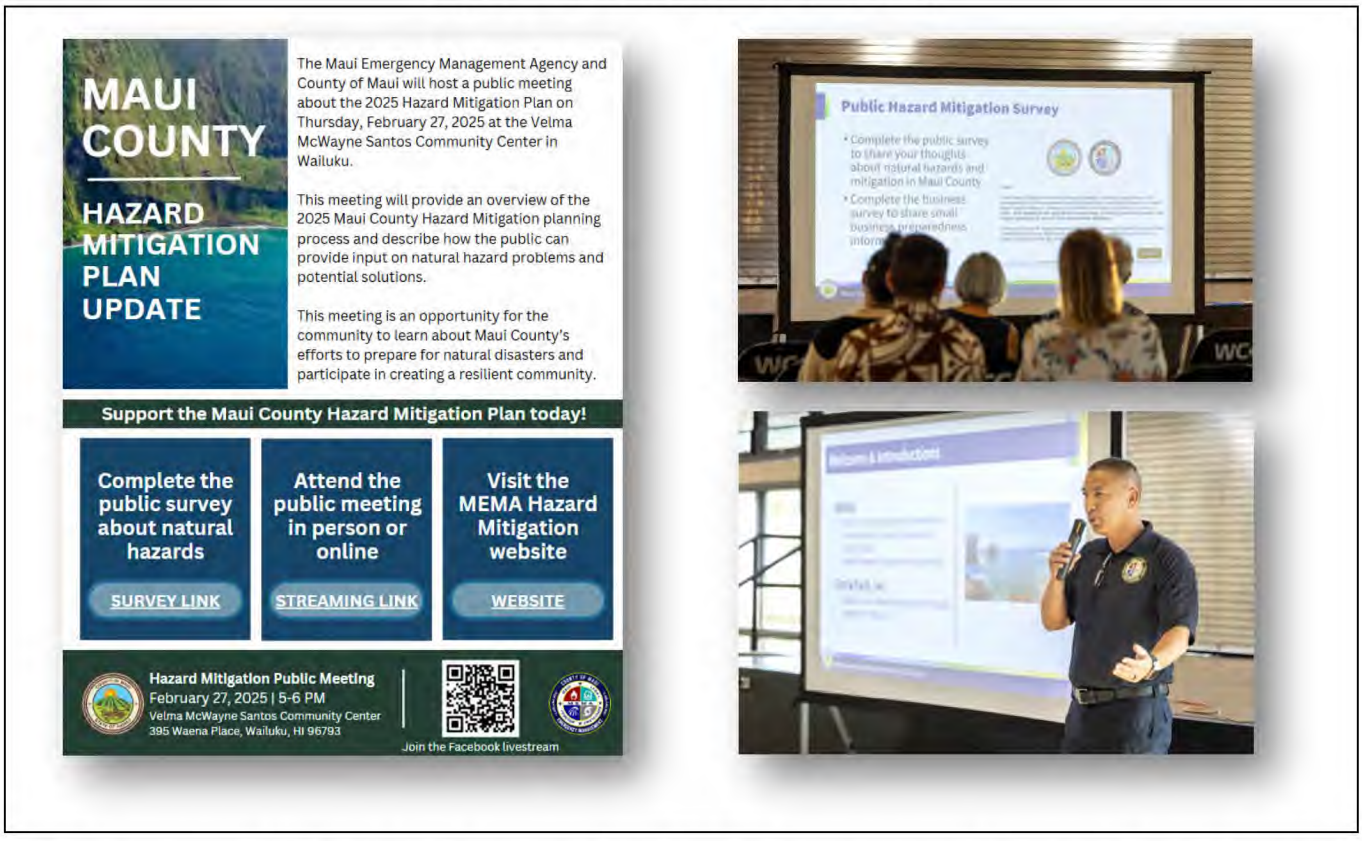
The Draft Plan was posted to the public website on April 23, 2025, for public review and comment. All public comments were directed to MEMA for collection and review by the HMWG.

A printed version of the Final Plan will be maintained at the MEMA office in the Kalana O Maui County Building.

2.4.2 Public Meetings

On February 27, 2025, MEMA and the County of Maui hosted an in-person public meeting at the Velma McWayne Santos Community Center in Wailuku. The purpose of the meeting was to provide an overview of the 2025 Maui County Hazard Mitigation planning process and describe how the public can provide input on natural hazard problems and potential solutions (see Figure 2-13). The meeting presented an opportunity for the community to learn about Maui County's efforts to prepare for natural disasters and participate in creating a resilient community. The meeting was announced via press release and advertised on social media; the event was also live-streamed on the County's Facebook page and a recording was posted for anyone unable to attend in person.

Figure 2-13. February Public Meeting



MEMA hosted two additional public meetings when the draft plan became available for public comment in April. The first occurred on April 23, 2025, at the Kihei Community Center and the second occurred on April 24, 2025 at the Mayor Hannibal Tavares Community Center in Pukalani. The purpose of both meetings was to provide the public with an overview of the sections of the draft plan, the results of the

risk assessment, and the planning process participants. The meetings presented an opportunity for the community to learn about the County's five-year plan to reduce risk and to ask questions about the mitigation strategy. Both meetings were announced vis press release and advertised on social media, with stakeholder networks, and through media outlets. The meetings were also live-streamed on the MEMA Facebook page and the recordings were posted there as well.

Figure 2-14. April Public Meetings

2.4.3 Public Survey Summary

To support the development of the HMP, Anthology Research, on behalf of Tetra Tech, conducted a comprehensive community survey to gather input directly from residents. This research explores personal experiences with and concerns about natural hazards, levels of household preparedness, and attitudes toward various mitigation actions. See Appendix G for the full public survey report.

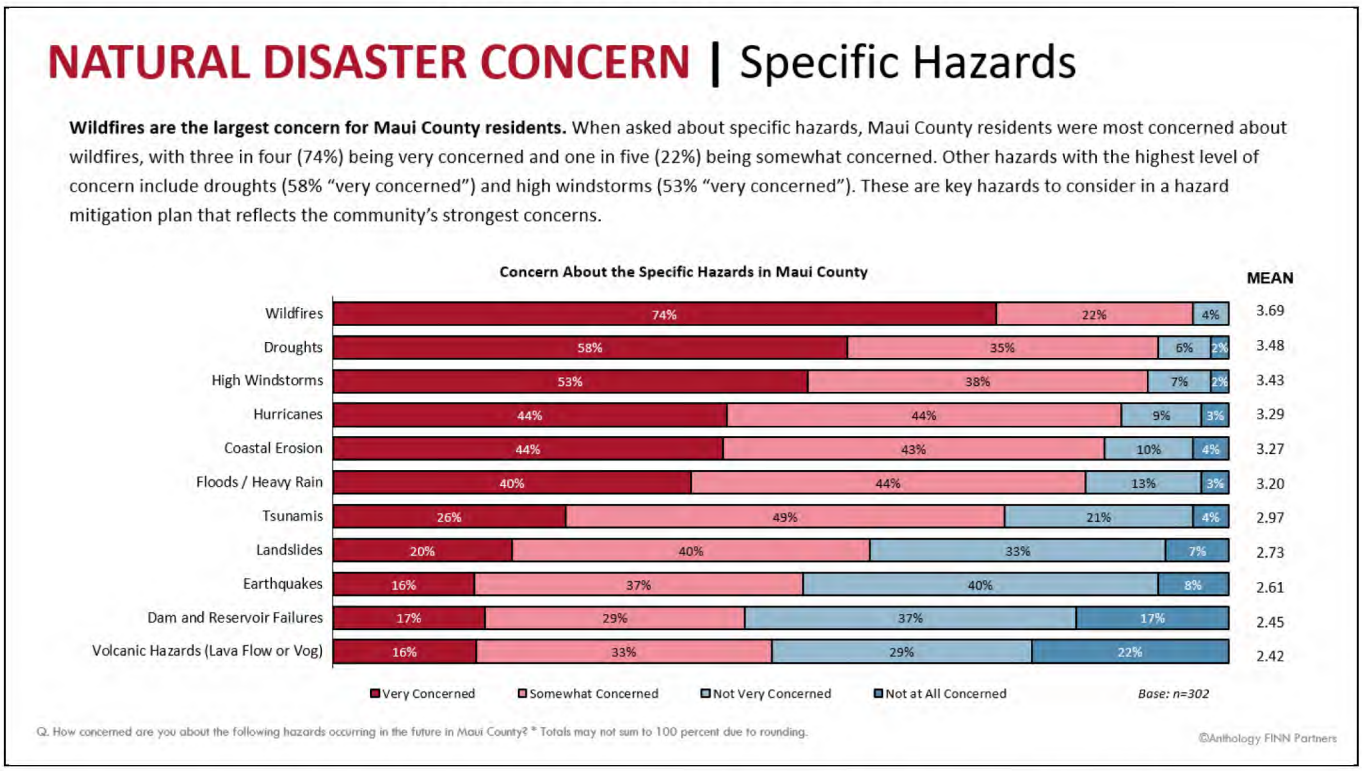
The survey serves as a foundational tool for understanding how natural disasters impact different areas and populations across Maui, Molokaʻi, and Lānaʻi. By incorporating feedback on risk perception, damage history, community vulnerabilities, and preferred information sources, the findings will help

shape data-driven, community-informed planning decisions that strengthen the county's resilience through an updated hazard mitigation plan.

Data collection for this study took place from February 12 to March 10, 2025, through a dual-sample approach. The survey was distributed via a random sample drawn from publicly available lists and Anthology FINN Partners' proprietary panel of Hawai'i residents who have previously agreed to participate in research, as well as through an open-link survey promoted to the broader community. This approach was designed to balance statistical rigor with broad public engagement. A total of 213 responses were collected from the random sample and an additional 89 responses from the open-link, yielding a combined sample of 302 Maui County residents. The findings from both data sources are merged in this report, so it is important to note that a traditional margin of error is not reported due to the inclusion of the open-link sample, which does not meet the same standards of statistical precision as a purely random sample.

Residents of Maui County are strongly concerned about the risk of natural disasters. Overall, about two-thirds (68 percent) of Maui County residents are very concerned about the risk of natural disasters, with an additional third (33 percent) being somewhat concerned. Meanwhile, only four percent are not very concerned, and one percent are not at all concerned. This distribution of responses suggests that there is strong concern among community members about future natural disasters in Maui County, see Figure 2-14 for all responses.

Figure 2-15. Natural Disaster Concern

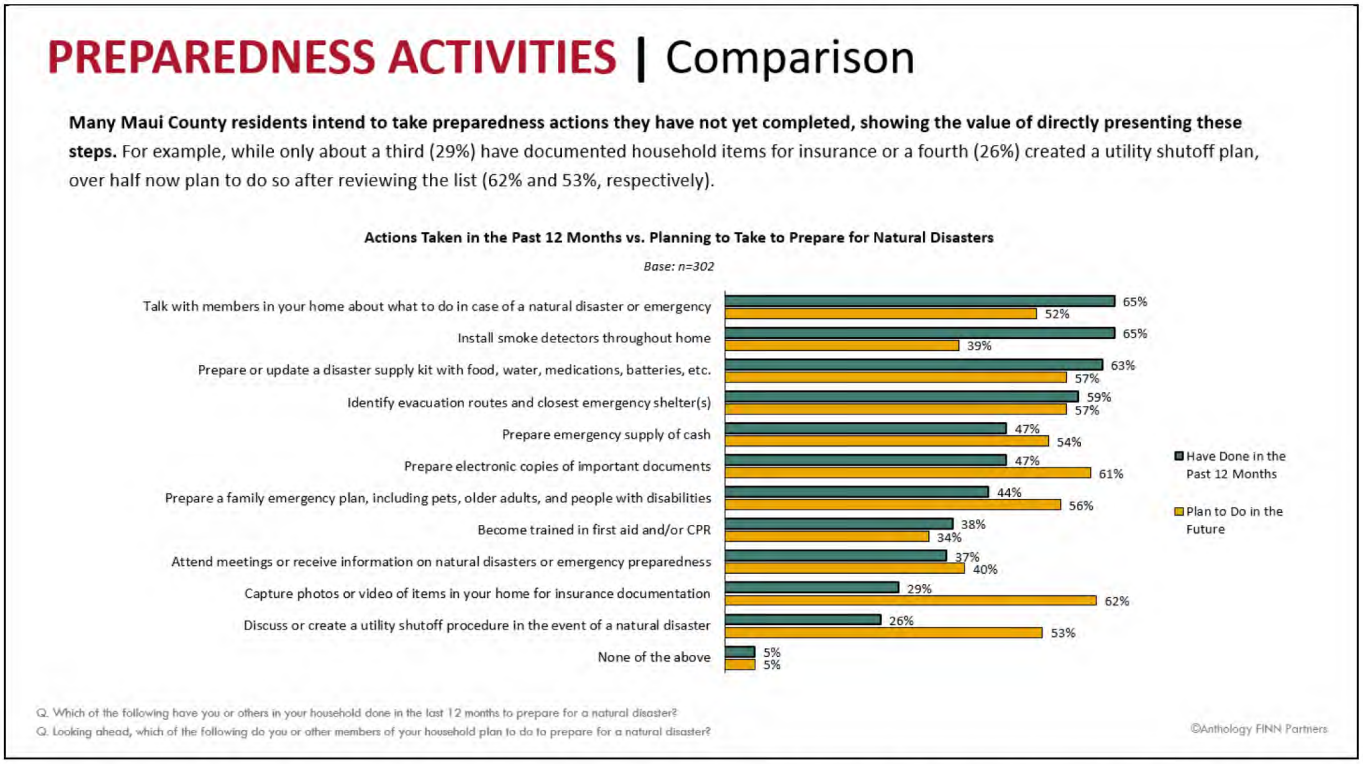


Many residents have taken basic disaster preparedness steps in the past year. Overall, about two-thirds of Maui County residents have talked with family members about what to do in case of a natural

disaster (65 percent), installed smoke detectors (65 percent), and prepared or updated a disaster supply kit (63 percent) in the past 12 months, indicating that many residents have recently taken basic natural disaster precautions. However, fewer residents have engaged with more thorough planning activities such as discussing utility shutoff procedures (26 percent), capturing photos/video of items for insurance documentation (29 percent), and attending meetings/receiving information on natural disasters/emergency preparedness (27 percent), highlighting an opportunity help residents be more prepared for future events.

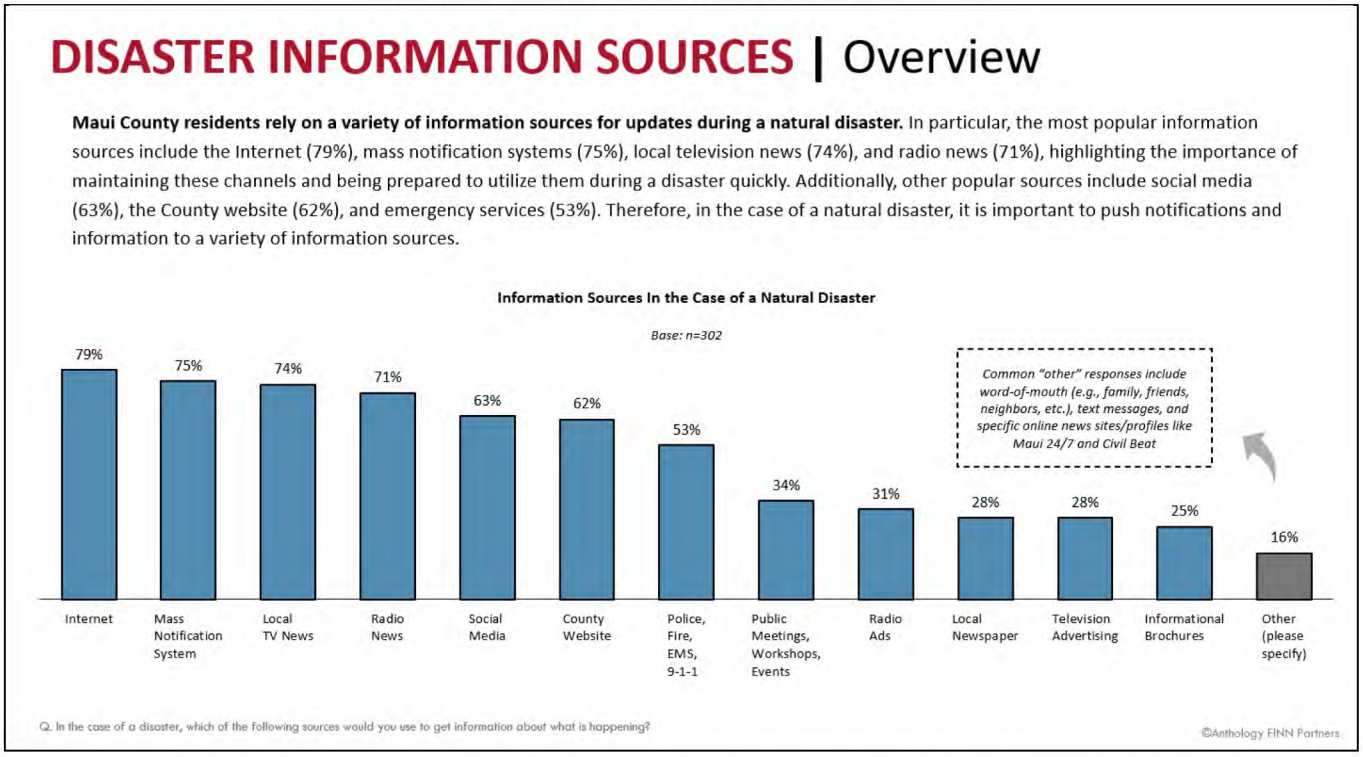
Many residents plan to bolster their preparedness plans in the future. Overall, over half of residents share that they or other members of their households are planning to engage in eight of the 11 preparedness activities tested, with capturing photos of items for insurance documentation (62 percent) and preparing electronic copies of important documents (61 percent) being mentioned the most. Additional top actions that residents plan to take include identifying evacuation routes (57 percent), preparing/updating disaster supply kits (57 percent), and preparing a family emergency plan (56 percent). While there is high intention for many of the activities tested, there is still a sizeable proportion of residents who did not select some activities and should be encouraged to prepare for future natural disasters. Figure 2-15 displays the full results of potential preparedness activities.

Figure 2-16. Preparedness Activities



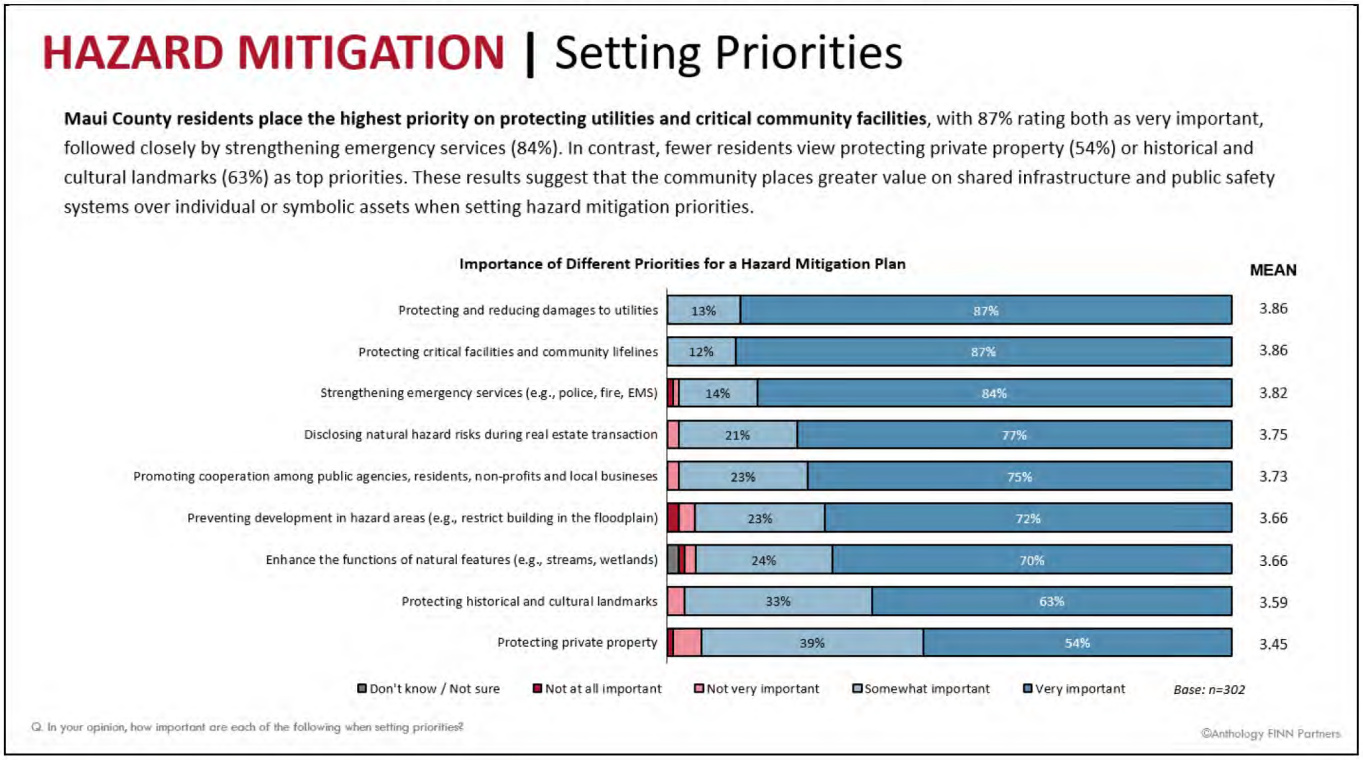
Residents were asked where they obtain information during a natural disaster event to gauge the importance of various outreach efforts. The MEMA Alerts mass notification system was the second most popular answer, indicating that 75 percent of respondents use the system. Figure 2-16 displays the full results.

Figure 2-17. Disaster Information Sources



Residents were asked about their priorities for hazard mitigation projects and responses indicated a strong preference for protecting community lifeline facilities and utilities, as well as strengthening emergency services. Figure 2-17 displays the full results of the question about hazard mitigation priorities.

Figure 2-18. Hazard Mitigation Priorities



2.4.4 Public Comment Period

On April 22, Maui County announced that the public was invited to review the draft plan posted on the MEMA website and that public comments would be accepted from April 23 through May 8, 2025. The County received 21 public comments. MEMA reviewed the comments and made updates to the draft HMP, as appropriate. Common themes expressed in the comments included the importance of:

- Evacuation routes for isolated communities
- Protection for electrical utilities
- Weather monitoring stations and cameras
- Hazard awareness education and warnings for visitors
- Public health integration into preparedness, response, recovery, and mitigation planning

2.5 INCORPORATION OF EXISTING PLANS, STUDIES, REPORTS AND TECHNICAL INFORMATION

The Maui County HMP incorporates available information as appropriate to support hazard profiling, risk assessment, review and evaluation of mitigation capabilities, and the development and prioritization of the updated mitigation strategy. Detailed sources of information used throughout this HMP are listed in the References section.

Plans, reports, and other technical information were identified and accessed through independent research by the planning consultant or provided directly by the County and stakeholders. Relevant County planning and regulatory documents were reviewed to identify the following:

- Existing capabilities
- Needs and opportunities to develop or enhance capabilities, which may be identified as recommended actions in the updated mitigation strategy
- Mitigation-related goals
- In-progress or potential new mitigation actions to be included in the updated mitigation strategy

Local, state, and federal regulations, codes, ordinances, and plans were reviewed to develop mitigation planning goals and mitigation actions that are consistent with existing County planning and regulatory mechanisms. These are all described in the capabilities assessment in Chapter 18. That assessment reviews relevant plans contributing to the capability of the County to integrate effective mitigation efforts into its daily activities. It lists plan types, names, and dates, as well as a summary of how each plan supports mitigation and resilience.

2.6 INTEGRATION WITH EXISTING PLANNING MECHANISMS AND PROGRAMS

Effective mitigation is achieved when hazard awareness and risk management approaches and strategies become an integral part of public activities and decision-making. Many existing plans and programs support hazard mitigation in the County. It is critical that this HMP integrate, coordinate with, and complement, those existing plans and programs.

The capability assessment presented in Chapter 18 provides a summary and description of the existing plans, programs, and regulatory mechanisms at all levels of government (federal, state, and county) that support hazard mitigation in the County. The capability assessment identifies how the County has already integrated hazard mitigation into its planning, regulatory, and administrative framework (“integration capabilities”) and how it intends to promote this integration (“integration actions”).

2.7 PLAN ADOPTION

Adoption by the County's governing body demonstrates the commitment of the County to fulfill the mitigation goals and strategies outlined in this HMP. Adoption via a County resolution legitimizes the HMP and authorizes responsible agencies to execute their responsibilities.

In addition to being required by DMA 2000, adoption of the HMP is necessary because:

- It establishes authority for the plan to serve as a guiding document for all local and state government officials.
- It gives legal status to the plan in the event it is challenged in court.
- It certifies to program and grant administrators that the plan's recommendations have been properly considered and approved by the jurisdictions' governing authority and citizens.
- It helps to ensure the continuity of mitigation programs and policies over time because elected officials, staff, and other community decision-makers can refer to the official document when making decisions about the community's future.

Source: FEMA. 2003. How to Series: Bringing the Plan to Life (FEMA 386-4).

The County will proceed with formal adoption proceedings and will forward the executed resolutions to HI-EMA, after which they will be forwarded to FEMA for the record. FEMA allows two options for submitting adoption resolutions:

- **Submittal of adoption resolutions with plan**—The County provides documentation of plan adoption when the plan is initially submitted to the state for review. After receiving the draft plan from the state, FEMA conducts its review and will approve the plan if it meets all requirements.
- **Approvable pending adoption**—A draft HMP is submitted to the state and FEMA for approval prior to adoption by the County. When FEMA determines that the plan meets all the requirements except adoption, FEMA will inform the state that the plan is "approvable pending adoption" (APA). A community with a plan in APA status does not meet the requirement for an approved mitigation plan to apply for and receive funding assistance. Once FEMA receives documentation of adoption resolution from the County, the status is changed from APA to approved.

The Maui County HMP Coordinator at MEMA will maintain a copy of the formal adoption resolution. FEMA will transmit acknowledgment of verification of formal plan adoption and the official approval of the plan to the Maui County HMP Coordinator. The date indicated on FEMA's approval letter is the official approval date. This date begins the five-year approval period and sets the expiration date for the plan. The County's adoption resolution for this HMP is included in Appendix A.

2.8 CONTINUED PUBLIC INVOLVEMENT

The County is committed to the continued involvement of the public in the hazard mitigation process. This Plan update will be posted online (https://www.mauicounty.gov/1832/Hazard-Mitigation), and the County will make hard copies of the Plan available for review at public locations.

After completion of this plan, implementation and ongoing maintenance will continue. The County will review the plan and accept public comment as part of an annual review and as part of the five-year

mitigation plan update. Additional meetings may be held as deemed necessary to provide the public an opportunity to express concerns, opinions, and ideas about the plan.

MEMA will be responsible for receiving, tracking, and filing public comments regarding this plan. The HMP Coordinator is responsible for coordinating the plan evaluation, soliciting feedback, collecting and reviewing comments, and ensuring their incorporation as appropriate into the 5-year plan update.

A notice regarding annual updates of the plan and the location of plan copies will be publicized after each HMP annual evaluation and posted on the public website.

Mr. Christopher Wegner of MEMA, identified as the ongoing County HMP Coordinator, may be contacted as follows:

Mailing Address:	Maui Emergency Management Agency 200 S High Street Kalana O Maui Building, First Floor Wailuku, HI 96793
Contact Name:	Mr. Christopher Wegner
Email Address:	MEMA.MITIGATION@mauicounty.gov
Telephone:	(808) 270-7285

Further details regarding continued public involvement are provided in Chapter 20.

3. COUNTY PROFILE

This chapter presents general information about the land, people, and assets of Maui County. This information provides a baseline for understanding the economic, structural, and population assets at risk from the hazards addressed in this HMP.

3.1 LOCATION

The Hawaiian Archipelago is situated in the middle of the Pacific Ocean, approximately 2,400 miles southwest of the continental United States. The island chain consists of 132 volcanic islands, atolls, reefs, and shoals. Among these, at the southeastern end of the chain, are the eight main Hawaiian Islands that make up the State of Hawai‘i (Kaua‘i, Ni‘ihau, Oahu, Maui, Moloka‘i, Lāna‘i, Kaho‘olawe, and Hawai‘i). The archipelago beyond those eight islands is known as the Northwestern Hawaiian Islands and forms part of the Papahānaumokuākea Marine National Monument created by Presidential Proclamation 8031 on June 15, 2006. The County of Maui comprises four of the main islands, as shown in Figure 3-1:

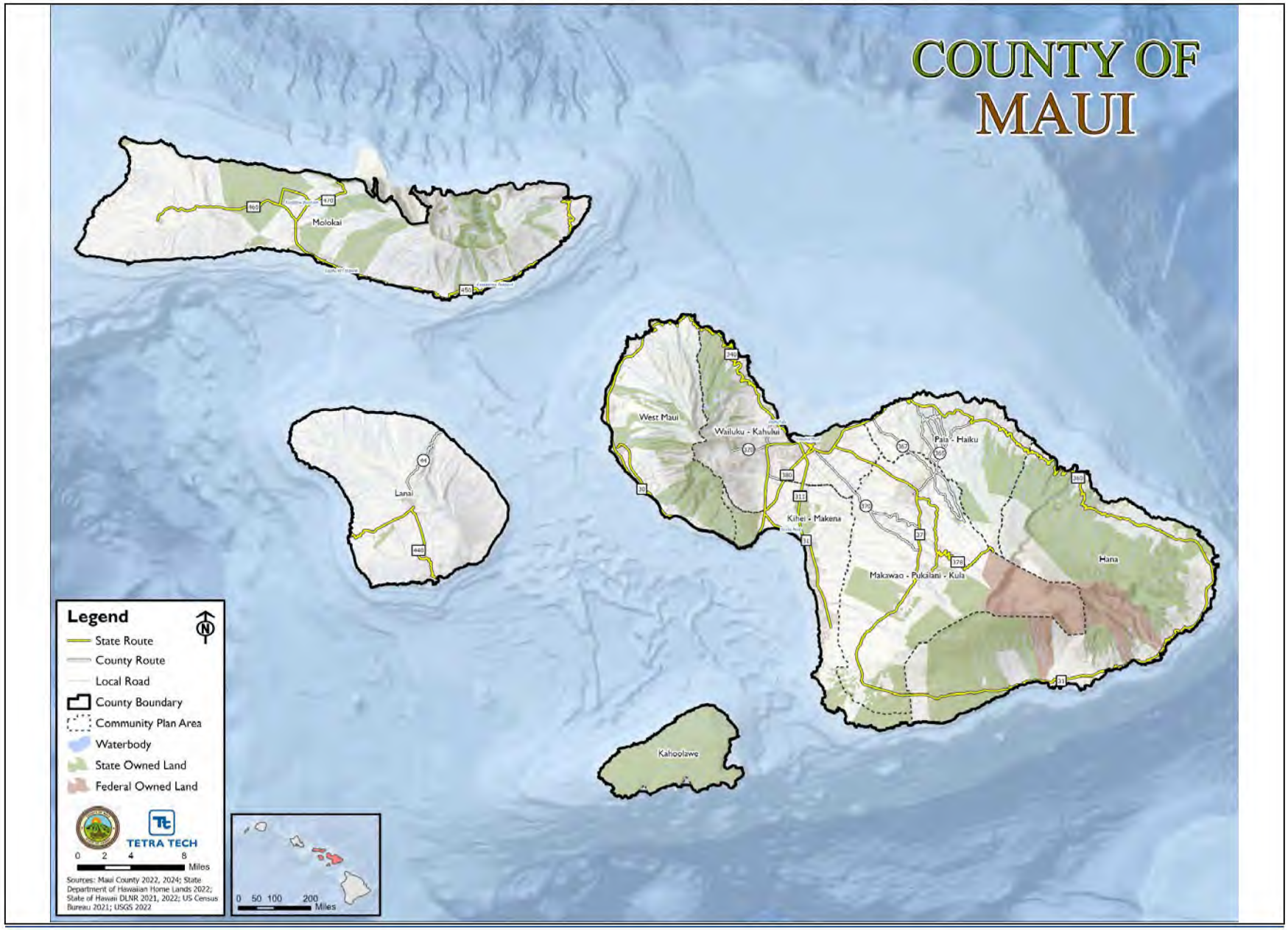
- Maui is the second largest island in the state and the third most populated island. The island was formed by two shield volcanos that are connected by a narrow isthmus.
- Moloka‘i is the fifth largest island and the fifth most populated island. The island is long and narrow, with mountains on the east side of the island and an arid plateau covering the west side. It is 38 miles long and 10 miles wide and has approximately 100 miles of shoreline. The Kalaupāpā peninsula on Moloka‘i constitutes the County of Kalawao and is not part of the County of Maui.
- Lāna‘i is the smallest of the populated main Hawaiian Islands that is not privately owned (privately owned Ni‘ihau is smaller in size and has fewer people).
- The Island of Kaho‘olawe is the smallest of the main Hawaiian Islands by size and does not have any permanent inhabitants.

There are no incorporated municipalities in the County. The seat of government for the county is on Maui in the community of Wailuku.

3.2 PLANNING AREA

The Maui County boundaries define the planning area for the 2025 HMP update. The Island of Kaho‘olawe, though a part of Maui County, is only peripherally included in the planning process due to its status as a nature reserve with no permanent residents.

Figure 3-1. Maui County Hazard Mitigation Plan Area



3.3 HISTORY

The islands of Hawai'i were first settled sometime between 400 and 1266 (Wilmshurst, et al. 2010). Polynesians arrived in the islands on canoes, bringing a variety of plants and animals with them, including pigs, chickens, coconut, bamboo, and taro (HDOA 2013). The pre-colonial Hawaiian population is estimated to have been between 200,000 and 1,000,000 (Dye 1994). Following contact with Europeans and the introduction of infectious diseases, the Native Hawaiian population plummeted to a low of 29,799 by 1900 (Swanson 2019).

The first European to arrive at the islands was British explorer Capt. James Cook, who arrived in Hawai'i in 1778. Beginning in 1795, King Kamehameha I from the Island of Hawai'i began a campaign to unite the inhabited Hawaiian Islands under one king and he succeeded in 1810. In 1820, the United States established a foreign consulate at the Port of Honolulu, and in 1826, the United States signed a treaty with the Kingdom of Hawai'i (DOS n.d.).

In 1848, Kamehameha III proclaimed the Great Māhele, or land division, establishing private ownership of lands in Hawai'i. Sugar planting and refining throughout Hawai'i were established between 1836 and 1861 (County of Maui 2012). In 1876, the Hawaiian Reciprocity Treaty with the United States allowed for duty-free admission of Hawaiian sugar to the U.S., resulting in a substantial increase in profits for island growers. With the massive growth of the sugar industry, the need for labor grew, resulting in the importation of workers from other countries.

Agricultural trade flourished in the 19th century with the introduction of cattle, coffee, pineapple, and sugarcane to Hawai'i (HDOA 2013). In 1840, a public education system was instituted by King Kamehameha III and is the oldest educational system in the United States west of the Mississippi (HIDOE n.d.). In 1893, Queen Liliuokalani was deposed by a group of businessmen and politicians who wanted to avoid a tax on sugar imports. In 1898, the Hawaiian Islands were officially annexed as a territory of the United States following the outbreak of the Spanish-American War (National Archives 2024). In 1959, Hawai'i became the 50th state of the United States.

3.3.1 Island of Maui

In the 18th and 19th centuries, most of the population on the Island of Maui lived in the towns of Hāna, Makawao, Wailuku, and Lahaina. These areas are more temperate than the rest of the island, which is dry and arid. In 1853, there were at least 300 small villages on the Island of Maui (County of Maui 2010).

Having no resistance to Western diseases, the native population dropped dramatically following the arrival of Europeans. An influx of foreign laborers came to the island to meet the needs of agricultural producers. In 1867, there were 5,080 acres on Maui dedicated to sugar cane; by 1880, the number of acres had more than doubled to 12,000 (County of Maui 2012). Pineapple was first planted as a crop on Maui in 1890 and by 1930, more than 28 percent of Maui's cultivated lands were dedicated to pineapple. Today, almost no sugar cane or pineapple is commercially grown on Maui. However, the old plantations include vast tracts of land and irrigation systems that re-route natural watersheds.

With a decline of the sugar and pineapple industries after World War II and bourgeoning economies on Oahu and the U.S. mainland, Maui lost 24 percent of its population between 1940 and 1960 (County of Maui 2012). In 1959, the Report of Land Use for the Island of Maui proposed that, to reverse the trend, Maui could work to capture a greater share of Hawai'i's tourist industry. In 1961 Kā'anapali became the first master-planned resort area in Hawai'i. The development of resort destinations and planned communities resulted in population gains every decade after 1970, as seen in Table 3-1.

Table 3-1. Maui Population, 1970 to 2020

Year	Population
1970	38,691
1980	62,823
1990	91,361
2000	117,644
2010	144,444
2020	154,100

Source: (DBEDT 2024)

As Maui's population grew, settlement patterns expanded rapidly, spreading out from the existing population centers of Hāna, Makawao, Wailuku, and Lahaina. Planned communities, such as Kīhei and Kahului, grew significantly with new subdivisions and visitor accommodations, as well as modern building technology that allowed homes to be built in the dry, arid landscape that makes up most of the island. Maui's rapidly expanding population eventually spread to the higher elevations and cooler temperatures of the Makawao-Pukalani-Kula area of the island, which experienced significant growth in the residential market.

3.3.2 Island of Moloka'i

The first significant European influence on Moloka'i came in 1832 when a Protestant mission was established at Kalua'aha on the east side of the island (NPS 1985). The first farmer to grow, produce, and mill sugar and coffee commercially on Moloka'i was Rudolph Wilhelm Meyer, who arrived from Germany in 1850. He built the first and only sugar mill on the island in 1878, which is now a museum (NPS 1985).

Kalaupāpā, a small, unincorporated community on the north shore of the island, was established as a leper colony in 1866 for patients seriously affected by Hansen's disease (NPS 2022). When the isolation law was repealed in 1969, residents chose to remain living there. With a current population of 82 people as of the 2020 Census, Kalaupāpā is the only settlement within Kalawao County and is now part of the Kalaupāpā National Historical Park.

Beginning in 1897 much of the western end of the island was purchased by Moloka'i Ranch to operate a cattle ranch. In 1910, the population of the island reached the lowest point in recorded history at around 1,000 people (County of Maui 2018).

The first Hawaiian homestead settlement, in Kalama'ula, initially named Kalaniana'ole Settlement, was created on Moloka'i as an agricultural homesteading demonstration project shortly after the passage of the Hawaiian Homes Commission Act in 1921. In 1923, Libby, McNeil, and Libby opened a pineapple plantation in Maunaloa and the population rose to around 4,500 people by 1930. From 1923 to 1985 thousands of acres of land were leased to pineapple producers.

In 2008, community members opposed attempts by Molokaʻi Ranch to expand operations, and what was then the island's largest employer shut down all operations including hotels, a movie theater, restaurants, and a golf course, dismissing 120 workers.

The island's population peaked in the 2000 census and has fallen slightly in the two decades since, as displayed in Table 3-2.

Table 3-2. Molokaʻi Population, 1970 to 2020

Year	Population
1970	5,261
1980	6,049
1990	6,717
2000	7,404
2010	7,345
2020	7,369

Source: (DBEDT 2024)

3.3.3 Island of Lānaʻi

In 1922, James Dole, president of the Hawaiian Pineapple Company, purchased the entire Island of Lānaʻi, and much of the land was used for pineapple plantations. When the pineapple industry started to plateau in the 1980s, the company, by that time called Dole Food Company, was reformed into a new company named Castle & Cooke. When David H. Murdock bought Castle & Cooke, he gained control over Lānaʻi Island and began developing it as a tourist destination.

When the pineapple plantations ended in the early 1990s, Lānaʻi's economy shifted to luxury tourism and resort home construction. This shift, combined with the economic recession of 2007-2008, resulted in fewer employment opportunities and the outmigration of residents seeking employment elsewhere. According to the 2020 census, 3,367 people are living on the island, as shown in Table 3-3.

Table 3-3. Lānaʻi Population, 1970 to 2020

Year	Population
1970	2,204
1980	2,119
1990	2,426
2000	3,193

Year	Population
2010	3,135
2020	3,367

Source: (DBEDT 2024)

3.3.4 Island of Kahoʻolawe

The Island of Kahoʻolawe was home to a school from 1828 to 1837 and a penal colony from 1832 to 1853. In 1858, the government issued the first of many ranch leases for the island. Ranching remained a primary use until 1952.

The island was ceded to the United States in 1898 and later taken over by the U.S. military following the bombing of Pearl Harbor in 1941. For many years, the island was used as a training ground and munitions testing site. Military use of the island remained significant until 1993, when the island was transferred to the State of Hawaiʻi under a federal act that called for clearance or removal of unexploded ordnance and environmental restoration of the island.

The state designated the island and its surrounding waters as the Kahoʻolawe Island Reserve, to be used solely for the preservation of native Hawaiian culture, preservation of historical and environmental resources, rehabilitation of habitat, and education (KIRC n.d.).

3.4 COMMUNITY PLAN AREAS

Nine Community Plan Areas have been designated within Maui County for the purposes of strategic planning and development:

- Hāna
- Kahoʻolawe
- Kīhei-Mākena
- Lānaʻi
- Makawao-Pukalani-Kula
- Molokaʻi
- Pāʻia-Haʻikū
- Wailuku-Kahului
- West Maui

Each Community Plan Area has a community plan to guide government action and decision-making. The community plans provide recommendations concerning land use, density and design, transportation, community facilities, infrastructure, visitor accommodations, commercial and residential areas, and other matters related to development that are specific to the region of each plan. Community plans for each area are updated every 10 years.

The Community Plan Areas group similar areas to allow for a more precise assessment of risk, as risk to each hazard varies across the county due to topography, wind and rainfall patterns, and coastal conditions, among other characteristics. The risk assessments in this HMP evaluate risk for the County overall and for individual Community Plan Areas. Eight of the nine Community Plan Areas form the basis for discussion and assessment and were the focus for community outreach and engagement over the course of the planning process. Because of Kahoʻolawe's designation as an island reserve, and having no residential population, it factors only peripherally into the HMP update.

The Community Plan Area boundaries are shown in Figure 3-1. The sections below provide general descriptions of each of the areas.

3.4.1 Hāna

The Hāna Community Plan Area encompasses 265 square miles of the eastern portion of the Island of Maui and is often referred to as "East Maui." The town of Hāna is situated along the easternmost shoreline of Maui, approximately 55 miles from the County seat of Wailuku. It serves several small rural settlements dispersed along the coast, including Keʻanae, Wailua, Nahiku, Kīpahulu, and Kaupo. An estimated 2,135 people live in the Hāna Community Plan Area, served by a small airport, fire station, public works base yard, schools, a hotel, several small businesses, and a community health center (ACS 2024).

The Hāna Community Plan Area is vulnerable to many different types of natural hazards. As a result, the small populations in this area have developed resilient and creative ways to sustain their livelihoods and support their rural lifestyle. Hāna experiences flooding from heavy rainfall events on windward mountain slopes, and from hurricanes and tropical storms. It is common for heavy rainfall to trigger landslides and rockfalls throughout the Community Plan Area, but Hāna Highway is especially vulnerable. Landslides and flooding during the wet season frequently close this single narrow and winding road, which links Hāna Town with the rest of the island, for hours to days at a time. Similarly, flooding causes road closures throughout the Community Plan Area. While the area is known for being the rainiest part of the County, the area of Kaupo has a history of wildfires. Damaging winds are also a frequent hazard within the Hāna Community Plan Area. Hāna is one of three Community Plan Areas at risk from lava flow.

3.4.2 Kahoʻolawe

Kahoʻolawe is the smallest and southernmost of the four major islands in Maui County. Lying 7 miles offshore of Mākena, Maui, and 16 miles from the Island of Lānaʻi, Kahoʻolawe is 11 miles long and 7 miles wide, with a total of 45 square miles. Once known for its abundant fishing, limited dryland agriculture, and schooling in celestial navigation and other ancient cultural arts, Kahoʻolawe has suffered greatly over the last two centuries from environmental degradation due to overgrazing, military use, and the introduction of alien species. Efforts to rehabilitate the land have been underway since 1994, after congressional legislation conveyed Kahoʻolawe back to the State of Hawaiʻi and established the Kahoʻolawe Island Reserve and the Kahoʻolawe Island Reserve Commission to manage the island and its surrounding waters. The Kahoʻolawe Community Plan Area has no resident population.

3.4.3 Kīhei-Mākena

The Kīhei-Mākena Community Plan Area, often referred to as "South Maui," spans just over 72 square miles of the southern coast of the Island of Maui and includes the communities of Māʻalaea, Kīhei, Wailea and Mākena. Between the small community of Māʻalaea, furthest west, and the more urban portion of the Community Plan Area to the east, lies a sizeable wetland known as Kealia Pond.

Māʻalaea has a functioning harbor that was established in 1950. The town of Kīhei is the residential and commercial center for the region.

Kīhei-Mākena has been one of the fastest-growing areas of Maui over the past several decades. In 1990 the resident population was 15,365 and there are now 29,174 people living in this area (ACS 2024). The abundance of sunny, dry weather and sandy beaches makes the Kīhei-Mākena area a desirable place to live and a popular visitor destination as well. This region of Maui has considerable shoreline development, including hotels, resorts, condominiums and residences ranging from affordable to exclusive.

The Kīhei-Mākena Community Plan Area is vulnerable to many types of hazards. Coastal erosion is a concern, notably in the North Kīhei, Halama Street, and Wailea areas. Further, the Community Plan Area experiences coastal and inland flooding. Flash flooding is a problem in Kīhei, especially in low-lying coastal areas where surface runoff cannot properly drain to the sea. Coastal flooding along North and South Kīhei Road is common, even during low-magnitude events. Kīhei-Mākena also experiences King Tides and high wave flooding. Further, the Community Plan Area is one of the most vulnerable to tsunamis and wildfires. It is also one of the three Community Plan Areas at risk from lava flow.

3.4.4 Lānaʻi

Known as the Pineapple Island, the Island of Lānaʻi – comprising its own Community Plan Area – covers just over 140 square miles and is the sixth largest of the main Hawaiian Islands. In the late 1800s, nearly all the land on the island was acquired by one person. Title to 98 percent of the island has changed hands several times in the years since and is currently privately owned by Larry Ellison and managed by Pūlama Lānaʻi.

The centrally located plantation town of Lānaʻi City sprang up in the 1920s to support the pineapple plantations of James Dole's Hawaiian Pineapple Company, for which the island became known. Today, Lānaʻi City remains the center for most commercial and community activities. Two resorts, a fire station, a single runway airport, schools, and a small boat harbor at Kaumālapaʻu Bay serve the island and its residents. An estimated 3,333 people currently live on the island (ACS 2024).

The Lānaʻi Community Plan Area is vulnerable to many types of hazards. Even though 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, it is at risk to flooding, windstorms, and hurricanes. Most development within the Community Plan Area is inland, which minimizes impacts from coastal flooding. Erosion due to land degradation is another hazard facing the island, although the islands of Maui and Molokaʻi largely protect the Island of Lānaʻi from erosion to the north and northeast. Therefore, the majority of erosion on Lānaʻi occurs on the southwest side of the island. The small boat harbor and one of the resorts are located within a tsunami evacuation zone and are susceptible to storm surge and sea level rise. These, along with the management of limited water resources, protection and restoration of fragile ecosystems, and economic diversification are among the important themes concerning Lānaʻi residents.

3.4.5 Makawao-Pukalani-Kula

The Makawao-Pukalani-Kula Community Plan Area, referred to as "Upcountry," is located on the western slopes of Haleakalā. Most of the residential population is located in the towns of Makawao and Pukalani, each with small concentrations of shops, restaurants, and businesses surrounded by mixed suburban and rural land uses. Kula also has a small cluster of shops and businesses serving the community, but is predominantly rural and agriculturally focused, known for its flower and vegetable exports.

The largest of Maui Island's planning regions, Makawao-Pukalani-Kula encompasses 202 square miles and is highly diverse in terms of the physical environment, history, and culture. Ranging from 600 to 10,000 feet in elevation and stretching from the windward facing slopes of Haleakalā to the north around to the south-facing leeward slopes of Ulupalakua and Kanaio, the area has numerous micro-climates supporting diverse flora and fauna, including rare species of native plants and birds.

The residential population of the Community Plan Area has grown significantly over the last several decades. In 1990, the U.S. Census estimated that 19,000 people lived in the area. Today, an estimated 24,505 people make Upcountry Maui their home (ACS 2024). Two issues of concern to new, as well as long-time residents are pollution of groundwater and the lack of a public wastewater treatment system. Much of Pukalani is presently connected to a privately owned water treatment system.

The Makawao-Pukalani-Kula Community Plan Area is the only Community Plan Area in Maui County that does not have a shoreline and is therefore not vulnerable to coastal hazards. However, the area is subject to other types of natural hazards, such as flooding, windstorms, and hurricanes. Flooding typically occurs in Makawao-Pukalani-Kula when gulches overflow due to heavy rainfall. Drought is a major concern for farms and residents. Wildfires tend to occur in the northernmost portion of the Community Plan Area. Further, the summit of Haleakalā experiences freezing temperatures in winter and can experience blizzard-like conditions during Kona storms. This area would be the first Community Plan Area to experience impacts from lava flow if Haleakalā were to erupt.

3.4.6 Moloka'i

The Island of Moloka'i is the fifth largest of the eight main Hawaiian Islands, covering 261 square miles (including Kalaupāpā). The island has 88 miles of coastline, with the longest continuous fringing coral reef in the U.S. Along the southern shoreline can be found the most intact pre-contact system of human-built fishponds anywhere in Polynesia.

Moloka'i is rich in natural and cultural resources and is the most rural of the Hawaiian Islands. Besides the Island of Ni'ihau, Moloka'i has the highest percentage of Native Hawaiians in the state. Approximately 8,092 people make Moloka'i their home (ACS 2024). The 2010 U.S. Census estimated that 24 percent of the population is of Native Hawaiian ancestry (excluding Kalawao County).

The town of Kaunakakai, located about midway along the southern coast, is the island's major population and commercial center, with schools, shops, and other services. Kaunakakai Harbor is the island's main point of entry for goods and resources, including fuel. A small airport is located 6 miles

northwest of Kaunakakai. The island's only resort destination is on the western end of the island at Kaluakoʻi.

Many Molokaʻi residents practice a subsistence-based lifestyle, relying on fishing, hunting, farming, and gathering for food, spiritual well-being, and cultural practices. The rural lifestyle, strong sense of community, and connection to place and culture are deeply valued by Molokaʻi residents. The challenges of remoteness, limited infrastructure, and few economic opportunities have been largely overcome by the resilience fostered by Molokaʻi's abundant social capital.

The Moloka'i Community Plan Area is vulnerable to many hazards, including coastal erosion, flooding, windstorms, hurricanes, tsunamis, and wildfires, among others. On Moloka'i, flooding along the Kaunakakai Gulch has caused closures along the Maunaloa Highway, and swift water rescues have been carried out in Hālawa Valley. Further, Moloka'i has experienced some of the county's largest wildfires, including the 2009 Kaunakakai Wildfire that burned over 8,300 acres. In addition, coastal erosion impacts Moloka'i's southern shoreline, characterized by scarped dunes, fallen trees, and outcrops of basalt rock.

3.4.7 Pāʻia-Haʻikū

The Pāʻia-Haʻikū Community Plan Area has a population of 17,037 (ACS 2024) and covers 83 square miles. Located along Maui's north shore, the towns of Pāʻia and Haʻikū lie east of the more densely populated urban center of Kahului and west of the remote town of Hāna. Pāʻia is the more urban of the two yet retains a small town scale and character. Haʻikū is more rural and further removed, yet still conveniently within 15 miles of Maui's central business district. Residential growth in Haʻikū has developed on what were once agricultural lands. Extensive pineapple fields have been slowly replaced by small-scale development, hobby farms, and diversified agriculture. Two small urban areas that were once pineapple canneries host small businesses, restaurants, and grocery stores. Unlike Pāʻia, public infrastructure in Haʻikū lacks a public sewage treatment system, and roadways are not routinely maintained.

The Pāʻia-Haʻikū Community Plan Area is vulnerable to several types of natural hazards, including flooding, coastal erosion, windstorms, landslides, and wildfires, among others. Flooding typically occurs along gulches near Haʻikū, are wildfires are most common in the northern part of the Community Plan Area.

3.4.8 Wailuku-Kahului

Located on the north shore of the Island of Maui, the Wailuku-Kahului Community Plan Area spans 104 square miles; including roughly half of the Central Valley's agricultural lands and the eastern half of the West Maui Mountains. Home to 58,606 people, "Central Maui" is the primary urban, business, and industrial center of the island (ACS 2024). The historic town of Wailuku, nestled at the foot of the West Maui Mountains, serves as the seat of county government. The adjoining and more expansive town of Kahului is the critical entry point for imported goods by way of the harbor, and transit hub for residents and visitors via the County's main airport.

Kahului is home to the University of Hawai‘i Maui college campus as well as to parks, sports facilities, community theaters, the War Memorial Center, and the Maui Arts and Cultural Center capable of supporting large community gatherings and cultural events.

Outside of the main urban areas of Wailuku and Kahului are the more rural settlements of Waihe‘e to the north and Waikapū and Pu‘unēnē to the southeast. Surrounding agricultural lands, once managed by Hawaiian Commercial & Sugar, are being transitioned to diversified agriculture and other uses.

The Wailuku-Kahului Community Plan Area is vulnerable to many types of natural hazards. Coastal erosion has impacted most shorelines in the area; Kahului Harbor, Kanaha, Spreckelsville, and Baldwin Park are noted for having significant rates of erosion. In addition, the Community Plan Area is one of the most vulnerable to tsunamis and was the hardest hit area during the 1960 tsunami generated by the Great Valdivia Earthquake in Chile. Severe flooding has occurred in the ‘Īao Valley along the Wailuku River, and wildfires are prevalent near Kahului. A significant dry spell contributed to major fires in the central valley in 2019.

3.4.9 West Maui

Encompassing 96 square miles and roughly half of the western portion of the Island of Maui, the West Maui Community Plan Area is home to an estimated 21,749 people (ACS 2024). Development is centered on the western slopes of the West Maui Mountains and along the coast, stretching from the small community of Oluwalu in the south to Kapalua in the north. Between the two are the communities of Lahaina, Kā‘anapali, Honokōwai, and Nāpili.

Lahaina, once the capital of the Hawaiian Kingdom and home to Hawaiian royalty, is the primary urban, commercial, and service center for this Community Plan Area. Kā‘anapali, to the north, was the state’s first master-planned resort area, and continues to attract a significant number of visitors each year. West Maui’s growing resident and visitor populations have put a strain on housing, infrastructure, and other resources such as water and wastewater services.

The West Maui Community Plan Area is vulnerable to many natural hazard types, including flooding, coastal erosion, windstorms, landslides, and wildfires, among others. Large populations live, work, or go to school within tsunami evacuation zones; almost half of West Maui’s structures are within tsunami evacuation zones. Sea level rise has caused significant shoreline erosion, which is threatening multiple residential structures and the single transportation lifeline between the area and the rest of Maui. Many shorelines in West Maui are experiencing coastal erosion, such as Alaeloa, Honokōwai, Lahaina, and Ukumehame. Flooding occurs throughout the Community Plan Area but is most notable in Lahaina. Further, West Maui has experienced more wildfires than any other Community Plan Area over the last 20 years. In August 2023, wind-driven wildfires destroyed more than 2,200 structures, caused about $5.5 billion in damages, and claimed 102 lives in this Community Plan Area.

3.5 PHYSICAL SETTING

3.5.1 Water Resources

Surface Waters

Fresh water is a precious commodity in Hawai‘i, a state surrounded by the ocean. The Island of Maui has 90 perennial streams, 56 of which are continuous (DLNR 2015). Major streams include Palikea (the second largest perennial stream in the state), Kalialinui-Waialae gulch (the state’s second longest stream), Honokohau stream (the longest stream channel in west Maui), and ‘Īao Stream. Many streams are diverted; Maui has the highest diversion of natural stream flows in the state. Fifty-seven streams are diverted and seven have altered channels; ‘Īao is the largest altered stream. Kanahā Pond, historically a natural freshwater lake, is approximately 3 feet in depth and 41 acres in size and is located wholly within the Kahului Airport boundary area. In addition, the island has 11 impaired streams and two impaired estuaries under Environmental Protection Agency (EPA) Clean Water Act standards (HDOH 2022). The East Maui canal system in Central Maui is the largest human-made stream system on the island (DLNR 2015).

Moloka‘i has 36 perennial streams, 16 of which are continuous. The Kamalo stream has an altered channel (DLNR 2015) and the Waialua stream is listed as impaired under EPA Clean Water Act standards (HDOH 2022). The Waikolu Canal in the northeast is the largest man-made stream system on the island. Kualapu‘u Reservoir is a significant man-made lake at 50 feet deep and 100 acres in area (DLNR 2015).

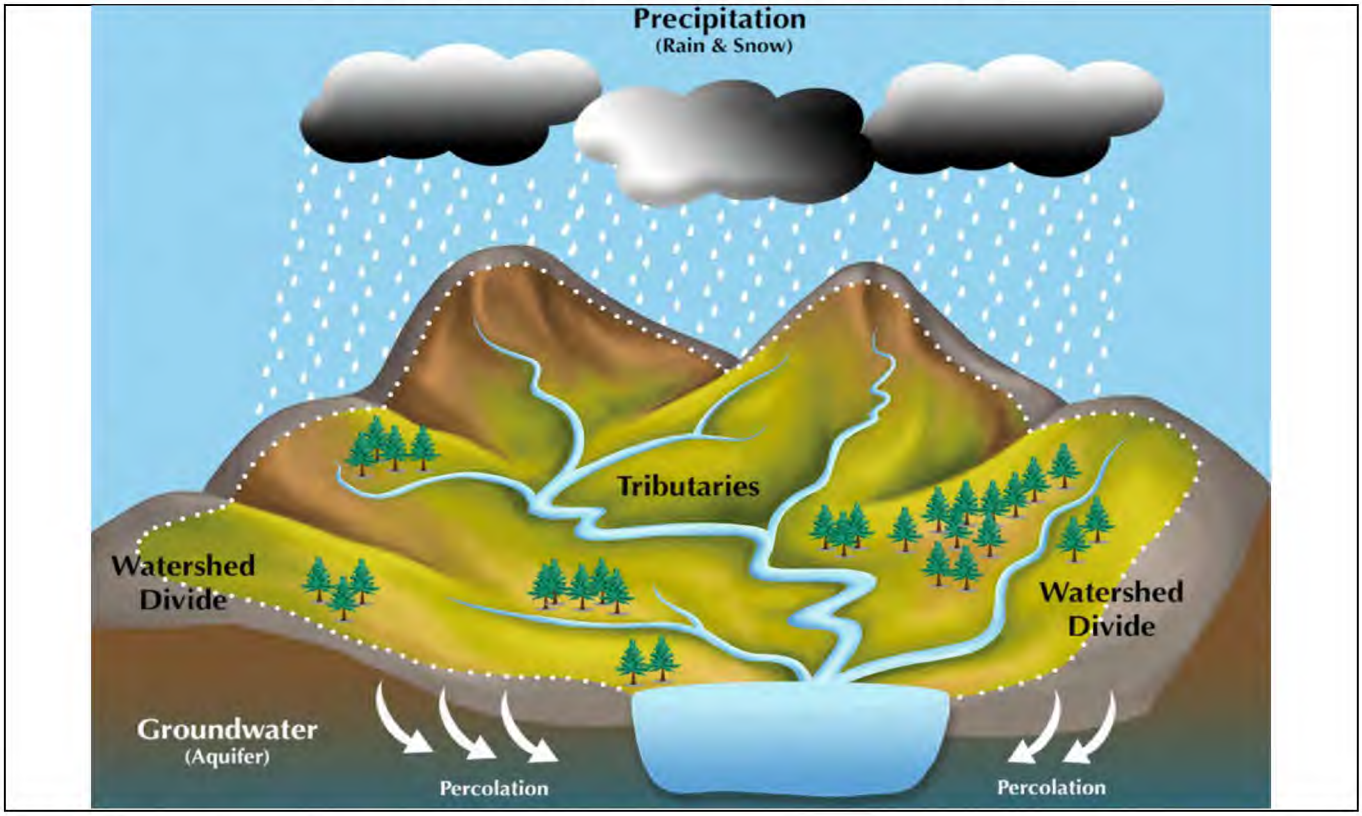
There are no perennial streams or lakes on Lāna‘i or Kaho‘olawe (DLNR 2015).

Watersheds

A watershed is an area of land, such as a mountain or valley, which collects rainwater into a common outlet, usually the ocean. Some of the precipitation is absorbed by plants and some infiltrates into the ground; what remains flows into surface rivers and streams as runoff, as illustrated in Figure 3-2. Watersheds are critical for both water management and drought resilience. They recharge an island’s water supply, delivering clean water while providing habitat for native flora and fauna (DLNR 2017).

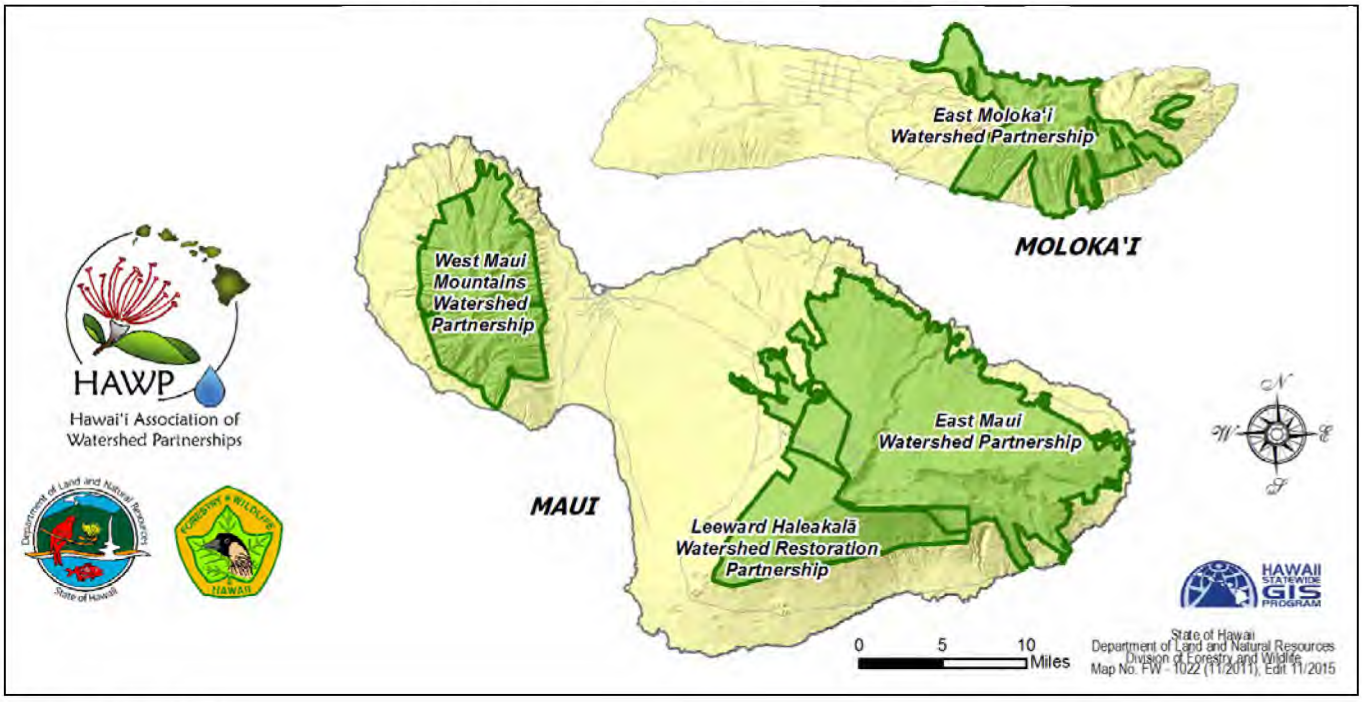
Watershed partnerships in Hawai‘i are voluntary alliances of public and private landowners committed to the common value of protecting forested watersheds for water recharge and other ecosystem services through collaborative management (DLNR n.d.). The first watershed partnership was formed in 1991 on East Maui when several public and private landowners realized the benefits of working together to ensure the conservation of a shared watershed that provided billions of gallons of fresh water to the area (DLNR n.d.). There are over 70 public and private landowners and partners involved with over 2 million acres included in watershed partnerships across the state. Maui and Moloka‘i have 434.34 square miles of land dedicated to watershed partnerships (HI-EMA 2023), as illustrated in Figure 3-2.

Figure 3-2. Hydrographic Features of a Typical Watershed



Source: (Seacoast Science Center n.d.)

Figure 3-3. Hawai‘i Watershed Partnerships



Source: (DLNR n.d.)

3.5.2 Topography and Geology

Island of Maui

At 465,408 acres, Maui is the second largest island in the Hawaiian Archipelago and was formed between 750,000 and 1.3 million years ago, as first west Maui then east Maui emerged from two large shield volcanoes; Haleakalā is the tallest peak at 10,023 feet and Puʻu Kukui in West Maui is 5,788 feet (DLNR 2015). Maui earned its nickname of "The Valley Isle" due to the relatively flat isthmus of land that joins the two cones. Rich in alluvial deposits and decomposed basaltic materials, the gentle slopes of central Maui and tablelands of West Maui are well-suited to agriculture. Haleakalā last erupted along East Maui's lower southwest rift zone sometime between A.D. 1480 and 1600 (USGS n.d.). While considered "dormant," Haleakalā's eruptive history indicates that it could erupt every ~200 to 500 years. Mauna Kahalawai on West Maui is considered extinct, having last erupted roughly 320,000 years ago (USGS n.d.). Approximately 25 percent of the island is below 500 feet in elevation; just over 40 percent is above 2,000 feet in elevation (DLNR 2015).

Island of Molokaʻi

At 170,240 acres, Molokaʻi is the fifth largest island in the Hawaiian Archipelago and was formed approximately 1.8 million years ago (DLNR 2015). Three shield volcanoes comprise most of the island, with the East Molokaʻi Mountains making up half of the island area. Approximately 37 percent of the island is below 500 feet in elevation, and about 18 percent of the island is above 2,000 feet in elevation (DLNR 2015). The island's geology and topography vary considerably from east to west. The highest point on the island is 4,970 feet, and steep cliffs characterize the northern windward coast with inaccessible deep valleys dissecting the coastal area. The Kamakou Preserve (2,774 acres of rainforest) is located on the east side of the island. Stream erosion has cut large amphitheater-headed valleys into its northern coast. Near the end of the shield stage of the East Molokaʻi volcano, its northern flank slid into the ocean, leaving behind the towering cliffs that dominate the northeast coast of the island. At more than 3,000 feet above sea level, these cliffs are the tallest sea cliffs in the world. Smaller and narrower valleys are found on the southern side of East Molokaʻi. The southeastern edge of the island is bordered by an alluvial plain produced from a series of semi-contiguous alluvial fans associated with upland gulches.

The leeward slopes descend to a narrow coastal plain fronting an extensive shallow offshore reef flat. The terrain of western Molokaʻi was formed by an older volcano and has a maximum elevation of 1,351 feet. This is the only Hawaiian volcano with no clear evidence of a summit caldera. The west side of the island has rolling arid land rather than valleys and is considerably drier than the east side. It is home to plantations, ranches, and small farms.

An East Molokaʻi volcanic episode approximately 300,000 years ago formed a 2,500-acre peninsula in the sea below the steep cliffs of the north side of Molokaʻi Island. The peninsula, known as Kalaupāpā, is virtually isolated from the rest of the island by cliffs 1,600 to 2,000 feet high. The island's broad Hoʻolehua Saddle forms a low-lying coastal plain along the south shore at the island's center.

Island of Lānaʻi

At 90,500 acres, Lānaʻi is the sixth largest island in the Hawaiian Archipelago,18 miles long and 13 miles wide. 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 remains of the volcano's caldera. The highest point is Lānaʻihale, at 3,370 feet (DLNR 2015). The northeastern coast is fringed with broad sandy beaches, while the southwestern coast is marked by sea cliffs. Approximately 25 percent of the island is below 500 feet in elevation; only 6 percent of the island is above 2,000 feet in elevation (DLNR 2015).

Island of Kahoʻolawe

Kahoʻolawe is the smallest of the main Hawaiian Islands at 28,800 acres in area. The island is 11 miles long and 7 miles wide at its broadest point. The island is gently sloped with a diagonal ridge running across it. Steep sea cliffs mark the southern and eastern coastlines while sloping ridges with bays and beaches characterize the northern and western coasts (DLNR 2015). The highest point on the island is Puʻu Moaulanui on the northeast end, at 1,483 feet above sea level. Approximately 39 percent of the island is below 500 feet in elevation (DLNR 2015).

3.5.3 Climate

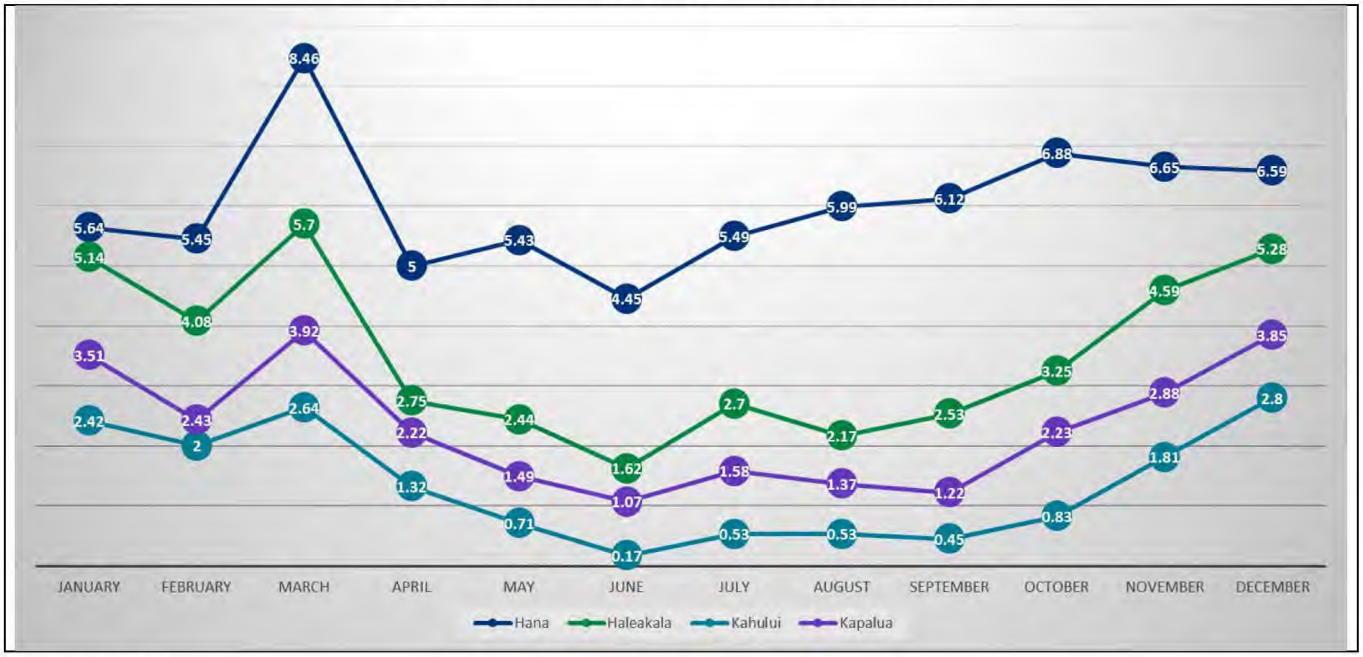
Island of Maui

Rainfall varies considerably across the Island of Maui, with windward areas experiencing much heavier rainfall than leeward areas. The slopes of Haleakalā (East Maui) and Puʻu Kukui (West Maui) force moist northeasterly trade wind air upwards, causing the formation of clouds and showers. Subsiding air over the leeward slopes suppresses cloud and shower development, leaving these areas mostly dry. The geologically older West Maui mountains receive an average rainfall of approximately 400 inches per year, making it the second wettest spot in the state (DLNR 2015). Median annual rainfall is 200 to 300 inches on the windward side of Haleakalā, but leeward areas such as Kīhei have a mean annual rainfall of only 10 inches. Figure 3-4 displays the average monthly rainfall in Hāna, the Haleakalā summit, Kapalua Airport, and Kahului Airport from 1991 to 2020.

Trade winds are deflected around the volcanic masses and funneled through gaps and valleys, causing local wind accelerations and eddies. A notable example is a feature known as the "Maui vortex," a persistent circulation that usually occurs during trade wind conditions over the western slopes of Haleakalā.

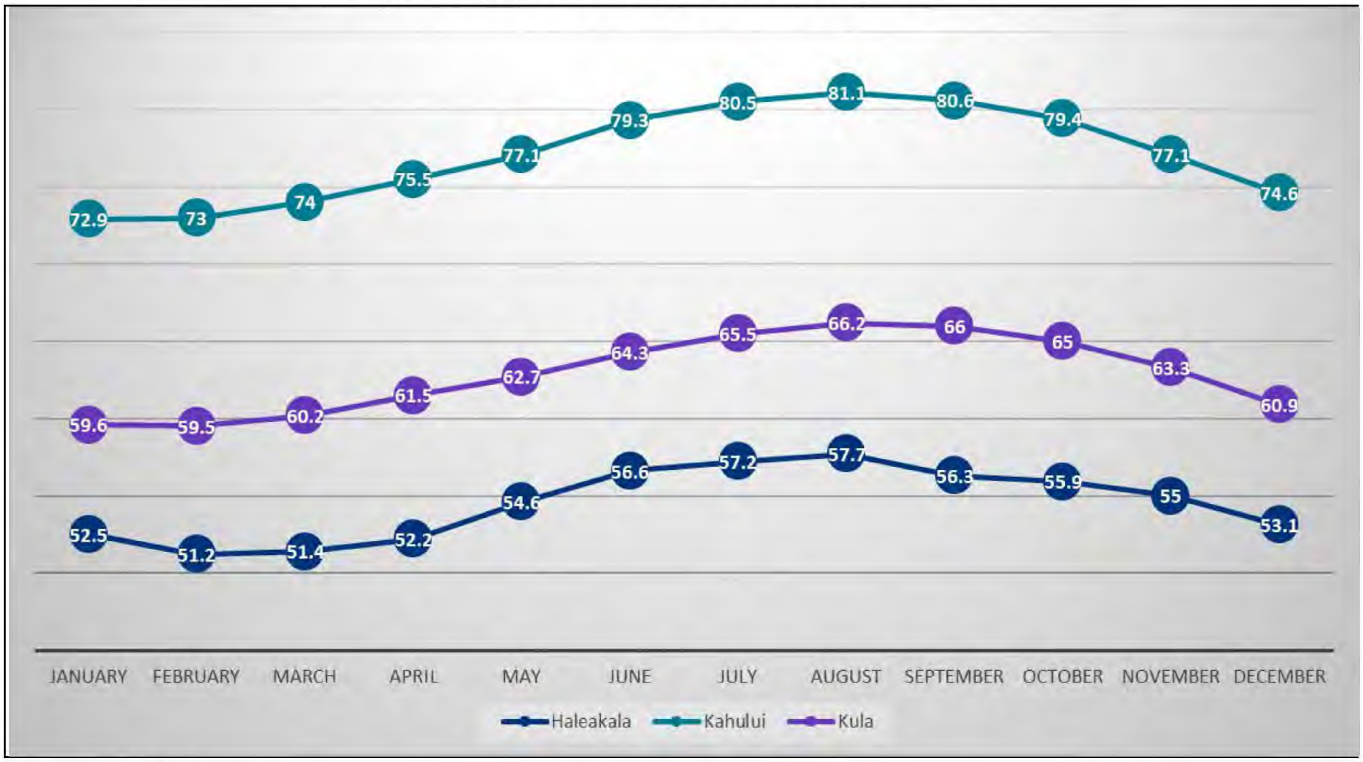
With an elevation of more than 10,000 feet, the summit of Haleakalā routinely experiences average temperatures in the 50s °F, which is significantly cooler than the rest of the island. The Kula area, on the slopes of Haleakalā, also experiences cooler temperatures than the rest of the island, averaging in the 60s °F most of the year. Most of the island experiences temperatures from the mid-70s to the low-80s year-round. Figure 3-5 displays the average monthly temperature for the Haleakalā Summit, Kula, and Kahului as measured from 1991 to 2020.

Figure 3-4. Maui Average Monthly Rainfall



Source: (NOAA n.d.)

Figure 3-5. Maui Average Monthly Temperature

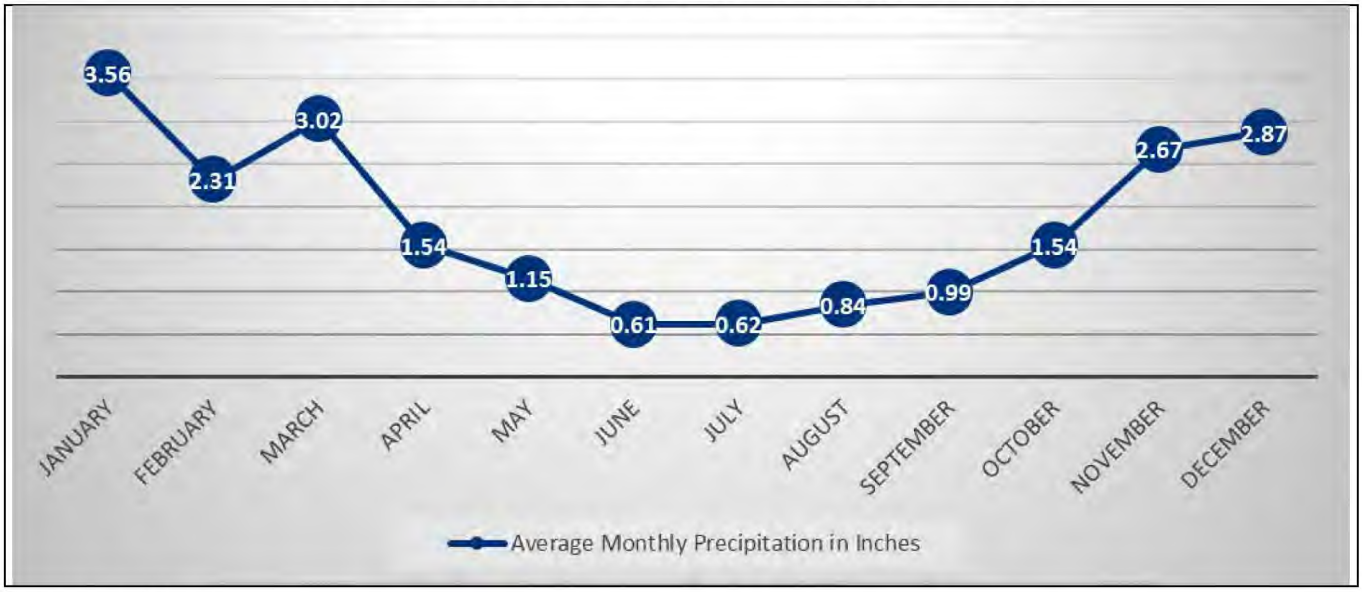


Source: (NOAA n.d.)

Island of Molokaʻi

The eastern portion of Molokaʻi receives much more rain than the western portion. Trade wind-driven rains throughout the year come in from the northeast and drop most of their moisture in the northern windward highlands, seldom on the southern or lee side of the island. From 1991 to 2020, the average annual rainfall at the Molokaʻi airport was 21.72 inches. The rainiest month is January with an average of 3.5 inches of rain and the dryest months are June and July, with an average of 0.6 inches of rain. Figure 3-6 displays the average monthly rainfall at the Molokaʻi Airport from 1991 to 2020.

Figure 3-6. Average Monthly Rainfall, Molokaʻi Airport

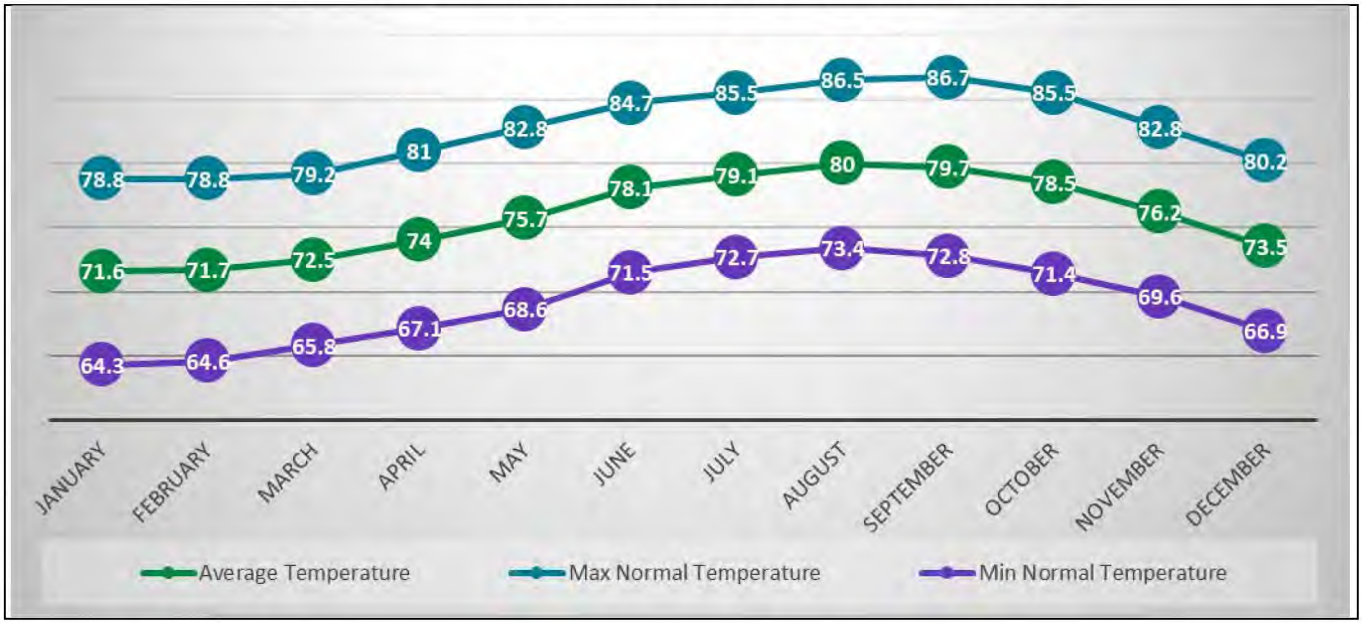


Source: (NOAA n.d.)

The eastern slopes of Kamakou (East Molokaʻi) receive up to 160 inches of rain per year (DLNR 2015). Kona storms—major storms that come from the south once or twice a year, normally between October and April—may drop 8 to 10 inches of rain within hours.

Molokaʻi is warm year-round, with an average yearly temperature of 74 °F. During winter (December through March), Molokaʻi experiences cooler nighttime temperatures as low as the lower 60s with more frequent rain and stronger ocean currents. Figure 3-7 illustrates the average monthly temperatures at the Molokaʻi Airport from 1991 to 2020.

Figure 3-7. Average Monthly Temperature, Moloka‘i Airport



Source: (NOAA n.d.)

Island of Lāna‘i

The Island of Lāna‘i is sheltered from the prevailing northeasterly trade winds by the mountains of West Maui. Because of its protected location, Lāna‘i has a much dryer climate than the other main Hawaiian Islands. The average annual rainfall at the summit of the island’s highest peak, Lāna‘ihale, is 30 to 40 inches (DLNR 2015).

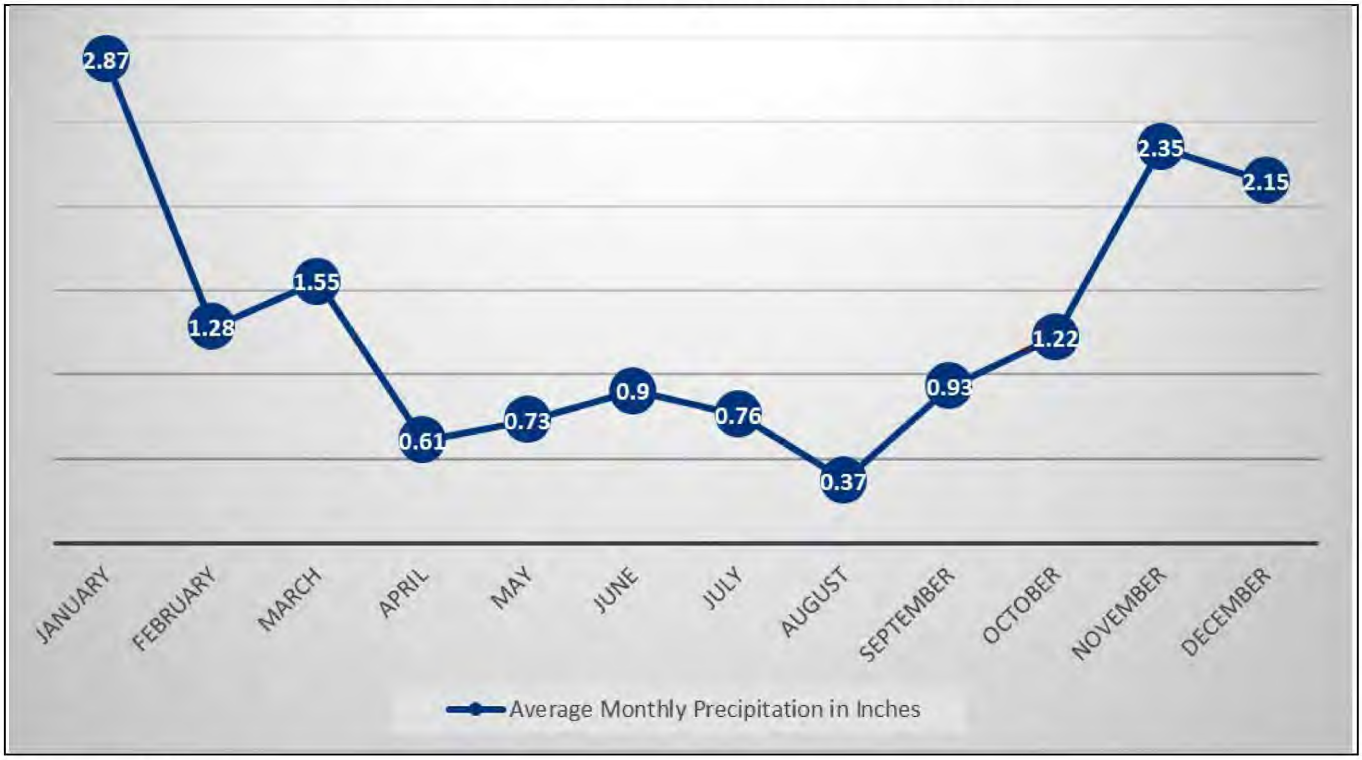
A large portion of the water in the island’s aquifer comes from “fog drip,” moisture pulled from clouds by trees and ferns in upper elevations (DLNR 2015). Strong trade winds funneled from Maui and Moloka‘i increase the evaporation of moisture and contribute to soil erosion, particularly on the western side of the island (DLNR 2015). Lower-lying areas of the island have an average annual rainfall of 10 to 20 inches. Figure 3-8 displays the average monthly rainfall at the Lāna‘i Airport from 1991 to 2020.

Lāna‘i tends to experience temperatures a few degrees cooler than the other islands in the county. During the winter (December through March), Lāna‘i experiences nighttime temperatures as low as the high 50s °F. In the warmer summer months, temperatures rarely rise above the low 80s °F. Figure 3-9 illustrates the average monthly temperatures at the Lāna‘i Airport from 1991 to 2020.

Island of Kaho‘olawe

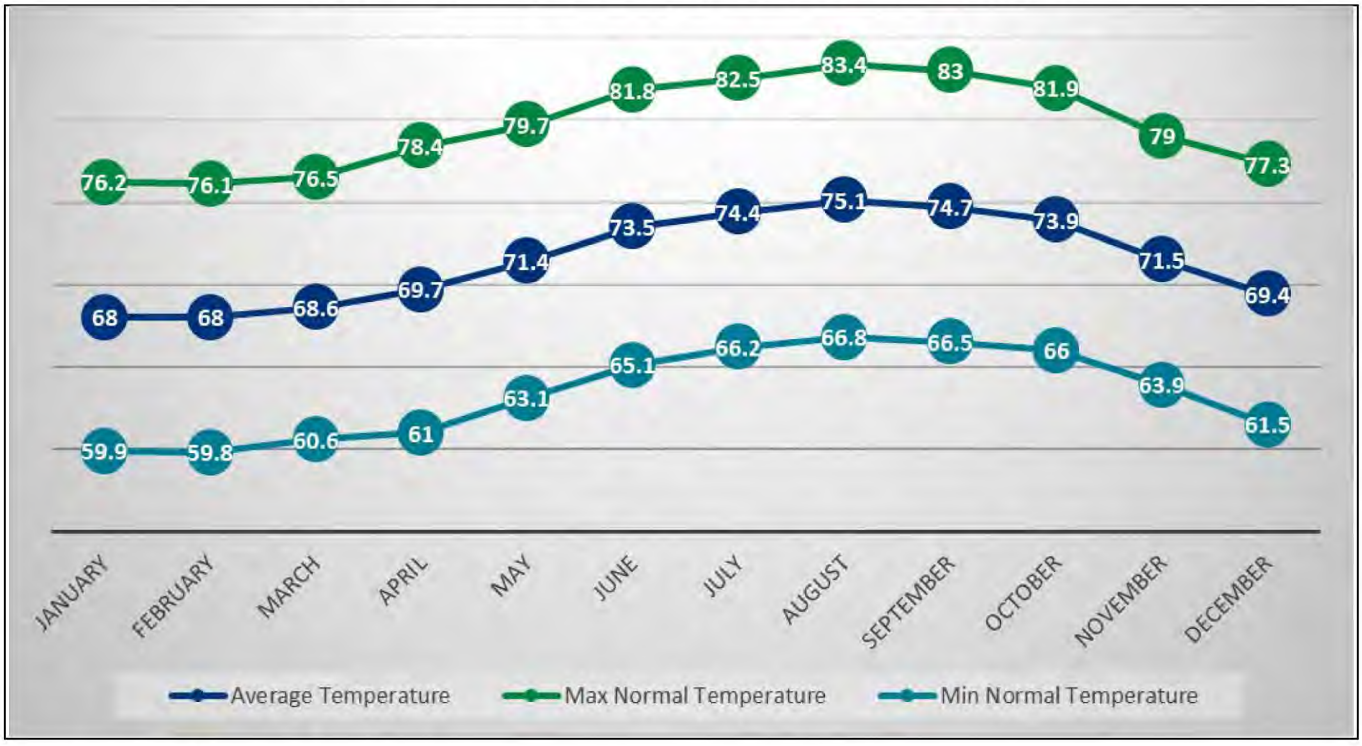
Kaho‘olawe has a very dry and arid climate because of its low relief and sheltered location in the shadow of Haleakalā on the Island of Maui. Annual mean precipitation throughout the island is 10 to 20 inches, with most occurring on the eastern side of the ridge (DLNR 2015).

Figure 3-8. Average Monthly Rainfall, Lānaʻi Airport



Source: (NOAA n.d.)

Figure 3-9. Average Monthly Temperature, Lānaʻi Airport



Source: (NOAA n.d.)

3.5.4 Land Cover

Island of Maui

Thirty percent of Maui island is dominated by native vegetation, mostly in east Maui. The upper elevation slopes and summits of both east and west Maui are typically native-dominated, with coastal and lower elevation areas dominated by non-native vegetation. Three notable areas contain continuous native vegetation spanning a range of habitats, forming a landscape with a high diversity of total species: summit and leeward west Maui (wet forests and bogs transitioning to lowland mesic communities), windward east Maui (subalpine shrubland transitioning to wet forest), and leeward east Maui (subalpine community transitioning to remnant montane mesic then lowland and coastal dry communities). In addition, large tracts of intact native-dominated montane forests remain, with a canopy composed primarily of ʻōhiʻa and koa and a well-developed sub-canopy layer of mixed native understory trees and shrubs (DLNR 2015).

Island of Molokaʻi

Molokaʻi supports a wide range of native habitats and a diversity of native wildlife. The mountains of eastern Molokaʻi are cut into deep valleys by perennial streams, and, due largely to their inaccessibility, these valleys contain high-quality native habitat for stream fauna, forest birds, montane-nesting seabirds, and native snails and insects (DLNR 2015).

Island of Lānaʻi

Due of the history of overgrazing by cattle, goats, and axis deer, much of Lānaʻi has suffered from extensive soil erosion, and few native-dominated natural communities remain. Though many species once native to Lānaʻi are no longer present, the last major remnant of the olopua/lama dryland forest that once covered large portions of the lowlands of the island remains. This forest provides habitat for several taxa of native invertebrates. The upland area surrounding the island's highest point, Lānaʻihale, contains most of the remaining native-dominated mesic forest and provides habitat for the ʻuaʻu, ʻapapane, and rare native land snails. Waterbird species rely primarily on human-made reservoirs (e.g., golf-course ponds, the Lānaʻi Sewage Treatment Plant), rather than natural wetlands (DLNR 2015).

Island of Kahoʻolawe

Kahoʻolawe suffered severe ecological degradation, and much of the soil (particularly on the eastern side and along the ridge crests) is exposed and lost to strong, easterly trade winds. Alien-dominated vegetation covers most of the island and includes kiawe forest and buffelgrass. Remaining native habitats include coastal dry shrubland dominated by maʻo, ʻilima, and ʻakiʻaki, lowland dry grassland, mixed shrub coastal dry cliff, a high salinity anchialine pool, intermittent streams, and ephemeral pools (DLNR 2015).

3.6 LAND USE

3.6.1 Current Land Use

Statewide Land Use Categories

Hawai'i's land use system is different from that of many other states, featuring a statewide classification approach. All land in Hawai'i is categorized into one of four zones: Conservation, Agricultural, Urban, and Rural. The State Department of Land and Natural Resources (DLNR) oversees the Conservation District, and counties are primarily responsible for managing land in the other three zones. This comprehensive system reflects Hawai'i's commitment to balancing development needs with the preservation of its unique natural resources.

The Conservation District, which covers about 48 percent of Hawai'i's total area (1,973,846 acres), is subject to stringent development and commercial activity restrictions, with varying levels of control based on specific subzones (DLNR 2015). The non-conservation areas are governed by county-level land-use and development controls, including community plans, zoning regulations, and building codes that regulate farm, residential, commercial, and industrial development and use.

An additional layer of regulation exists in Special Management Areas along the shoreline, where each county imposes extra development controls, even on land already under Conservation District restrictions.

Land Use in Maui County

Current land uses in Maui County are shown in Figure 3-10 and listed in Table 3-4. Table 3-5 summarizes land use distribution and major land owners for each island.

The U.S. Navy used Kaho'olawe for several decades of military bombing exercises which ceased in 1990. The following 10-year Navy clean-up resulted in approximately 10 percent subsurface clearance of the island and 69 percent surface clearance of unexploded ordnance from the island (DLNR 2015). In 2003, management and ownership of the island was transferred from the U.S. Navy to the Kaho'olawe Island Reserve Commission, a state agency attached to the DLNR that manages Kaho'olawe in trust for a future Native Hawaiian sovereign entity.

The Island of Kaho'olawe and the waters 2 miles from the shoreline are designated as the Kaho'olawe Island Reserve, owned by the State of Hawai'i. Access to the island is restricted due to unexploded ordnance, and commercial use is prohibited. The island is managed and maintained in perpetuity for the following purposes:

- Preservation and practice of all rights customarily and traditionally exercised by the Native Hawaiians for cultural, spiritual, and subsistence purposes
- Preservation and protection of its archaeological, historical, and environmental resources
- Rehabilitation, revegetation, habitat restoration, and preservation
- Education

Figure 3-10. Land Use Classification

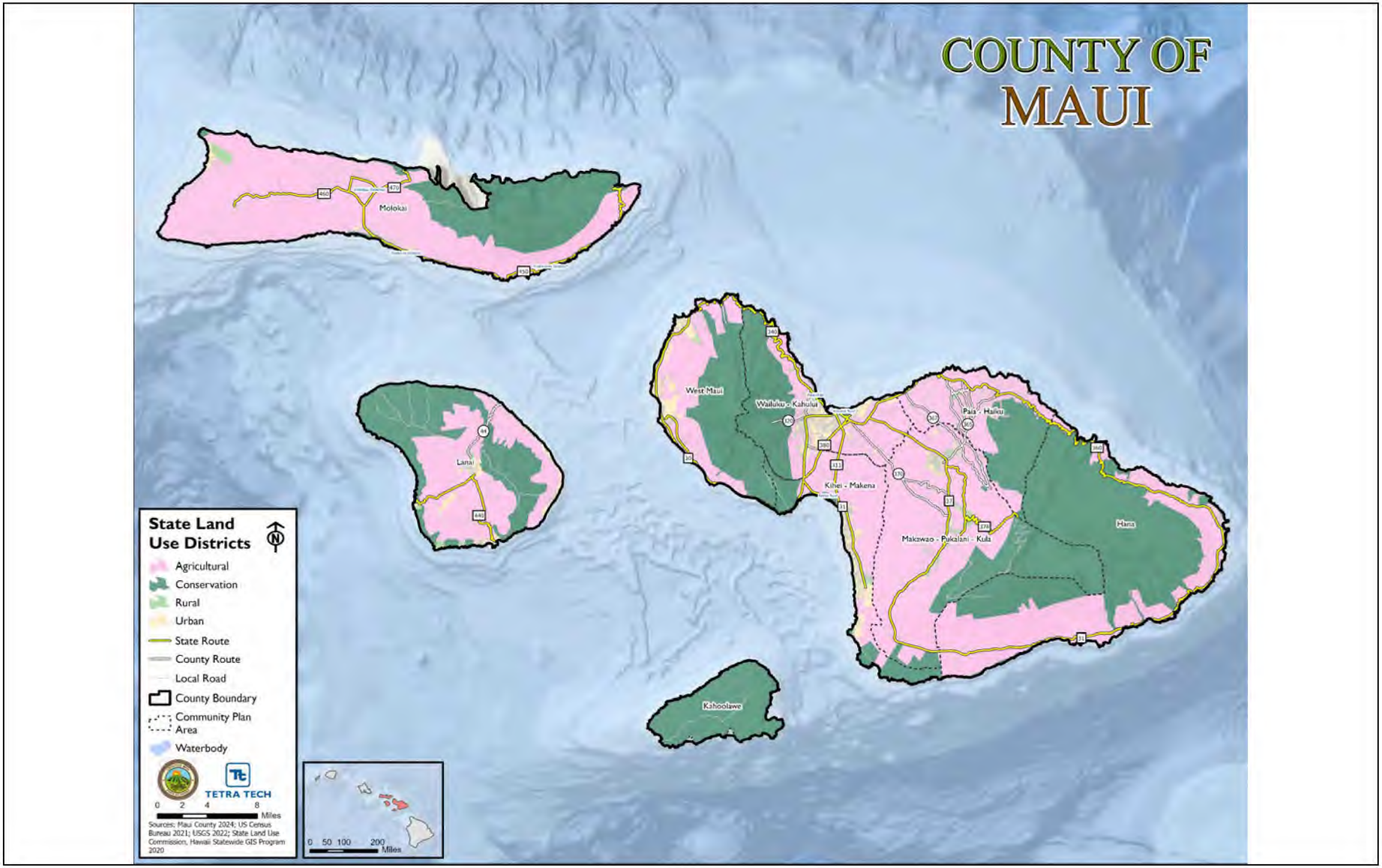


Table 3-4. Maui County Land Use Classification

Land Use Category	Designated Area (acres)	% of County Total Area
Agricultural District	387,665	52.1%
Conservation District	319,571	43.0%
Rural District	8,168	1.1%
Urban District	28,224	3.8%
Maui County (Total)	743,628	100.0%

Source: State Land Use Commission, Hawai'i Statewide GIS Program 2020

Table 3-5. Land Use and Major Land Owners, by Island

	Island of Maui	Island of Moloka'i	Island of Lāna'i	Island of Kaho'olawe
Agricultural District (% of Total Area)	53%	67%	52%	0%
Conservation District (% of Total Area)	42%	30% (primarily covering the East Moloka'i Mountains and the coastlines)	42% (primarily around Lāna'ihale and on the western end of the island)	100%
Rural District (% of Total Area)	<1%	1%	2% (primarily along remote coastlines)	0%
Urban District (% of Total Area)	5%	2%	4% (around Lāna'i City, Mānele Bay and the airport)	0%
Major Land Owners	**West Maui:** State of Hawai'i, Maui Land and Pineapple, Inc., Makila Land Company, Kahoma Land Company, Kā'anapali Land, LLC, Kamehameha Schools, Maui County (Department of Water Supply). **East Maui:** State of Hawai'i (including the Department of Hawaiian Home Lands), National Park Service (NPS), Alexander and Baldwin, Ulupalakua Ranch, Haleakalā Ranch	State of Hawai'i and private entities such as The Nature Conservancy of Hawai'i, Kamehameha Schools, Pu'u O Hoku Ranch, and Moloka'i Ranch	Nearly the entire island (98 percent) is privately owned by Lāna'i Resorts LLC and managed by Pulama Lāna'i. The State Division of Forestry and Wildlife leases 30,000 acres for use as the Lāna'i Cooperative Game Management Area	Kaho'olawe Island Reserve Commission

Source: State Land Use Commission, Hawai'i Statewide GIS Program 2020

3.6.2 Land Use Trends

There has been little change in land use designations in recent decades. Statewide, the Agricultural District changed from 48 percent to 47 percent of the total area from 1993 to 2023 (DBEDT 2024).

3.7 POPULATION AND DEMOGRAPHICS

3.7.1 Current Population

As of 2023, the U.S. Census American Community Survey (ACS) estimated that 164,632 people were living in Maui County, making it the third most populated county in the state. Table 3-6 displays the populations of the various Community Plan Areas. The largest population center is the Kahului-Wailuku Community Plan Area, where the county government seat is located. Figure 3-11 illustrates population density in the county. The heaviest population density occurs in the Wailuku-Kahului, Makawao, and Kīhei areas.

Table 3-6. Maui County Population 2023

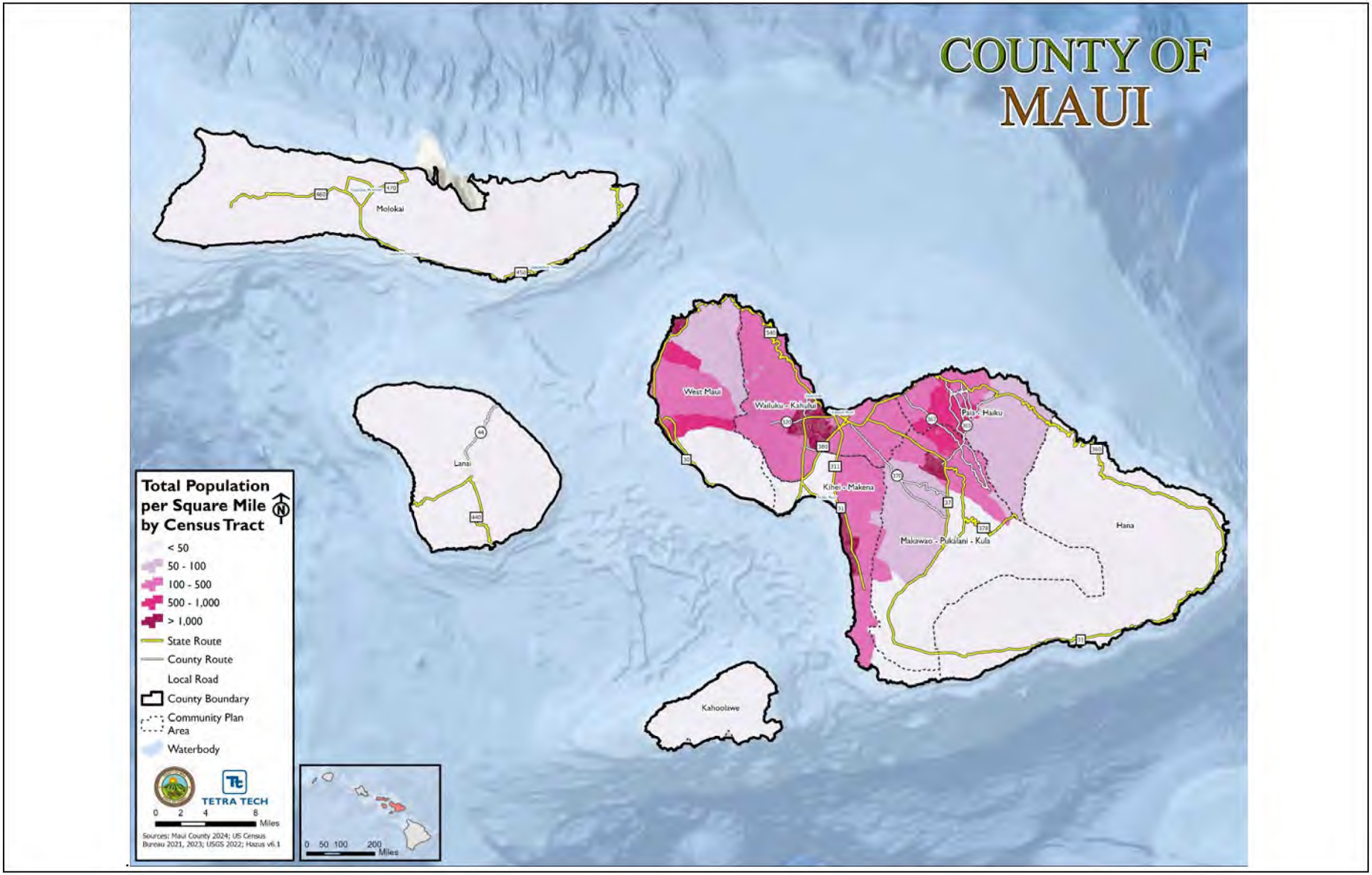
Community Plan Area	Total Population	% of County Total
Hāna	2,135	1.3%
Kahoʻolawe	0	0.0%
Kīhei-Mākena	29,174	17.7%
Lānaʻi	3,333	2.0%
Makawao-Pukalani-Kula	24,505	14.9%
Molokaʻi	8,092	4.9%
Pāʻia-Haʻikū	17,037	10.3%
Wailuku-Kahului	58,606	35.6%
West Maui	21,749	13.2%
Maui County (Total)	164,632	100.0%

Source: U.S. Census Bureau 2023 ACS

3.7.2 Population Trends

Population trend information was evaluated to estimate future shifts that could change the character of the area. Population trends provide a basis for making decisions on the type of mitigation approaches to consider and the locations where these approaches should be applied. This information can also be used to support planning decisions regarding future development in vulnerable areas. Knowledge of the composition of the population and how it has changed in the past and how it may change in the future is needed for making informed decisions about the future. Information about the population is a critical part of planning because it relates to current needs and future development related to housing, industry, businesses, public facilities and services, and infrastructure such as energy and transportation.

Figure 3-11. County Population Density



As seen in Table 3-7, Maui County's population has increased every decade since 1960 and is projected to continue to rise for the next three decades.

Table 3-7. Historical and Projected Population Change in Maui County

	Historical Maui County Population							Projected Maui County Population		
	1960	1970	1980	1990	2000	2010	2020	2030	2040	2050
Population	42,855	46,156	70,991	100,504	128,241	154,924	164,836	173,520	181,000	184,870
Growth	-	8%	54%	42%	28%	21%	6%	5%	4%	2%

Source: (DBEDT 2024)
Note: Population counts include Kalawao County on Moloka'i.

While the overall population of Maui County increased by 285 percent from 1960 to 2020, this growth is not geographically uniform throughout the County. Maui Island's population grew by 298 percent during that 60-year time frame, while Lāna'i's population grew by 53 percent from 2,204 to 3,367 people, and Moloka'i grew by 40 percent from 5,261 to 7,367 people.

3.7.3 Socially Vulnerable Populations

Research has shown that people living near or below the poverty line, older people (especially older single men), individuals with disabilities, women, children, ethnic minorities, and renters all experience, to some degree, more severe effects from disasters than the general population. These populations may vary from the general population in risk perception, living conditions, access to information about hazard events, capabilities during an event, and access to resources for post-disaster recovery.

Social vulnerability refers to the socioeconomic factors such as these that affect community resilience. Communities with disproportionate populations that are socially vulnerable are more likely to realize the negative impacts of disasters and less equipped for a timely, meaningful recovery. These populations can be more susceptible to hazard events based on factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. From a planning perspective, understanding where there are higher concentrations of vulnerable community members helps to extend focused public outreach and education to these most vulnerable citizens. By considering the elderly, disabled, and impoverished populations living within Maui County, more effective plan can be implemented to safeguard lives before, during, and after a disaster.

This HMP considers several socially vulnerable population groups: persons over the age of 65, persons under the age of 5, non-English speaking households, those with disabilities, and those living below the poverty level. Table 3-8 lists population statistics for these socially vulnerable populations, for each Community Plan Area in the County, based on the 2023 ACS 5-year estimates. Twenty percent of the County's population is over the age of 65, and 5.4 percent of the population is under the age of 5. The 2023 ACS 5-year estimates indicate a total of 9.7 percent of all persons living in households that fall below the poverty level, 3.7 percent of the County's residents live in non-English speaking households, and 10.7 percent of the County's residents live with a disability.

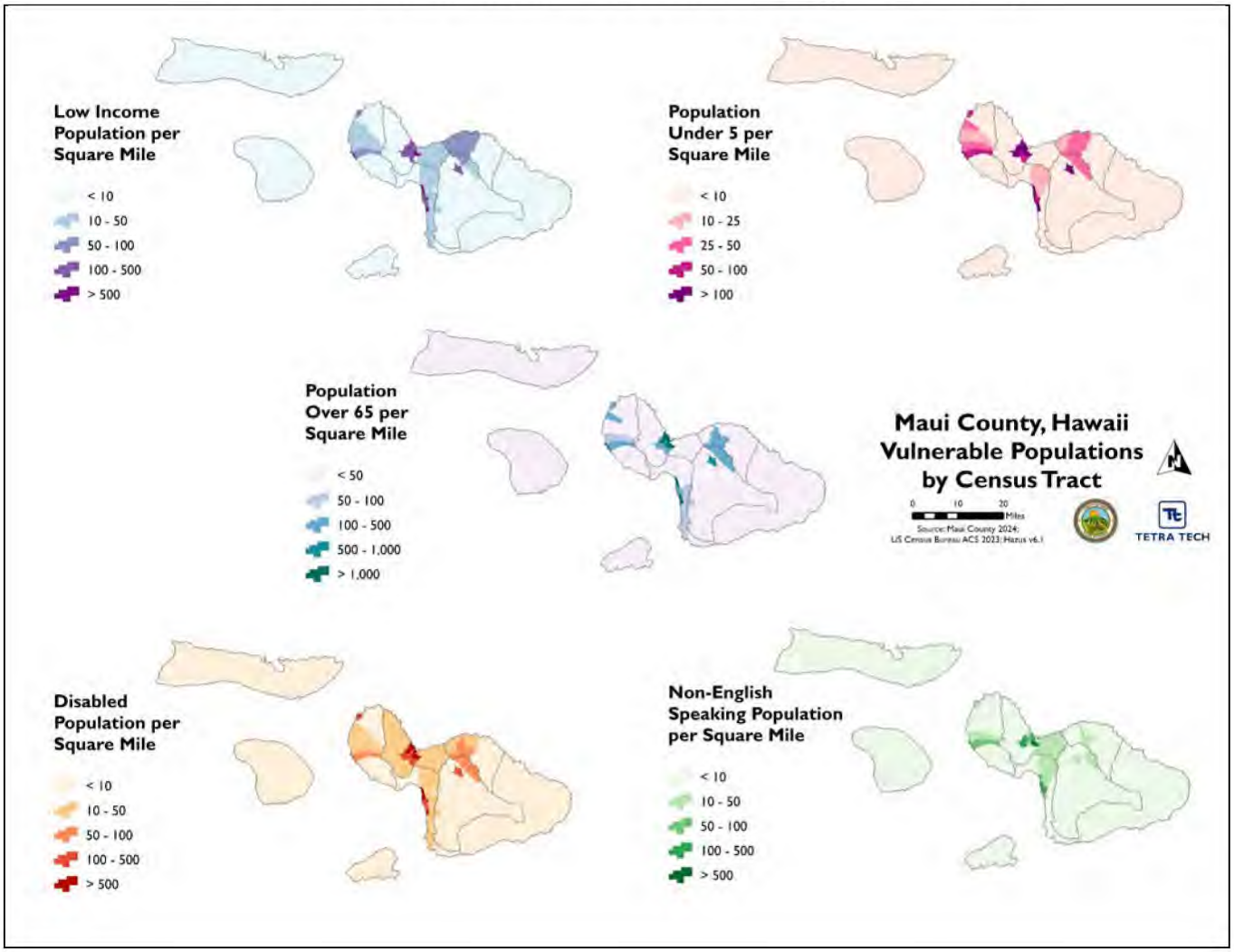
Table 3-8. Maui County Demographic Statistics

Community Plan Area	American Community Survey 5-Year Population Estimates (2023)									
	Population Over 65		Population Under 5		Non-English Speaking Population		Population with Disability		Population Below Poverty Level	
	Total	% of Plan Area Total	Total	% of Plan Area Total	Total	% of Plan Area Total	Total	% of Plan Area Total	Total	% of Plan Area Total
Hāna	565	26.4%	102	4.8%	40	1.9%	232	10.9%	335	15.7%
Kīhei-Mākena	6,115	21.0%	1,331	4.6%	851	2.9%	3,149	10.8%	2,900	9.9%
Lānaʻi	713	21.4%	222	6.7%	377	11.3%	578	17.3%	248	7.4%
Makawao-Pukalani-Kula	5,450	22.2%	1,373	5.6%	483	2.0%	2,427	9.9%	2,670	10.9%
Molokaʻi	1,724	21.3%	355	4.4%	58	0.7%	1,394	17.2%	1,491	18.4%
Pāʻia-Haʻikū	2,831	16.6%	1,131	6.6%	164	1.0%	1,420	8.3%	1,957	11.5%
Wailuku-Kahului	11,526	19.7%	2,958	5.0%	3,183	5.4%	6,456	11.0%	4,289	7.3%
West Maui	4,058	18.7%	1,479	6.8%	930	4.3%	2,021	9.3%	2,081	9.6%
Maui County (Total)	32,982	20.0%	8,950	5.4%	6,085	3.7%	17,677	10.7%	15,969	9.7%

Source: U.S. Census Bureau 2020 Decennial; U.S. Census Bureau 2023 ACS Vulnerable Population Totals
Note: 2.92 persons per household. This number was used to calculate the non-English speaking populations.

The distributions of the general population density (persons per square mile) for five metrics of social vulnerability are shown in Figure 3-12.

Figure 3-12. Maui County Socially Vulnerable Population Density



Specific planning attention for the elderly is an important consideration given the current aging of the American population. As a group, kupuna, or elders, are more likely to lack the physical and economic resources necessary to respond to hazard events and may suffer health-related consequences, making recovery slower. They are more likely to be vision, hearing, and/or mobility impaired, and more likely to experience mental impairment or dementia. Additionally, elders are more likely to live in assisted-living facilities where emergency preparedness occurs at the discretion of facility operators. Emergency managers typically identify these facilities as “critical facilities” because they require extra notice to implement evacuation. 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 5 are vulnerable to disaster events because of their young age and dependence on others for care and 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.

People with disabilities are more likely to have difficulty responding to a hazard event than the general population. 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. Emergency managers need to distinguish between functional and medical needs to plan for incidents that require evacuation and sheltering. Knowing the percentage of the population with a disability will allow emergency management personnel and first responders to have personnel available who can provide services needed by those with access and functional needs.

3.7.4 Visitor Population

Tourism is a major factor in Hawai'i's economy. In 1966, the state saw 834,732 annual visitors to the islands; that number peaked in 2019 at 10,243,165 before dropping due to the COVID-19 pandemic (DBEDT 2024). By 2023, state annual visitors returned to 9,499,995 and visitor expenditures exceeded $20 billion (DBEDT 2024).

A popular tourist destination, Maui County welcomed 2,531,196 visitors in 2023. Of those visiting in 2023, most (2,495,038 persons) spent time on Maui, with fewer visiting the smaller islands of Moloka'i (33,224) and Lāna'i (53,870) (DBEDT 2024). Visitors frequently visit more than one island during their stay. Table 3-9 indicates the average daily number of domestic and international visitors on each island.

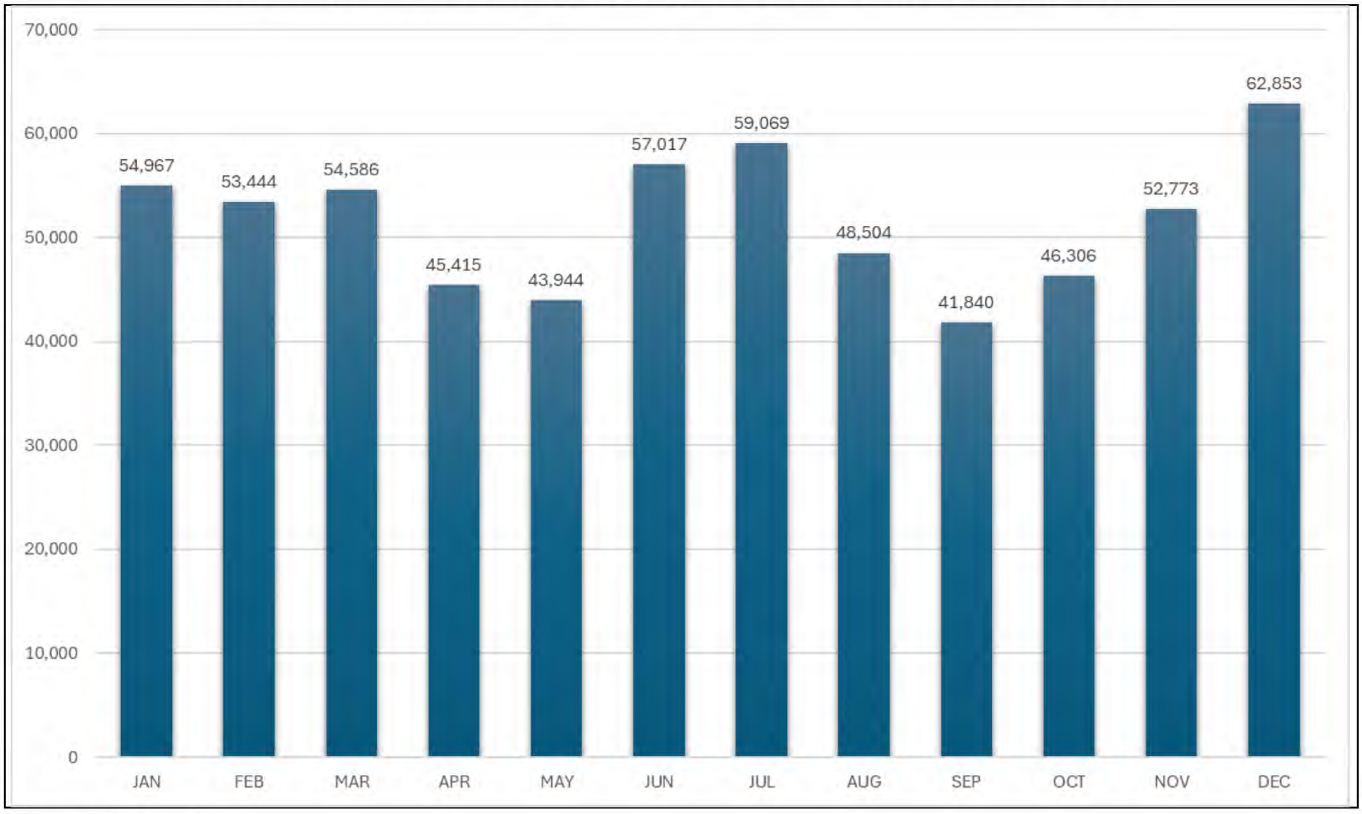
Table 3-9. Average Daily Visitor Census by Island

Island	Domestic Visitors	International Visitors	Total
Oahu	82,699	16,394	99,092
Hawai'i	35,635	2,066	37,701
Kaua'i	37,566	1,038	28,604
Maui	58,924	6,364	62,287
Moloka'i	664	39	703
Lāna'i	713	53	766
State Total	206,201	25,953	232,154

Source: (DBEDT 2024)

Overall, Maui County's 2023 visitors represented 26.6 percent of the total visitors to the State of Hawai'i. Figure 3-13 displays the average daily number of visitors in Maui County throughout the year. Of these visitors, between 6 and 13 percent arrive on international flights (HTA n.d.).

Figure 3-13. Maui County Average Daily Visitor Census by Month



Source: (HTA n.d.)

Based on these statistics, at any given time approximately one third of Maui County's population consists of non-residents. This has implications for hazard mitigation planning, as many tourists seek recreational activities such as hiking, swimming, and other water sports in places of natural beauty yet lack the awareness of their exposure to hazards such as flash flooding of streams and natural freshwater pools, and coastal hazards such as high surf and strong currents.

3.8 ECONOMY

3.8.1 Major Institutions

Maui County's economy is based on a combination of industry, government services, agriculture, and tourism. Many of the top employers are hotels and resorts located in West Maui and the Kīhei-Mākena area. Most large private businesses and government employers are in the Wailuku-Kahului area. As of 2019, 20 of the top 50 employers in the county were accommodation providers (resorts, hotels, motels, cottages, or condos). Government services on the top employers list include the Maui Police Department, Maui Fire Department, Maui Community Correctional, school, and county agencies. Table 3-10 lists the top 50 employers in Maui County. It is important to note that while individual County agencies are listed in the below table, overall, the County employs more people than any other organization.

Table 3-10. Top 50 Employers in Maui County

Rank	Name	Community Plan Area	Business Description	Employee Size	Year Established
1	Grand Wailea-Waldorf Astoria	Kīhei-Mākena	Resorts	1,000-4,999	1991
2	Ritz-Carlton-Kapalua	West Maui	Hotels & Motels	1,000-4,999	1992
3	Maui Memorial Medical Ctr	Wailuku-Kahului	Hospitals	500-999	2000
4	Four Seasons-Maui	Kīhei-Mākena	Hotels & Motels	500-999	1988
5	Westin Maui Resort-Spa Kā'anapali	West Maui	Hotels & Motels	500-999	1971
6	Four Seasons Lāna'i	Lāna'i	Hotels & Motels	500-999	1991
7	Kea Lani Maui Restaurant	Kīhei-Mākena	Restaurants	500-999	1991
8	Hyatt Regency-Maui Resort & Spa	West Maui	Hotels & Motels	500-999	1980
9	Mākena Beach & Golf Resort	Kīhei-Mākena	Resorts	500-999	1986
10	Walmart	Wailuku-Kahului	Department Stores	500-999	2003
11	Kā'anapali Beach Club	West Maui	Resorts	500-999	1988
12	Royal Lahaina Resort	West Maui	Resorts	500-999	1909
13	Maui County Police Dept	Wailuku-Kahului	Police Departments	250-499	1988
14	Wailea Beach Resort-Marriott	Kīhei-Mākena	Hotels & Motels	250-499	1976
15	Sensei Lāna'i, a Four Seasons Resort	Lāna'i	Hotels & Motels	250-499	2013
16	Hale Makua Health Svc	Wailuku-Kahului	Day Care Centers-Adult	250-499	1946
17	PWC the People Who Clean	West Maui	Janitor Service	250-499	1973
18	Lāna'i Resorts LLC	Lāna'i	Resorts	250-499	2014
19	Inn At Mama's	Pā'ia-Ha'ikū	Cottages & Cabins	250-499	2006
20	Wailuku Elementary School	Wailuku-Kahului	Schools	250-499	1984
21	Kā'anapali Beach Hotel	West Maui	Hotels & Motels	250-499	1984
22	Maui Electric dba Hawaiian Electric	Wailuku-Kahului	Electric Companies	250-499	1921
23	Tiki Terrace Restaurant	West Maui	Full-Service Restaurant	250-499	1985
24	Sheraton Maui Resort & Spa	West Maui	Hotels & Motels	250-499	1988
25	Kaiser Permanente	Wailuku-Kahului	Clinics	250-499	2001
26	Aloha Air Cargo	Wailuku-Kahului	Air Cargo Service	250-499	2005
27	PWC Hawai'i Corp	West Maui	Janitor Service	250-499	1973
28	Maui County Fire Dept	Wailuku-Kahului	Government Offices-County	250-499	1995
29	Macy's	Wailuku-Kahului	Department Stores	250-499	1984
30	Lodge At Koele	Lāna'i	Resorts	250-499	1990
31	Aston Kā'anapali Shores	West Maui	Condominiums	250-499	2009
32	Kula Hospital	Makawao-Pukalani-Kula	Hospitals	100-249	1996
33	Dorvin D Leis Co Inc	Wailuku-Kahului	Mechanical Contractors	100-249	1967
34	Bayada Home Health Care	Wailuku-Kahului	Home Health Service	100-249	2006

Rank	Name	Community Plan Area	Business Description	Employee Size	Year Established
35	PWC the People Who Clean	West Maui	Cleaners	100-249	1973
36	Kaiser Permanente Maui Lani	Wailuku-Kahului	Physicians & Surgeons	100-249	2005
37	Maui Canoe Club	Kīhei-Mākena	Fraternal Organizations	100-249	2009
38	Goodfellow Brothers Inc	Kīhei-Mākena	Contractors-Engineering General	100-249	1992
39	Sheraton-Vistana Resort	West Maui	Hotels & Motels	100-249	2016
40	Mama's Fish House	Pāʻia-Haʻikū	Full-Service Restaurant	100-249	1973
41	Costco Wholesale	Wailuku-Kahului	Wholesale Clubs	100-249	2003
42	Aloha Mixed Plate	West Maui	Restaurants	100-249	2003
43	Old Lahaina Luau	West Maui	Restaurants	100-249	1998
44	Baldwin High School	Wailuku-Kahului	Schools	100-249	1984
45	Lowe's Home Improvement	Wailuku-Kahului	Home Centers	100-249	2016
46	Maui County Department of Water Supply	Wailuku-Kahului	Government Offices-County	100-249	2001
47	Home Depot	Wailuku-Kahului	Home Centers	100-249	2002
48	Travasa Hāna Hotel	Hāna	Hotels & Motels	100-249	1946
49	Maui Community Correctional	Wailuku-Kahului	Government Offices-State	100-249	1992
50	Maui Beach Hotel	Wailuku-Kahului	Hotels & Motels	100-249	1984
51	Westin Ka'anapali Ocean Resort	West Maui	Hotels & Motels	100-249	2003
52	Valley Isle Motors Ltd	Wailuku-Kahului	Automobile Dealers-New Cars	100-249	1923

Source: (Hawai'i Open Data 2019)

Due to its history as a plantation and ranching location, Maui County has a strong agricultural identity. As of 2022, there were 1,405 farms in Maui County covering 258,218 acres and the total market value of products sold by these farms was $93,906,000 (USDA 2022). Most of these farms are small; 68 percent of the farms are less than 10 acres, as shown in Table 3-11.

Table 3-11. Maui County Farms by Size

Farm Size	Number of Farms	Percent of Total
1 to 9 acres	956	68%
10 to 49 acres	329	23%
50 to 179 acres	63	4%
180 to 499 acres	14	1%
500 to 999 acres	17	1%
1,000+ acres	26	2%

Source: (USDA 2022)

3.8.2 Employment

Maui County has a labor force of 86,911 people and an average unemployment rate of 5.4 percent (DBEDT 2024). As of 2023, Hawai'i's Department of Business, Economic Development, and Tourism (DBEDT) listed 74,100 jobs in Maui County by the North American Industry Classification System (NAICS) code. The leisure and hospitality industry is the leading sector with 30 percent of the jobs, followed by trade, transportation, and utilities at 19 percent and education and health services at 13 percent, as displayed in Table 3-12. Agricultural jobs are not included in this table.

Table 3-12. Maui County Job Count by NAICS Industry

Industry	Jobs	Percent of Total
Leisure and Hospitality	22,200	30%
Trade, Transportation and Utilities	14,300	19%
Education and Health Services	9,400	13%
Government Services	9,000	12%
Professional and Business Services	6,600	9%
Natural Resources, Mining, and Construction	4,700	6%
Other Services	3,200	4%
Financial Activities	2,800	4%
Manufacturing	1,200	2%
Information	700	1%

Source: (DBEDT 2024)

The agriculture sector is a core part of the county's identity. However, from 2007 to 2022, Maui County lost almost one third of its farm jobs. This level of decline is specific to Maui County; Kaua'i and Honolulu gained farm jobs during the same period and Hawai'i County lost only 6 percent of its farm jobs. Table 3-13 displays the number of workers across the state engaged in the direct production of agricultural commodities (livestock or crops), whether as a sole proprietor, partner, or hired laborer.

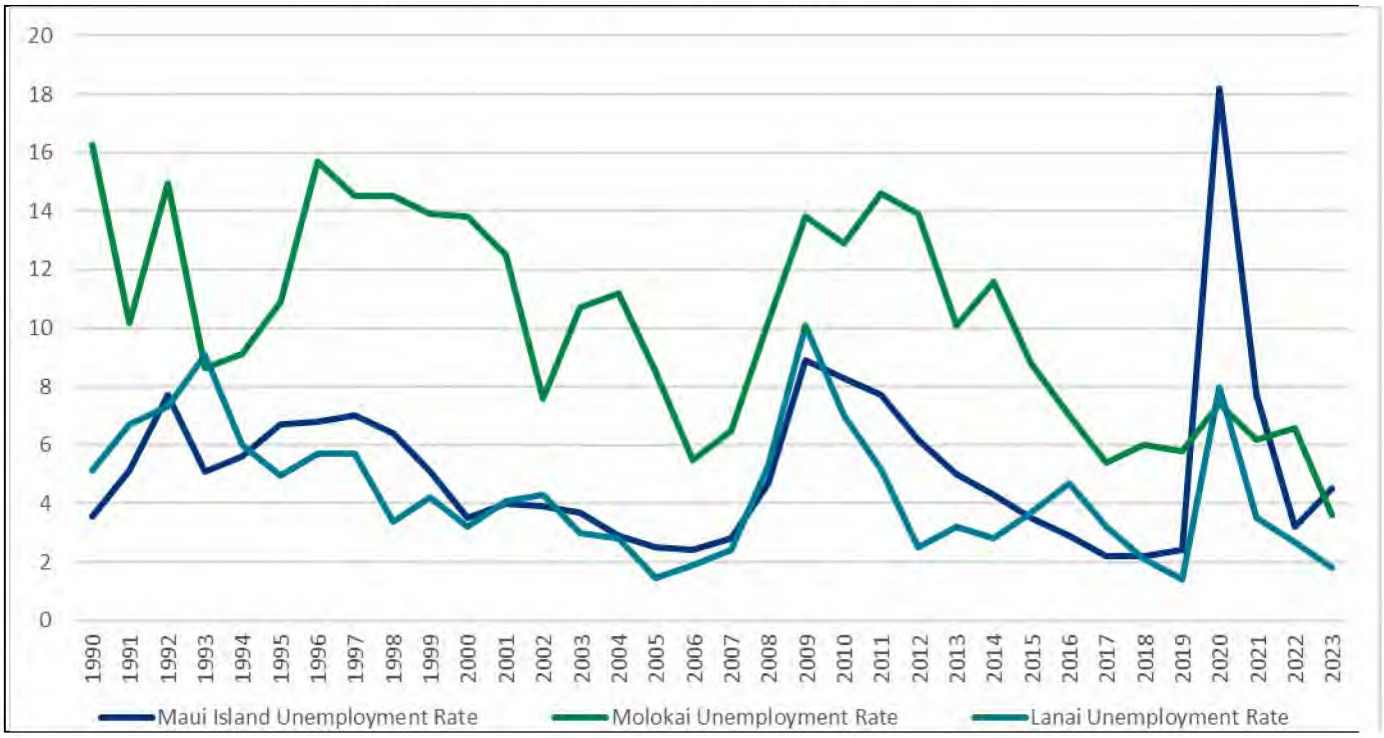
Unemployment in the county varies by island. Figure 3-14 compares the unemployment rates of Maui, Moloka'i, and Lāna'i from 1990 to 2023. Moloka'i has historically had the highest unemployment rate; however, this island did not experience an unemployment spike during the COVID-19 pandemic. Maui, on the other hand, experienced its highest-ever unemployment rate during the pandemic, at 18.2 percent. In 2023, Moloka'i experienced its lowest-ever unemployment rate of 3.6 percent.

Table 3-13. Farm Employment by County, 2007 to 2022

Year	State	Honolulu	Hawai'i	Maui	Kaua'i
2007	12,489	2,167	6,362	2,874	1,086
2008	11,661	2,069	5,916	2,661	1,015
2009	11,288	2,120	5,666	2,463	1,039
2010	11,510	2,352	5,599	2,572	987
2011	12,304	2,717	5,776	2,790	1,021
2012	11,735	2,582	5,577	2,591	985
2013	11,950	2,717	5,618	2,609	1,006
2014	13,161	3,027	6,154	2,873	1,107
2015	12,625	2,910	6,033	2,606	1,076
2016	12,255	2,804	5,965	2,453	1,033
2017	12,011	2,799	6,079	2,094	1,039
2018	12,531	2,988	6,337	2,093	1,113
2019	10,664	2,396	5,510	1,742	1,016
2020	10,365	2,274	5,414	1,714	963
2021	11,308	2,517	5,841	1,911	1,039
2022	11,581	2,552	5,974	1,956	1,099
Total Gain/Loss	-908	+385	-388	-918	+13

Source: (DBEDT 2024)
Note: Maui County includes Kalawao County

Figure 3-14. Maui County Unemployment Rates



Source: (DBEDT 2025)

3.8.3 Income

The average annual wage in 2022 in Maui County of $56,618 was below the state ($61,529) and national ($69,986) averages (DBEDT 2024). Table 3-14 lists the Top 25 occupations in the Kahului-Wailuku-Lahaina Metropolitan Statistical Area by number of people employed, with mean hourly and annual wages.

Table 3-14. Maui Metropolitan Statistical Area Top 25 Occupations by Number Employed

Occupation	Number of Employees	Mean Hourly Wage	Mean Annual Wage
Waiters & waitresses	2,960	$25.86	$53,800
Fast food and counter workers	2,900	$15.81	$32,890
Maids and housekeeping cleaners	2,430	$23.97	$49,860
Retail salespersons	2,420	$19.82	$41,230
Cooks, restaurant	2,270	$24.58	$51,130
Office clerks, general	1,980	$22.55	$46,900
Cashiers	1,860	$17.55	$36,500
General and operations managers	1,630	$57.42	$119,440
Landscaping and groundskeeping workers	1,340	$21.92	$45,590
Maintenance & repair workers, general	1,340	$28.70	$59,690
First-line supervisors of office & admin. supp. workers	1,300	$31.02	$64,510
Janitors & cleaners, exc. maids & housekeeping cleaners	1,250	$19.94	$41,460
First-line supervisors of food preparation and serving workers	1,110	$26.52	$55,160
Laborers and freight, stock, and material movers, hand	1,090	$21.51	$44,730
Dining room and cafeteria attendants and bartender Helpers	1,080	$21.49	$44,700
Registered Nurses	1,070	$57.25	$119,080
Stockers and order fillers	1,000	$19.95	$41,490
First-line supervisors of retail sales workers	980	$28.04	$58,310
Customer service representatives	890	$21.65	$45,030
Secretaries & administrative assistants, except legal, medical, and executive	870	$24.96	$51,930
Amusement and recreation attendants	800	$20.96	$43,590
Bartenders	790	$28.98	$60,270
Carpenters	770	$38.72	$80,540
Home health and personal care aides	750	$17.78	$36,980
Dishwashers	740	$19.72	$41,010

Source: (DBEDT 2024)

Note: Annual wages have been calculated by multiplying the hourly mean wage by a "year-round, full-time" hours figure of 2,080 hours; for those occupations where there is not an hourly mean wage published, the annual wage has been directly calculated from the reported survey data.

Legislation to increase the minimum wage was passed under Hawai'i's last three governors, resulting in a 213 percent increase in the minimum wage from 2002 to 2028. Table 3-15 displays the progression of minimum wage increases since 2002.

Table 3-15. Hawai'i Minimum Wage History and Future

Effective Date	State Minimum Wage
2002	$5.75
2003	$6.25
2006	$6.75
2007	$7.25
2015	$7.75
2016	$8.50
2017	$9.25
2018	$10.10
2022	$12.00
2024	$14.00
2026	$16.00
2028	$18.00

Source: (DBEDT 2024)

The median household income in Maui County is $95,076 and the median per capita income is $44,403. Both of these figures are below the state average but above the national average. Table 3-16 displays median income figures for Maui County, the State of Hawai'i, and the United States.

Table 3-16. Income in Maui County

Income	Maui County	Hawai'i	United States
Median Household Income	$95,076	$98,317	$75,538
Per Capita Income	$44,403	$44,823	$43,289

Source: ACS 2019-2023 5-Year Estimates
Note: In 2023 dollars

3.8.4 Economic Trends

Employment

Maui County employment is forecasted to increase by 4,080 jobs by 2028 (DLIR 2021), with the following projections by industry or sector:

- The leading job growth will be in the health care and social assistance sector, with the addition of 1,240 positions. As the population ages, ambulatory health care services will grow rapidly

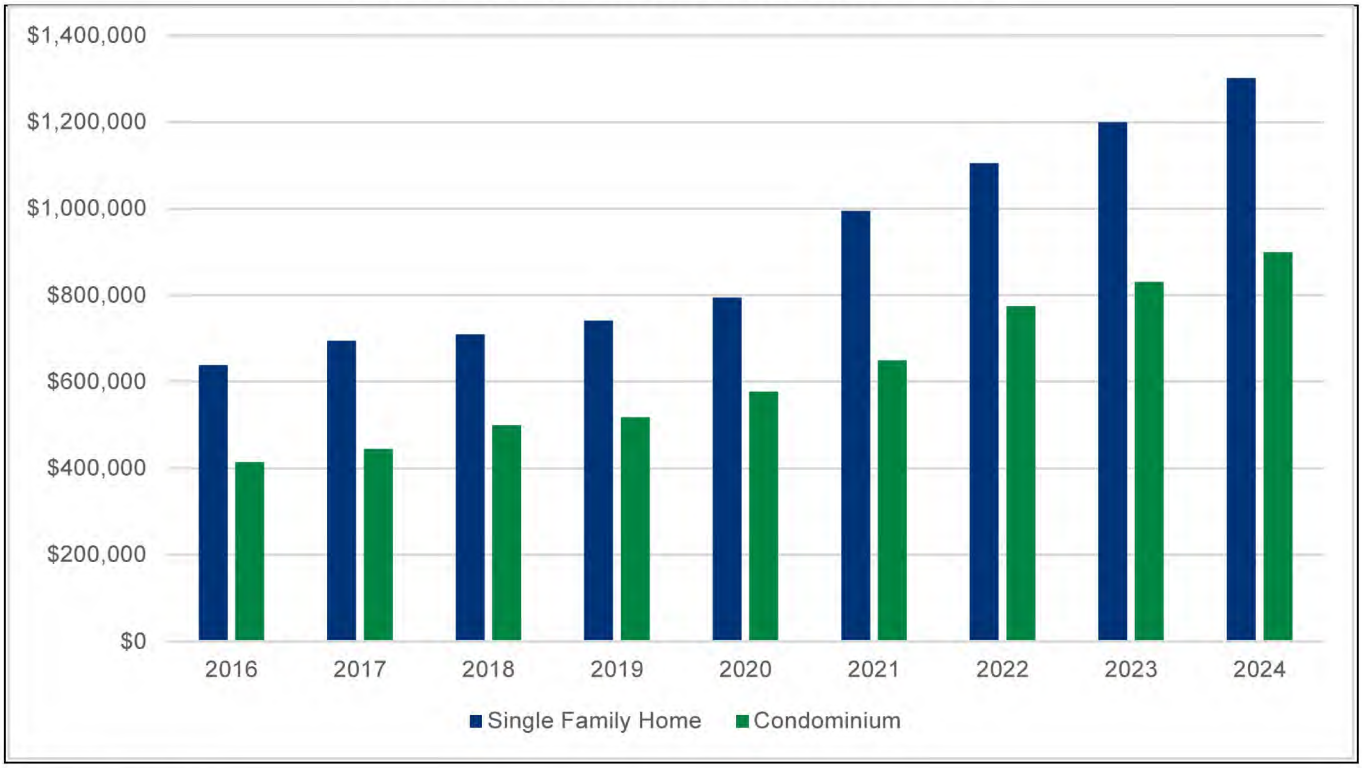
(25.1 percent), a large industry sector that includes doctors and dentist offices, outpatient medical centers, home health care, and medical labs.

- The fastest-growing industry is construction, which is expected to generate 650 new jobs between 2018 and 2028 at a rate of 16.4 percent.
- With consumer spending and tourism on the rise, food services and drinking places are poised to add 920 new jobs, ranking it second in terms of job creation.
- The transportation and warehousing industry will add 520 jobs for a gain of 13.4 percent. Support activities for transportation will benefit from 210 more positions mostly in the air transportation field. The largest sector, scenic and sightseeing transportation, will generate 130 new positions to support the resurgence of the visitor industry. Another sector with growth potential is transit and ground passenger transportation.
- Wholesale trade is forecast to expand by 10.1 percent to 1,680 jobs in 2028 while adding 160 new positions. Most of the jobs will benefit merchant wholesalers of nondurable goods, which includes groceries, beverages, and petroleum and paper products.

Housing Affordability

Housing affordability in Maui County has been a concern for several decades. The cost of housing saw a significant boom during the COVID-19 pandemic, as illustrated in Figure 3-15. From 2020 to 2021, the median price of a single-family home on Maui Island rose 25 percent from $795,000 to $995,000. As of December 2023, the median price of a single-family home is more than $1.3 million.

Figure 3-15. Median Home Price on Maui Island



Source: (RAM 2025)

3.9 GENERAL BUILDING STOCK

3.9.1 Existing Development

For the purposes of this plan, 45,548 structures were identified from available tax data and spatial data. These structures account for a replacement cost value of approximately $30.5 billion. Content value was estimated as 50 percent of the structure's replacement cost value for residential properties, and 100 percent of the structure's replacement cost value for non-residential properties. Using this methodology, approximately $21 billion in contents exist within these properties.

Table 3-17. Structures and Replacement Cost Value

Community Plan Area	Number of Buildings	Replacement Cost Value		
		Structure	Contents	Total
Hāna	930	$445,797,991	$295,468,485	$741,266,476
Kīhei-Mākena	7,613	$7,222,909,415	$4,469,851,575	$11,692,760,990
Lānaʻi	1,258	$576,943,081	$435,903,054	$1,012,846,136
Makawao-Pukalani-Kula	8,868	$3,695,867,951	$2,341,449,747	$6,037,317,698
Molokaʻi	3,056	$1,351,250,513	$1,033,201,485	$2,384,451,998
Pāʻia-Haʻikū	4,316	$1,643,178,916	$1,042,875,460	$2,686,054,376
Wailuku-Kahului	15,444	$10,119,885,932	$8,182,489,419	$18,302,375,352
West Maui	4,063	$5,531,362,173	$3,365,125,446	$8,896,487,618
Maui County (Total)	45,548	$30,587,195,972	$21,166,364,672	$51,753,560,644

Source: USACE NSI 2022; Hawai'i Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; RSMeans 2024

Table 3-18 presents building stock statistics by occupancy class for Maui County. The countywide distribution is as follows:

- Residential structures account for 88.7 percent of the total buildings in the County and 60.4 percent of the total building stock value.
- Commercial structures account for 8.4 percent of the buildings and 25.1 percent of the total building stock value.
- Industrial structures account for 1.9 percent of the buildings and 6.7 percent of the total building stock value.
- The remaining structures (government, religious, agricultural, or education) account for 1.0 percent of the buildings and 7.8 percent of the total building stock value.

Figure 3-16 through Figure 3-18 show the value density of residential, commercial, and industrial buildings in Maui County. Value density is the dollar value of buildings (structure and contents) per unit area. These maps indicate areas of high loss potential.

Table 3-18. Building Stock by Occupancy Class

Community Plan Area	Residential		Commercial		Industrial		Other[a]	
	Building Count	Total Replacement Cost Value	Building Count	Total Replacement Cost Value	Building Count	Total Replacement Cost Value	Building Count	Total Replacement Cost Value
Hāna	835	$469,962,067	73	$193,846,899	10	$14,537,246	12	$62,920,264
Kīhei-Mākena	6,632	$8,616,827,971	752	$2,078,212,494	164	$551,940,295	65	$445,780,229
Lānaʻi	1,152	$511,640,719	83	$317,787,079	15	$109,384,617	8	$74,033,721
Makawao-Pukalani-Kula	8,292	$4,246,671,736	414	$823,587,892	78	$243,378,716	84	$723,679,355
Molokaʻi	2,827	$1,286,451,265	143	$583,501,661	68	$360,484,179	18	$154,014,893
Pāʻia-Haʻikū	3,932	$1,884,764,969	275	$482,041,875	72	$156,341,177	37	$162,906,354
Wailuku-Kahului	13,207	$7,584,755,416	1,648	$6,894,219,616	386	$1,801,458,234	203	$2,021,942,086
West Maui	3,534	$6,647,586,338	419	$1,605,532,365	58	$224,340,015	52	$419,028,901
Maui County (Total)	40,411	$31,248,660,482	3,807	$12,978,729,880	851	$3,461,864,480	479	$4,064,305,802

Source: USACE NSI 2022; Hawai'i Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; RSMeans 2024

a. Other = Government, Religion, Agricultural, and Education

Figure 3-16. Distribution of Residential Building Stock and Value Density in Maui County

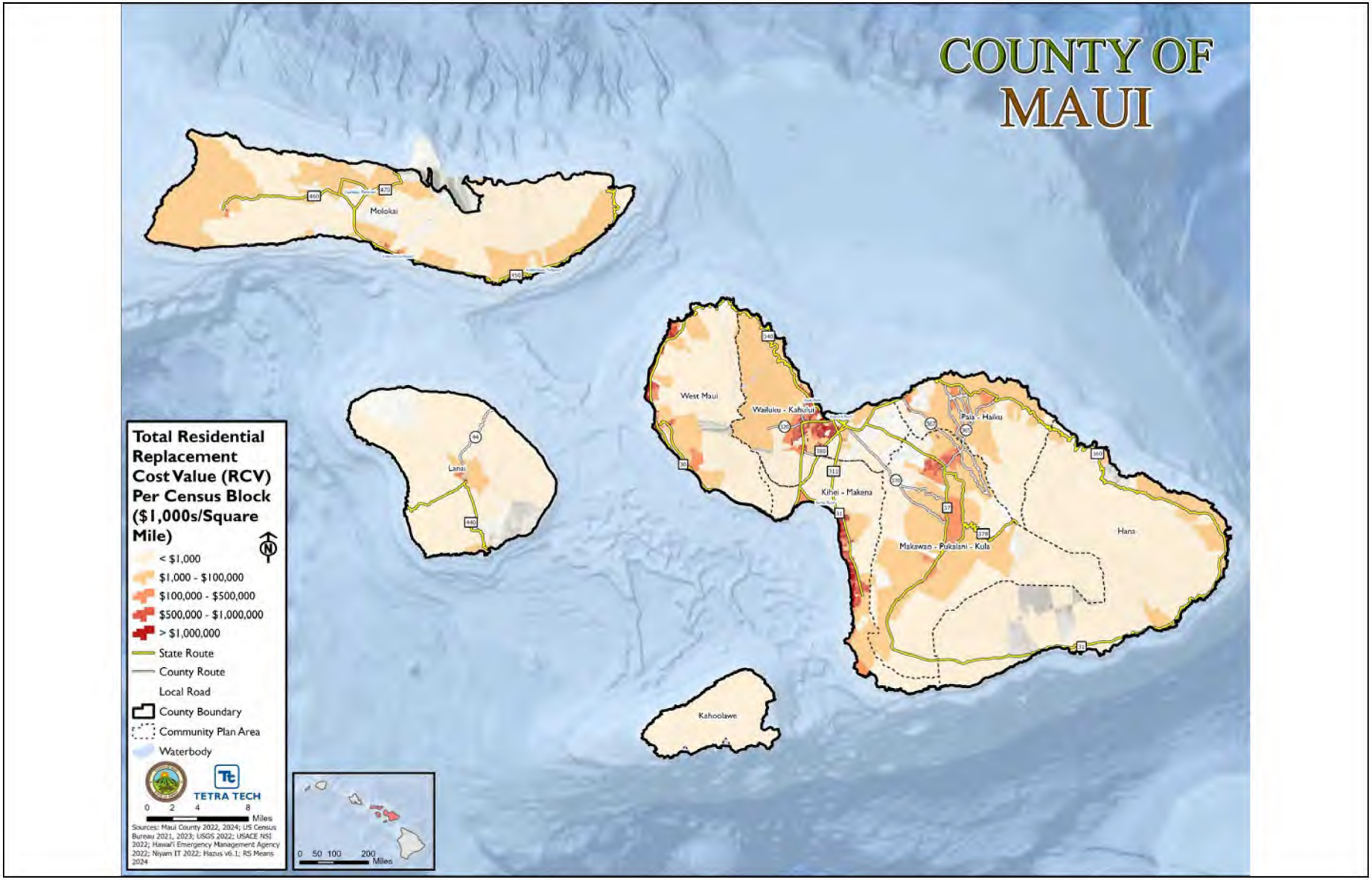


Figure 3-17. Distribution of Commercial Building Stock and Value Density in Maui County

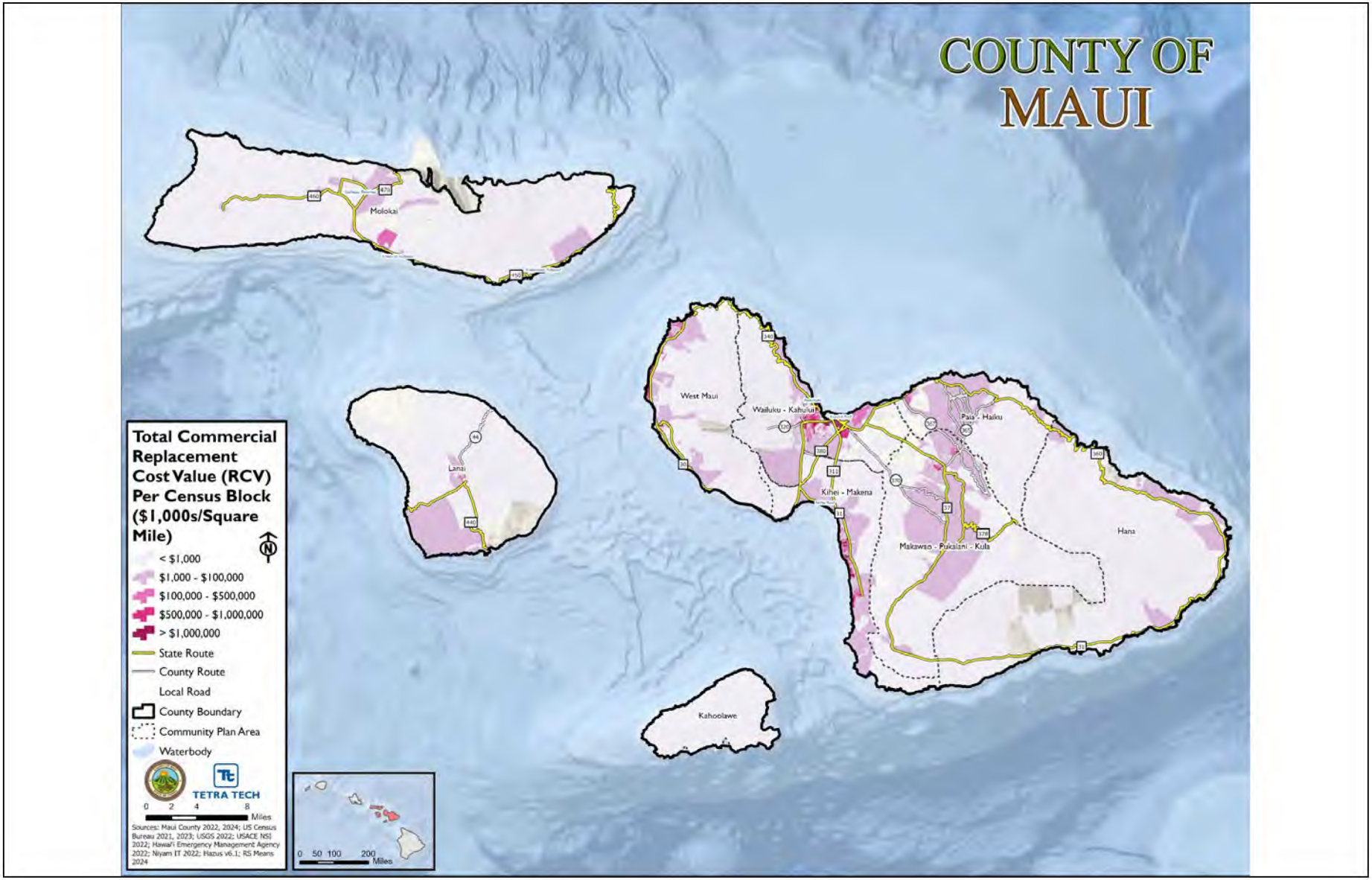
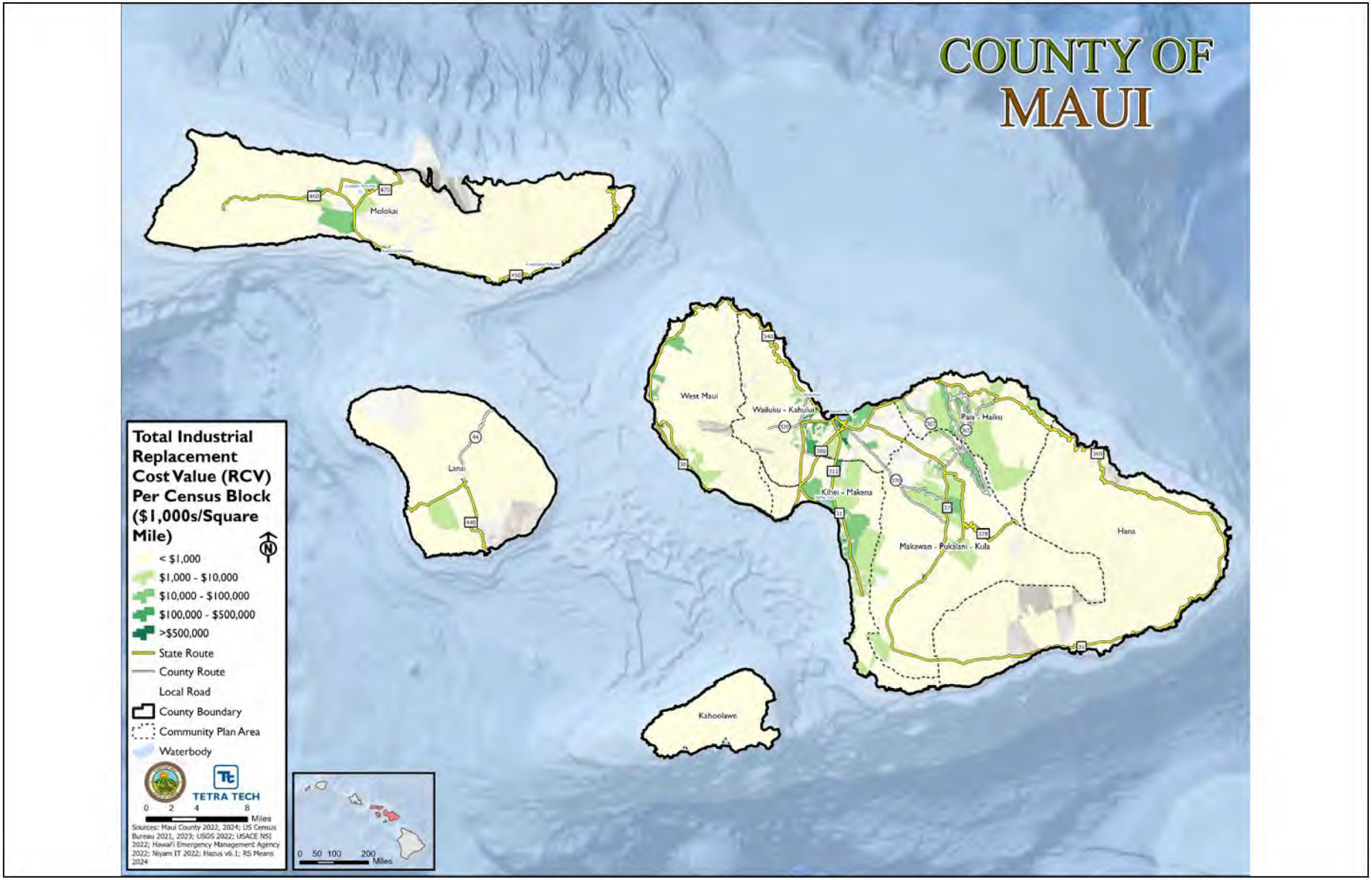


Figure 3-18. Distribution of Industrial Building Stock and Value Density in Maui County



3.9.2 New Development

Based on permit data provided by the Maui Department of Public Works, the County has issued 3,248 permits for new development since 2020. Table 3-19 lists new permits by Community Plan Area. The most popular Community Plan Area for new development is the Wailuku-Kahului area, with 23.1 percent of new permits.

Table 3-19. New Development in Maui County

Community Plan Area	New Development Count
Hāna	39
Kīhei-Mākena	516
Lānaʻi	272
Makawao-Pukalani-Kula	624
Molokaʻi	114
Pāʻia-Haʻikū	358
Wailuku-Kahului	752
West Maui	573
Maui County (Total)	3,248

Source: County of Maui 2025

Figure 3-19 shows the locations of new development projects permitted in Maui County in 2020, 2021, 2022, 2023, and 2024. While coastal development remains popular in the West Maui and Kīhei regions, significant development also occurred in the Upcountry area during this period.

The 2025 HMP provides a detailed overview of new development in hazard-prone areas, showing that vulnerability is increasing across several community planning areas. A significant share of new development is occurring in areas at risk from wildfire, earthquakes, tsunamis, and volcanic hazards, contributing to greater exposure for the general building stock. While exposure to flooding, coastal erosion, and landslides remains relatively limited, the overall trend indicates that new development is expanding into high-risk zones, increasing the County's overall vulnerability.Community Lifelines

Facilities that are essential to the health and welfare of the population and that maintain essential and emergency functions are designated as critical facilities. These typically include police and fire stations, schools, emergency operations centers, and infrastructure such as roads, bridges, and utilities that provide water, electricity, and communications. Facilities that use or store hazardous materials are designated as critical facilities as well. All of these facilities are especially important after any hazard event.

FEMA defines some types of critical facilities, as well as public services or activities, as "community lifelines." Community lifelines provide the fundamental services in a community that, when stabilized, enable all other aspects of society. Following a disaster event, intervention is required to stabilize lifelines. FEMA defines eight categories of community lifelines as summarized in Table 3-20.

Figure 3-19. New Development in Maui County

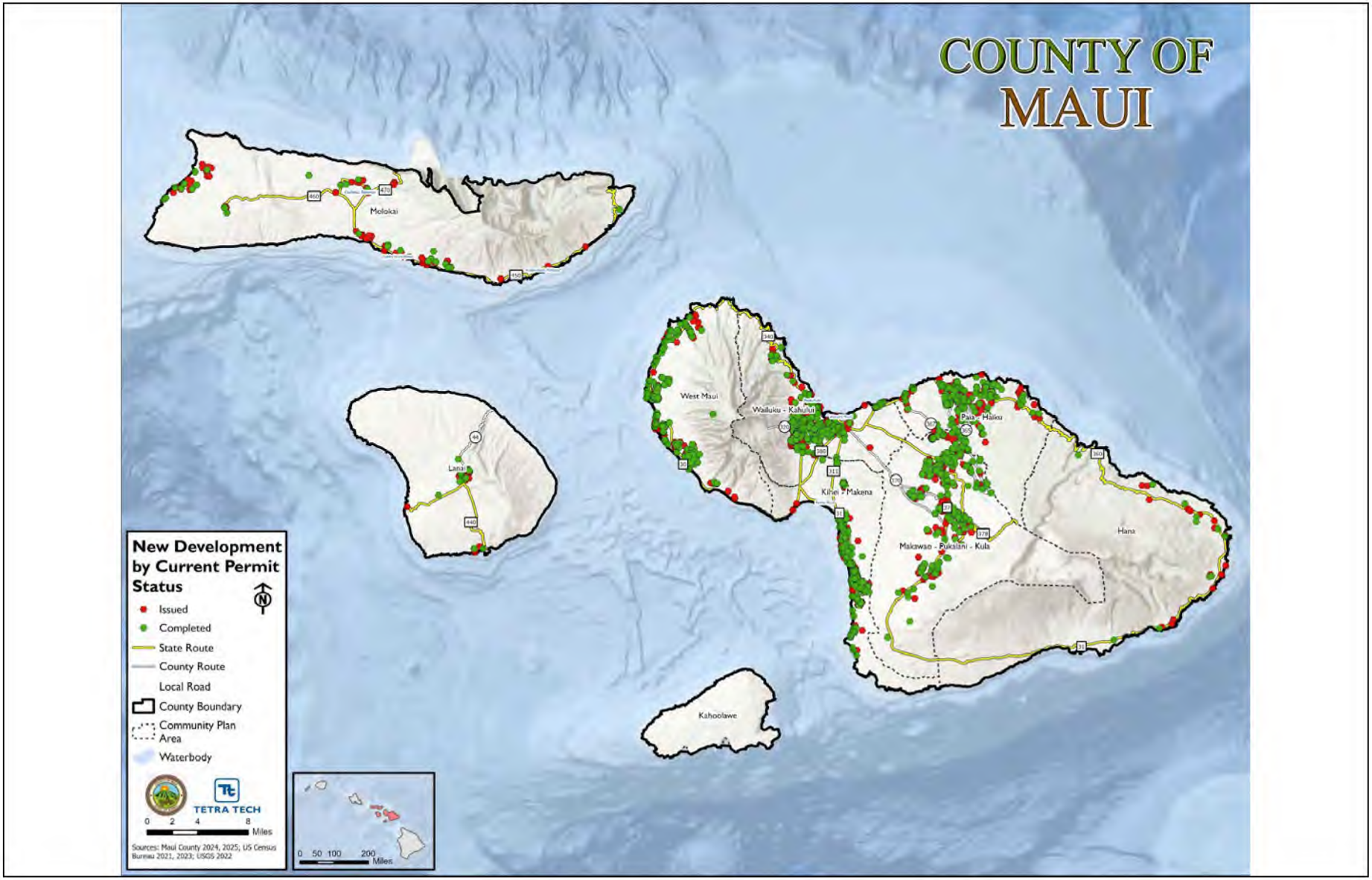


Table 3-20. FEMA-Defined Categories of Community Lifelines

Community Lifeline Category		Types of Facilities and Services Included
	Safety and security	Law enforcement/security, fire service, search and rescue, government service, community safety
	Food, hydration, shelter	Food, hydration, 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 materials	Facilities, hazmat, pollutants, contaminants
	Water systems	Potable water infrastructure, wastewater management

Source: FEMA 2023

A comprehensive inventory of community lifelines in Maui County was developed from various sources for use in the risk assessment of this HMP, as described in the following sections. Many facilities could fall under numerous categories, but each was categorized only under its primary function.

3.9.3 Safety and Security

Figure 3-20 shows the location of safety and security facilities included in the lifelines inventory. Key facilities and services considered for the inventory under this category are as follows:

- MEMA facilities used for the following missions:
  - Aiding communities in emergency planning and response
  - Providing training and equipment for emergency response volunteers
  - Developing, maintaining, and executing Maui County's Comprehensive Emergency Management Plan for disaster relief before, during, and after a disaster
  - Coordinating emergency alert and warning messaging for the County
- Maui Department of Fire and Public Safety facilities to provide emergency and non-emergency services for the islands of Maui, Molokaʻi, Lānaʻi, and Kahoʻolawe and the surrounding waters.
  - The Department has 14 fire stations—10 on the Island of Maui, three on the Island of Molokaʻi, and one on the Island of Lānaʻi.
  - The Department works with community leaders to reduce the impacts of wildfires within their communities through the Wildland Urban Interface Program.
- Maui Police Department facilities:
  - The Department maintains four district stations, six police cottages, one forensic facility, five sub-stations, two places of storage, and one correctional facility.
- The National Inventory of Dams lists 56 dams in Maui County, including 52 listed as high hazard (USACE n.d.).
- The National Levee Database lists nine levees in Maui County (USACE n.d.).
- The Hawai`i State Department of Education is a statewide school district comprising 257 schools divided into seven smaller districts across the Hawaiian islands. The Maui District includes 31 schools on the islands of Maui, Molokaʻi, and Lānaʻi.

3.9.4 Food, Hydration, Shelter

Figure 3-21 shows the location of food, hydration, and shelter facilities included in the lifelines inventory. An area for future improvement of the HMP includes updating the County critical facility list with emergency shelters, critical food suppliers, and essential agricultural facilities.

Figure 3-20. Safety and Security Facilities In Maui County

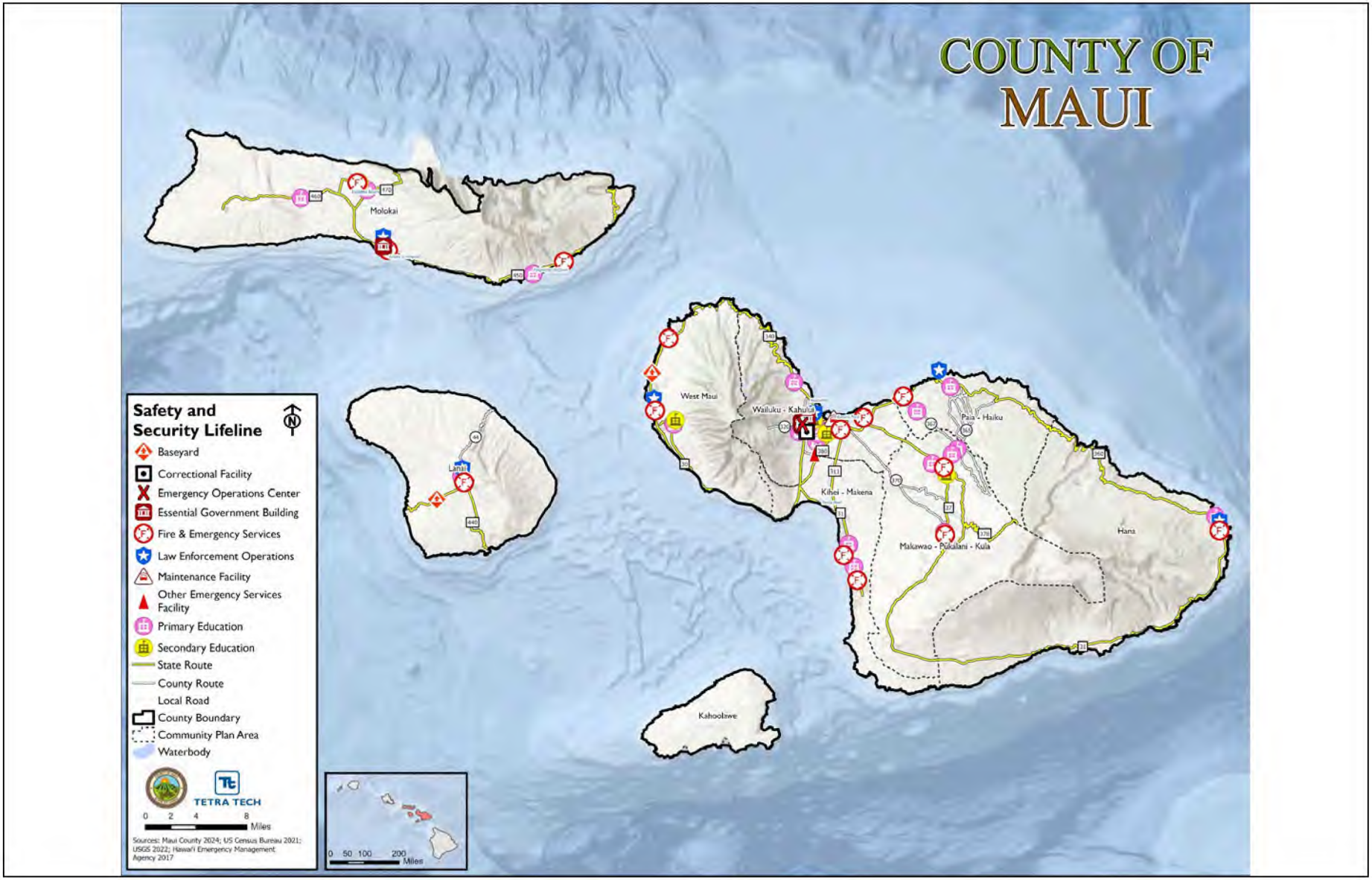
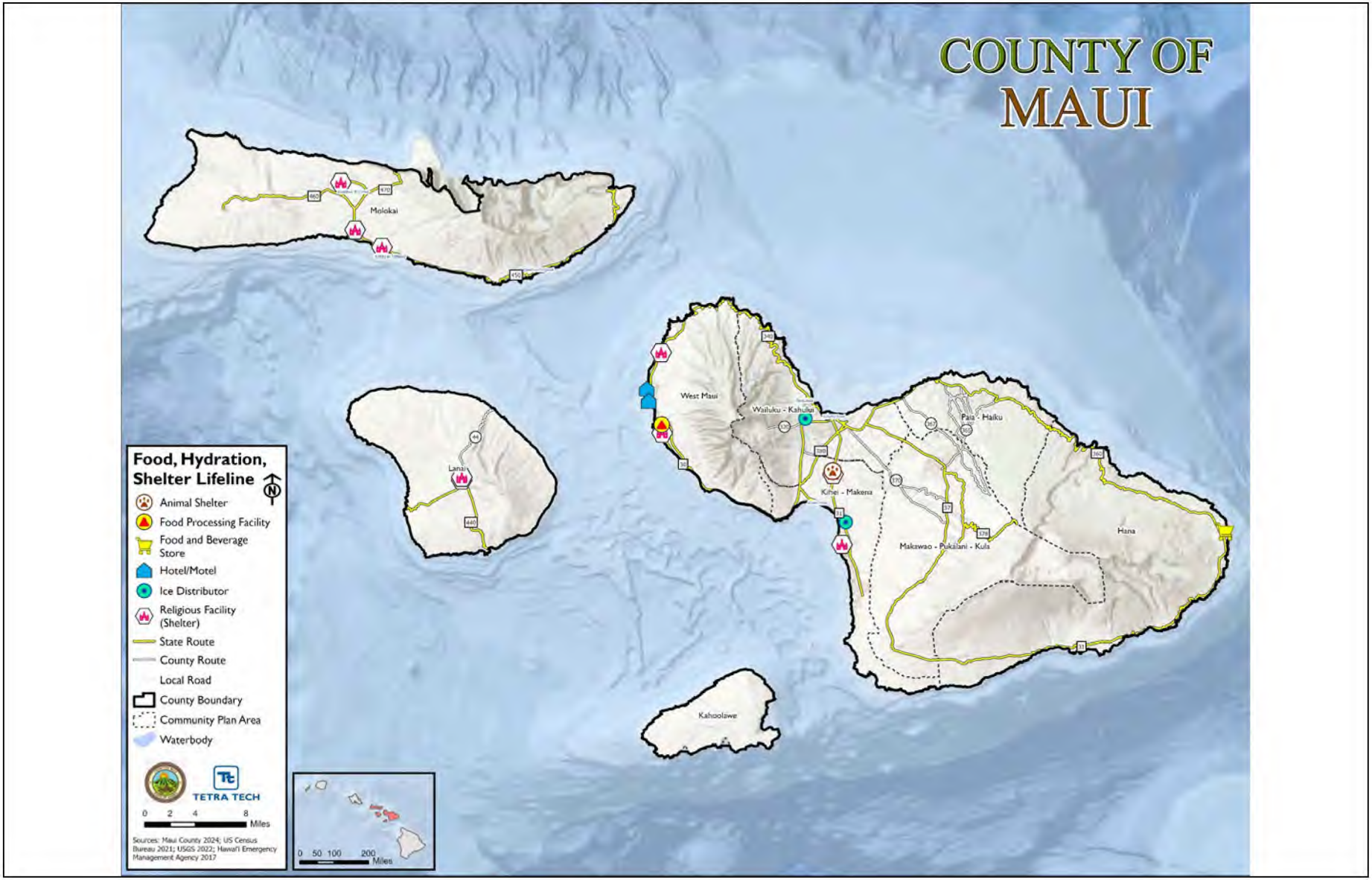


Figure 3-21. Food, Hydration, and Shelter Facilities in Maui County



Key partners and services considered for the inventory under this category are as follows:

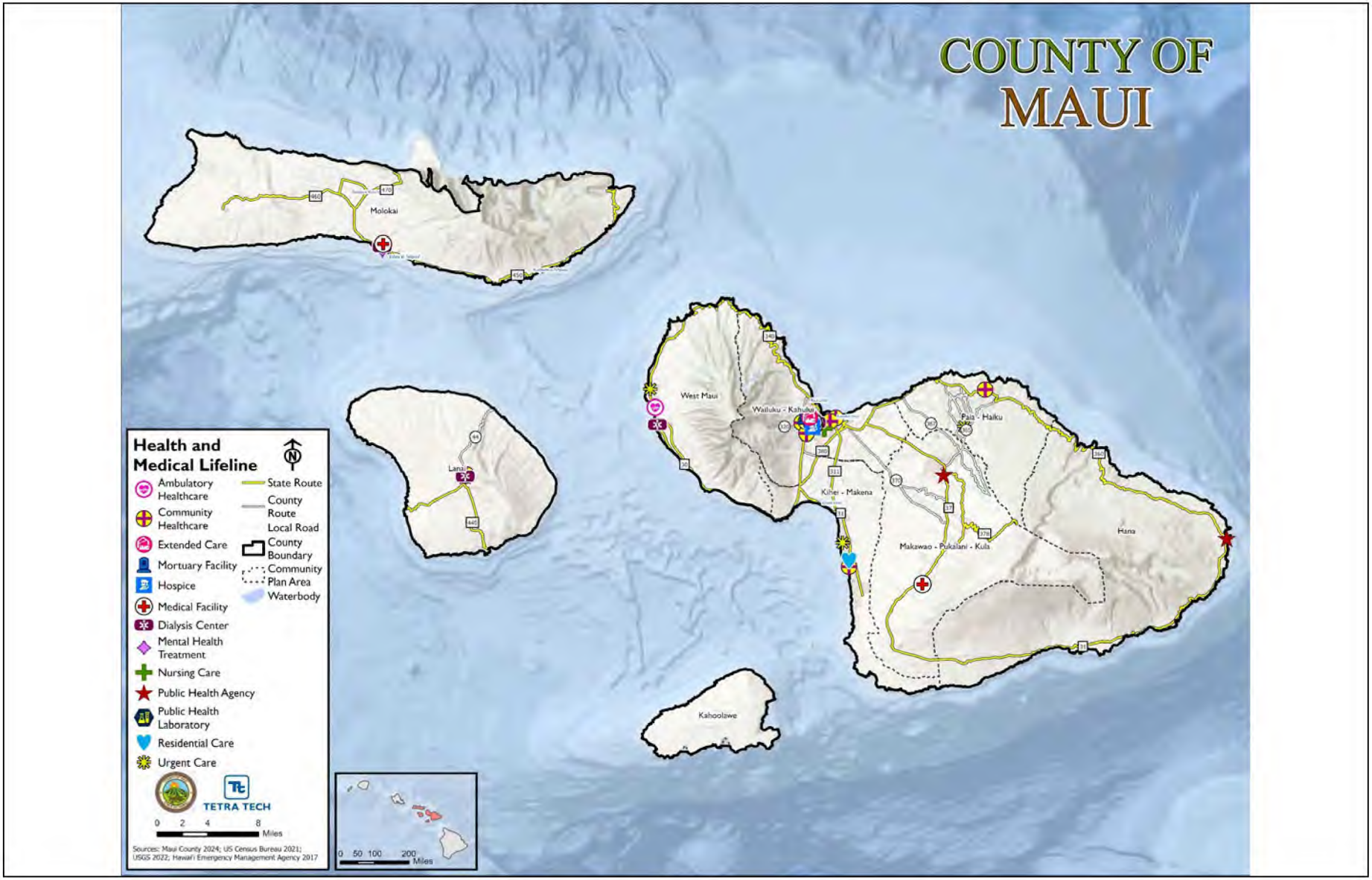
- With the support and cooperation of the American Red Cross, the county references an inventory of suitable shelter locations and can assist with the coordination and communication of shelter availability as necessitated by the execution of local emergency operation plans.
- Habitat for Humanity Maui builds and sells homes to low-income families at a zero interest and no profit basis. They serve families that earn between 25 and 80 percent of the Maui County median income. Their mission is to build decent housing and renovate substandard housing on Maui in partnership with community volunteers and potential homeowners so that homelessness and substandard housing on Maui are eliminated.
- Maui United Way provides emergency food, sheltering (including transitional sheltering), and rent/mortgage and utility assistance to disaster survivors. Their goal is to bring people, organizations, and the community together around a common cause, a common vision, and a common path forward.

3.9.5 Health and Medical

Figure 3-22 shows the location of health and medical facilities included in the lifelines inventory. Key facilities and services considered for the inventory under the health and medical category are as follows:

- Maui Health is a not-for-profit organization that provides care for residents and visitors on Maui and Lānaʻi. They operate the following:
  - Maui Memorial Medical Center is the only acute care hospital on Maui Island. Located in Wailuku, the hospital has 219 beds and a Level III trauma center.
  - Kula Hospital was established in 1910 as a tuberculosis sanitorium and is recognized as a historic site for its significance in the history of health care in Hawaiʻi. Kula Hospital offers 123 beds and urgent and limited rural emergency care for Maui's growing up-country population and may be an option if a medical problem is non-life-threatening.
  - Lānaʻi Community Hospital is the only hospital on the Island of Lānaʻi. Lānaʻi Community Hospital offers 24-hour urgent and limited emergency care, as well as skilled and long-term care services.
- The Molokaʻi General Hospital is part of the Queen's Health System, a non-profit healthcare system established in 1859. The hospital offers primary care and emergency services.
- For non-emergency health care needs, five urgent care centers are located in the County.
- The County has seven kidney dialysis centers and two mental health facilities.

Figure 3-22. Health and Medical Facilities in Maui County



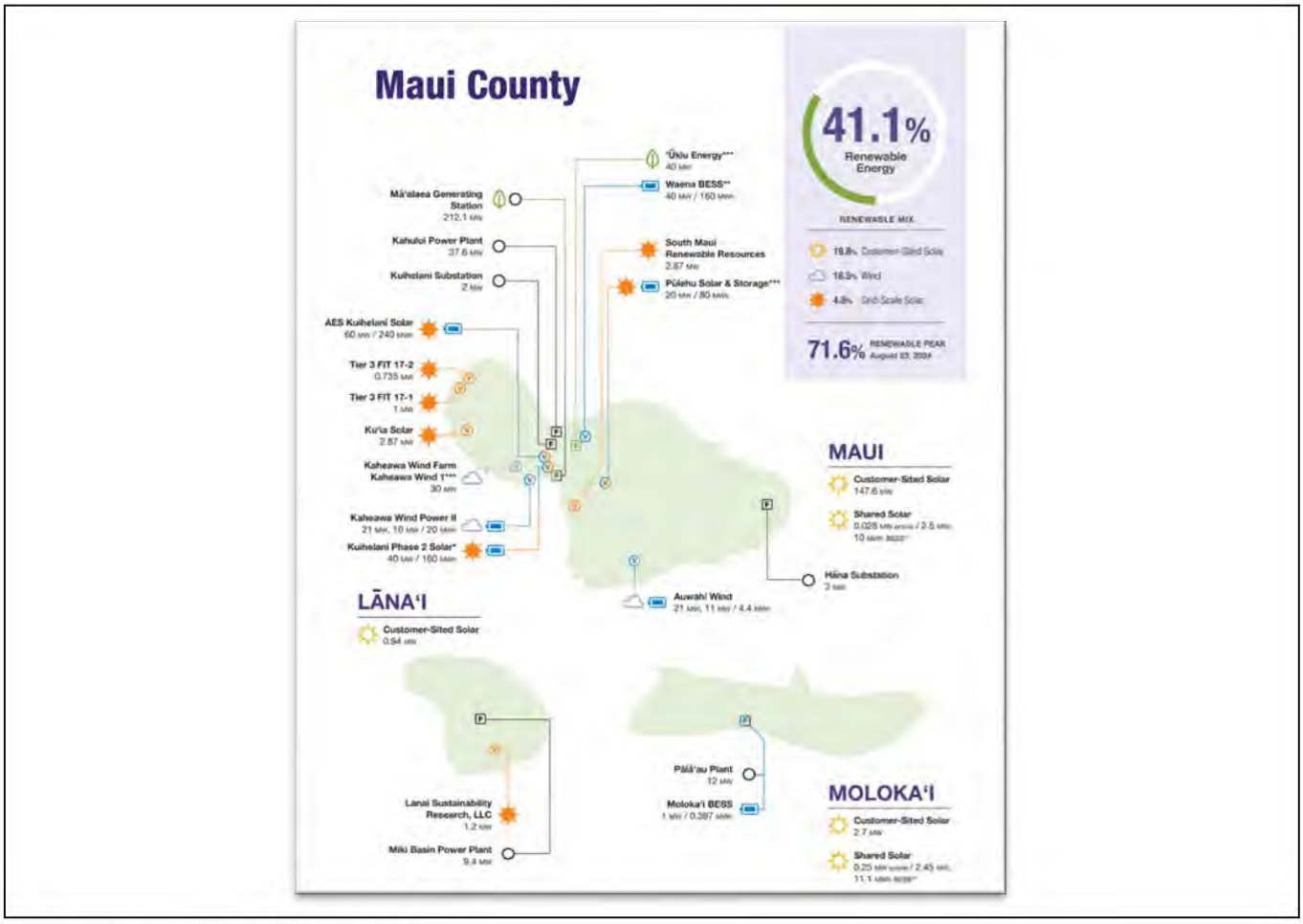
3.9.6 Energy

Figure 3-23 shows the location of Hawaiian Electric Company (HECO) energy facilities located in Maui County; these facilities were not used in the risk assessment. An area for future improvement of the HMP includes updating the County critical facility list in collaboration with the energy sector.

Key facilities and services considered for the inventory under the energy category are as follows:

- Established in 1891, Hawaiian Electric serves approximately 72,000 customers in Maui County, encompassing a service area of 1,128 square miles.
- Since 1904, Hawai'i Gas has been the only franchised gas utility in the state of Hawai'i. The company maintains 1,100 miles of gas pipeline infrastructure and bulk storage facilities, a fleet of over 60 gas delivery vehicles, and over 150 customer service and utility vehicles across the state.

Figure 3-23. Energy Facilities in Maui County



Source: (Hawaiian Electric 2024-2025)

3.9.7 Communications

Figure 3-24 shows the location of communications facilities included in the lifelines inventory. Key facilities and services considered for the inventory under this category are as follows:

- MEMA operates an Emergency Operations Center in Wailuku, where public organizations and private-sector agencies meet to decide and coordinate emergency response to community-wide disasters.
- Hawaiian Telcom and Spectrum are telephone providers that operate within Maui County, offering telephone services to residential and business customers.
- T-Mobile, AT&T Wireless, and Verizon Wireless are companies that offer wireless services within Maui County.
- Internet service providers in Maui County include Hawaiian Telcom and Spectrum.
- There are 22 communication facilities in Maui County identified as critical facilities, mostly servicing emergency service communications.

3.9.8 Transportation

Figure 3-25 shows the location of transportation facilities included in the lifelines inventory. Key facilities and services considered for the inventory under this category are as follows:

- The Hawai‘i Department of Transportation maintains 245.9 miles of road in Maui County, including the Honoapi`ilani Highway, Hāna Highway, Kamehameha V Highway, and Kaumalapau Highway.
- The Maui Department of Transportation operates six programs: Maui Bus Fixed Route; Maui Bus ADA Paratransit; Maui Bus Commuter; Human Services Transportation; Air Ambulance; and Park Maui.
- No passenger or commercial rail services are operating in the county.

Figure 3-24. Communications Facilities in Maui County

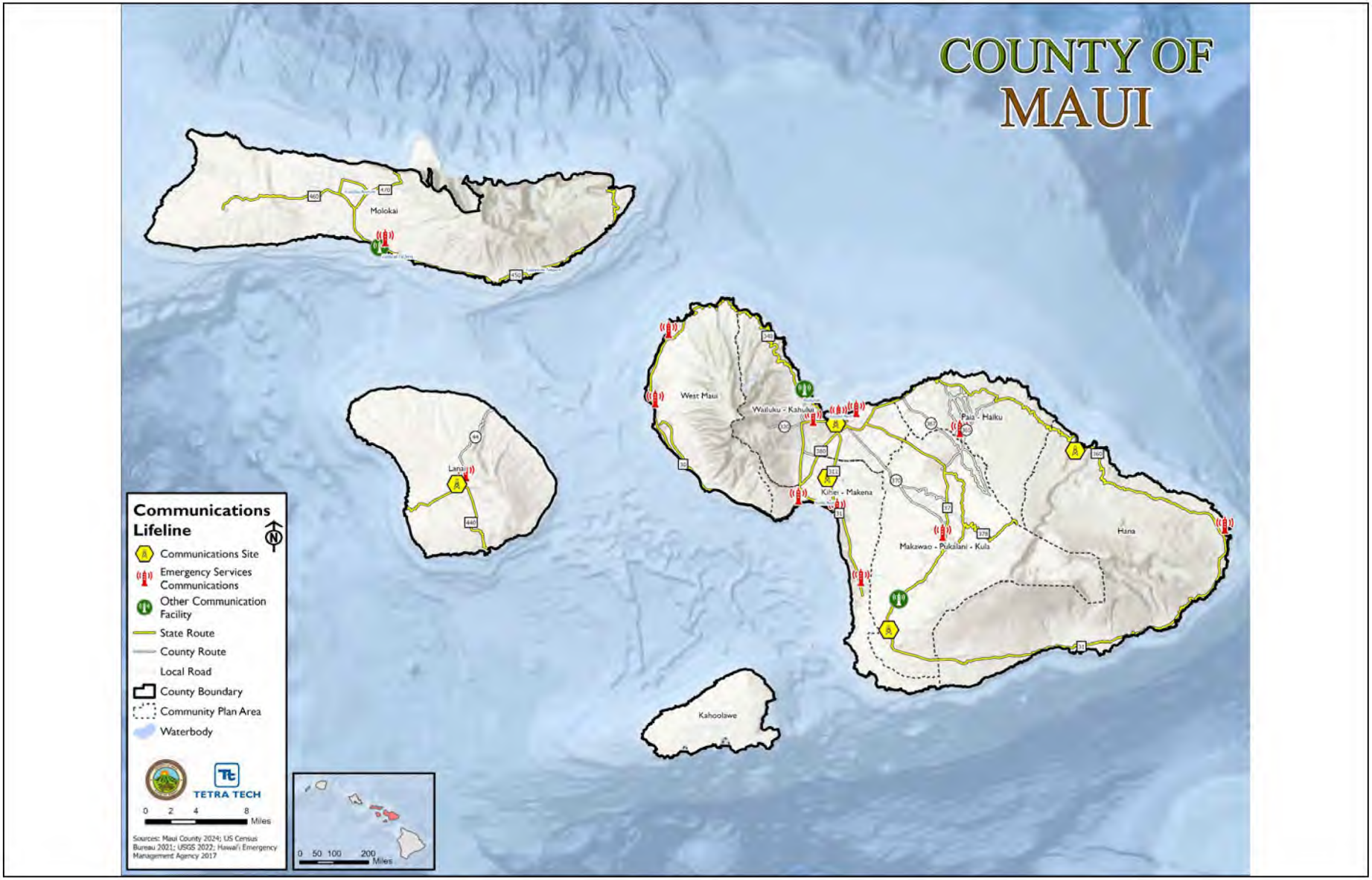
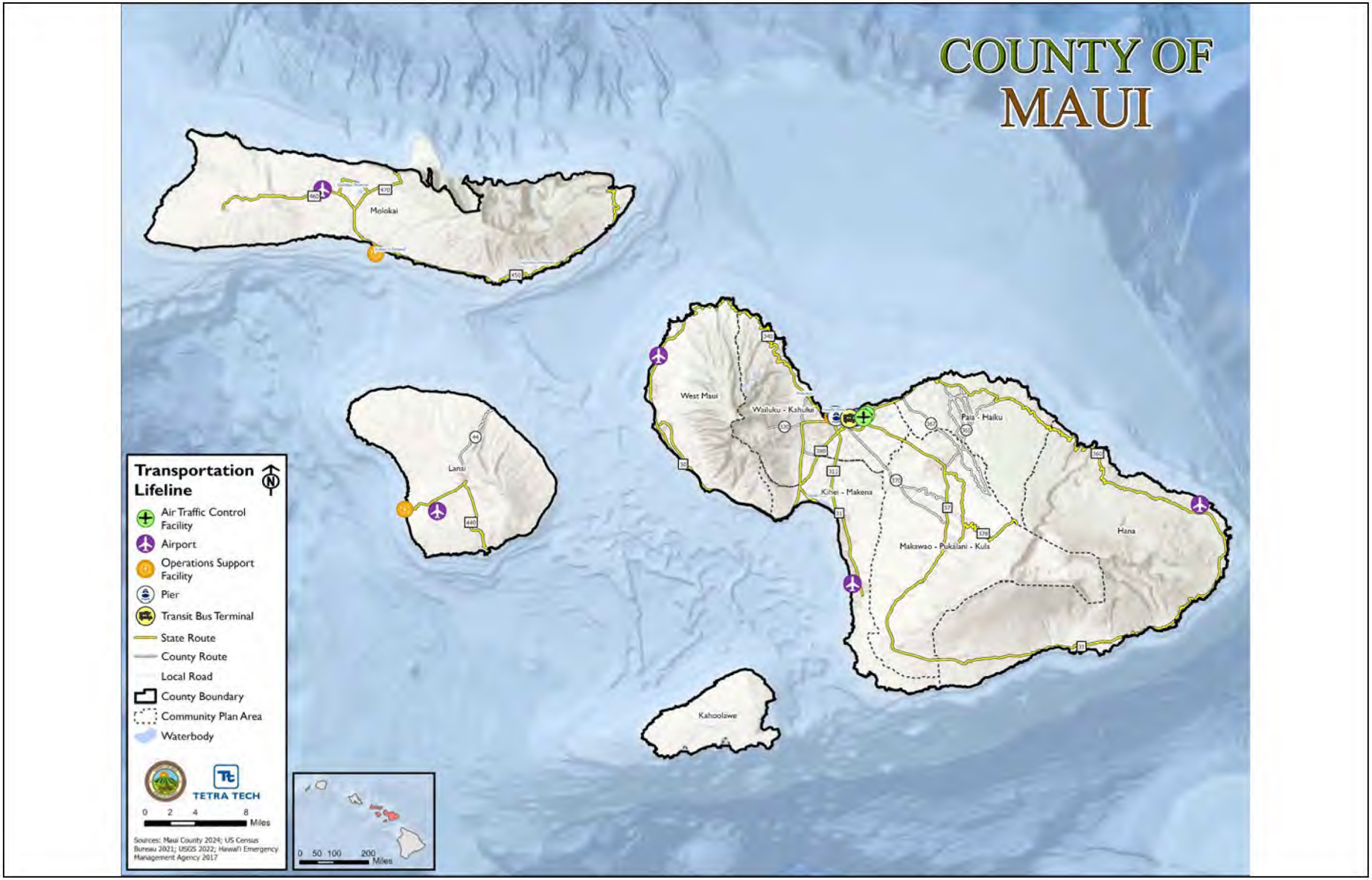


Figure 3-25. Transportation Facilities in Maui County



- There are four commercial airports in Maui County and one commercial airstrip on the Kalaupāpā Peninsula on the Island of Molokaʻi.
  - Kahului Airport is on the northern edge of the land bridge between Haleakalā and the West Maui Mountain Range on the Island of Maui. The airport occupies 1,391 acres and is 3 miles east of the town of Kahului. Kahului is the second busiest airport in the State of Hawaiʻi and the newest in terms of terminal facilities. The airport serviced 6,558,000 passengers in 2024 (U.S. DOT n.d.).
  - The Kapalua Airport is in West Maui and is served by commercial propeller air carriers and commuter/air taxi aircraft only. The facility consists of a single runway, terminal facilities, and support facilities. There are no air cargo facilities at this airport. Access to this airport is provided from a two-lane road off of Honoapi`ilani Highway. The airport serviced 143,000 passengers in 2024 (U.S. DOT n.d.).
  - Molokaʻi Airport occupies 288 acres on the central plateau of the Island of Molokaʻi. The airport has two runways that accommodate commuter/air taxi and general aviation, as well as some military flights. The airport serviced 40,000 passengers in 2024 (U.S. DOT n.d.).
  - Lānaʻi Airport is 3 miles southwest of Lānaʻi City on the Island of Lānaʻi. The airport has a single runway and primarily serves scheduled inter-island and commuter/air taxi traffic, with some unscheduled charter and general aviation activity. The airport serviced 40,000 passengers in 2024 (U.S. DOT n.d.).
  - There is a small airstrip at the Kalaupāpā peninsula that services the residents of Kalawao County and provides the main ingress/egress for the county. The facility is mentioned here as it would be the main evacuation route for the fewer than 100 residents of that county. The airport serviced 9,000 passengers in 2024 (U.S. DOT n.d.).
- There are three ports in Maui County, one on each of the occupied islands.
  - Kahului Harbor, on the Island of Maui, has container and freight handling facilities, petroleum and asphalt pipelines, and a passenger terminal. Kahului Harbor is the busiest port outside Honolulu in Hawai'i's Commercial Harbor System. In fiscal year 2022 cargo throughput at Kahului Harbor was 2.25 million short tons, a 23 percent increase from the previous year (HI-DOT n.d.).
  - Kaunakakai Harbor on the Island of Molokaʻi receives container and break bulk cargo by barge. All cargo received at Kaunakakai Harbor is transshipped via barge from Honolulu. In fiscal year 2022 Kaunakakai Harbor saw 84,000 short tons of cargo (HI-DOT n.d.).
  - Kaumalapau Harbor on the Island of Lānaʻi services about 6 barge calls per month. Kaumalapau Harbor began tracking cargo throughput in fiscal year 2010, and from then until 2020, cargo volumes into the harbor had steadily risen. In fiscal year 2022, the harbor saw 185,000 short tons of cargo (HI-DOT n.d.).

3.9.9 Hazardous Materials

The critical facilities list provided by the County did not include hazardous materials sites. An area for improvement in the HMP is to develop a list of such facilities. This could be coordinated using the Maui Fire Department Palmtop Emergency Action for Chemical software, which catalogs Tier II facilities.

3.9.10 Water Systems

Figure 3-26 shows the location of water system facilities included in the lifelines inventory. Due to security concerns, water system lifeline data was only partially obtained. Key facilities and services considered for the inventory under this category are as follows:

- The Maui Department of Water Supply provides clean water to 36,400 services on Maui and Molokaʻi.
- The Maui Department of Environmental Management oversees three divisions: Wastewater Reclamation; Solid Waste; and Environmental Protection and Sustainability. The Wastewater Reclamation Division produces R1 recycled water for irrigation, landscaping, and other non-potable uses.
- The Lānaʻi Water Company supplies water to over 1,700 homes and businesses on Lānaʻi.

3.10 ADDITIONAL CRITICAL FACILITIES

Some facilities that are identified as critical for hazard mitigation in Maui County do not fit in any of FEMA's community lifeline categories. These include civic and community centers, gyms, home improvement centers, and management offices. Figure 3-27 shows the location in Maui County of these additional critical facilities.

3.11 NATURAL RESOURCES

Consideration of natural resources in hazard mitigation planning is relevant because of the potential impacts upon them and because of the ecosystem services they provide, such as reducing hazard impacts on the built environment. Hawaiʻi's environment and natural resources are integral to the economy, sense of place, and traditional culture of the island communities. Maui County's natural resources range from tropical rain forests and jagged-peaked mountains to the near-shore environment and coral reefs. The islands are home to flora, fauna, and ecological communities that can be found nowhere else in the world. These natural resources face pressure from development, invasive species, natural hazards, and climate change.

The U.S. Fish and Wildlife Service lists 49 plant species and 10 animal species as "endangered" within the Hawaiian Islands; of these, 26 plant species and 8 animal species are found on one or more of the islands of Maui County (Federal Register 2016).

The varied elevation zones on Maui give the island a diversity of habitats for wildlife. These include alpine deserts, subalpine and montane forests and bogs, lowland forests, coastal communities, anchialine pools, wetland habitats, lava tube caves, and aeolian habitats. Additionally, parts of East Maui have healthy freshwater aquatic systems on the slopes of ridges, in the streams of lower Hanawī, and in the streams of the Kipahulu and Kaupō area. These habitats support a diversity of native species including forest birds, invertebrates, ʻōpeʻapeʻa, pueo, waterbirds, freshwater species, and seabirds (DLNR 2015).

Figure 3-26.Water Systems Lifelines in Maui County

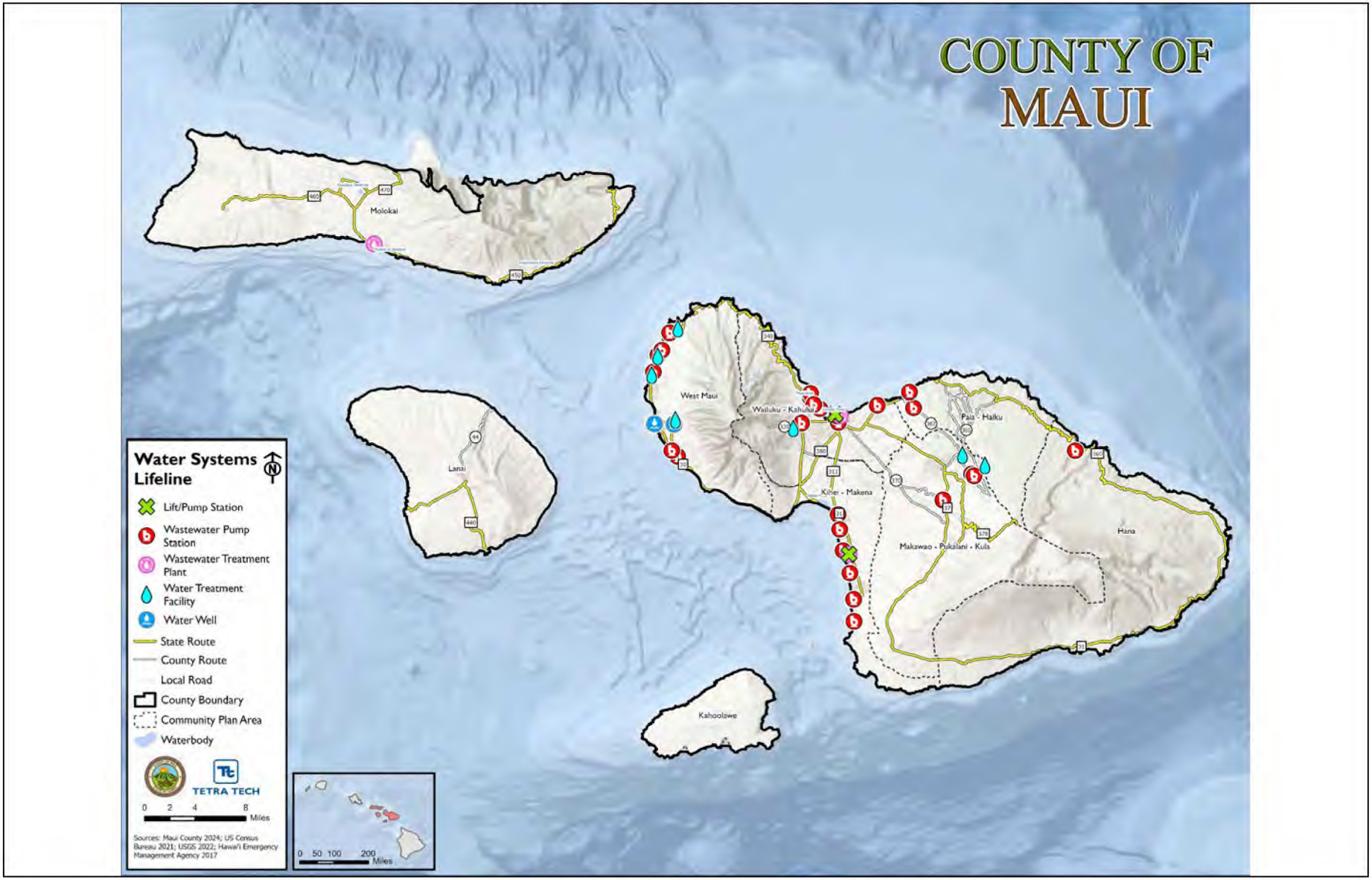
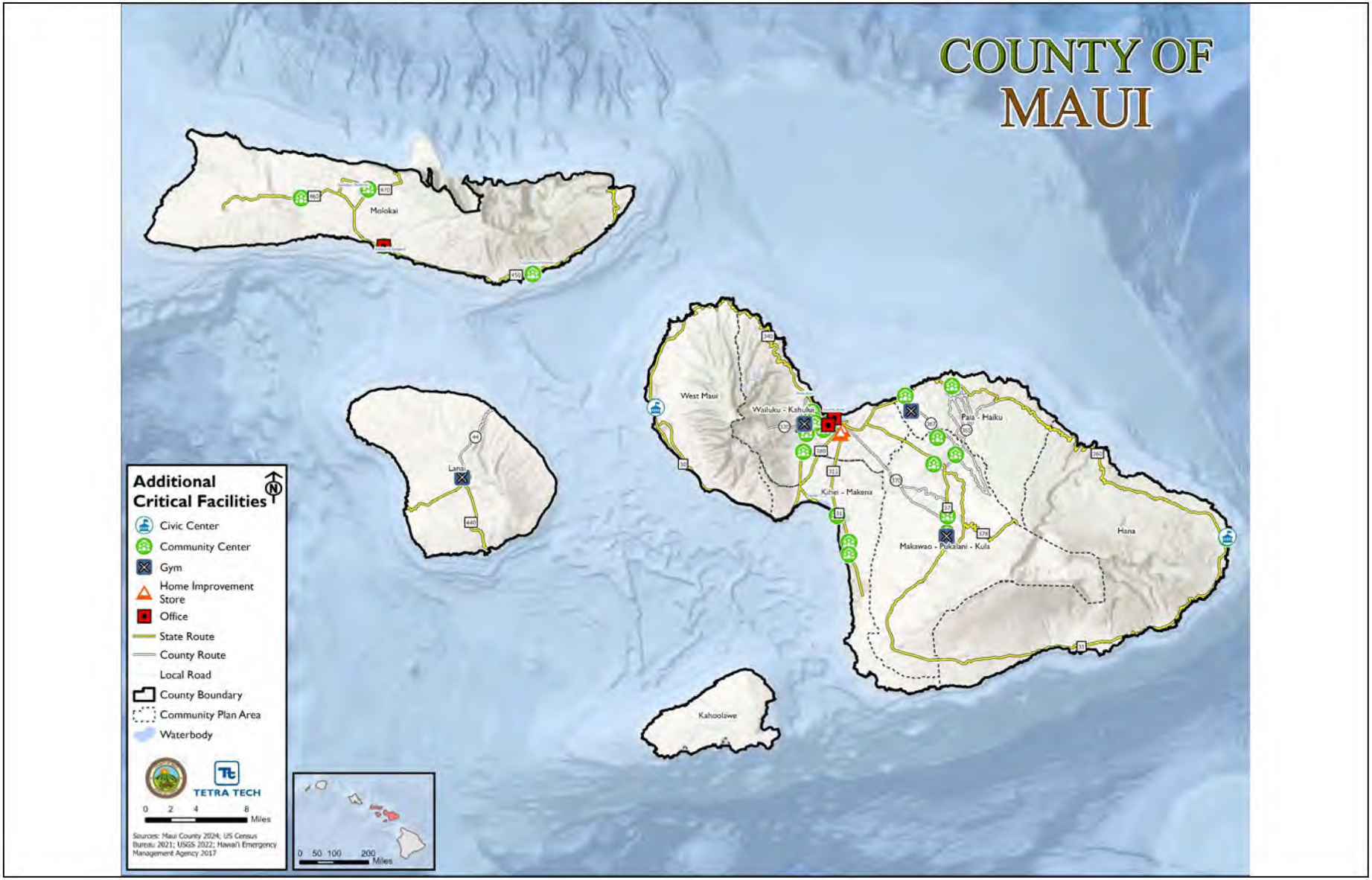


Figure 3-27. Additional Critical Facilities in Maui County



Beaches provide habitat for a few nesting sea turtles. Maui also has 10 offshore islets that are significant habitats for seabirds, migratory birds, raptors, invertebrates, plants, and marine fauna. Maui is an important habitat for native forest birds, including the following Maui endemic species: ʻākohekohe, Maui ʻalauahio, poʻouli, and Maui parrotbill. Maui is also home to the third largest population of nēnē in the state. Other federally listed species include the ʻalae keʻokeʻo, aeʻo, koloa maoli, ʻuaʻu, ʻaʻo, ʻōpeʻapeʻa, Hawaiian monk seal, hōnu ʻea, and hōnu (DLNR 2015).

Major habitat types on Molokaʻi include montane wet forests and shrublands, coastal systems (including dunes and grasslands), perennial streams, lava tubes and caves, cliffs, bog communities, and nine offshore islets. Important geographic features include the state's third largest perennial stream, and the highest sea cliffs in the world. Most of Molokaʻi's endemic forest birds are likely extinct; however, ʻiʻiwi, ʻamakihi, and ʻapapane persist at low numbers. In addition, Molokaʻi supports populations of several endangered and threatened species, such as ʻōpeʻapeʻa, nēnē, aeʻo, alae keʻokeʻo, ʻuaʻu, ʻaʻo, and the Blackburn's sphinx moth. Other species groupings that can be found on Molokaʻi are terrestrial invertebrates, freshwater fishes, freshwater invertebrates, seabirds, migratory birds, and raptors. The coastal strand along the island's northwest coast contains one of the state's last intact dune systems and is important to nesting seabirds and marine animals (DLNR 2015).

Habitats on Lānaʻi are primarily lowland dry communities and coastal communities. While few areas of native-dominant vegetation remain, there are opportunities for habitat restoration through a combination of fencing to exclude ungulates, outplanting of native species, and invasive plant control. Species endemic to Lānaʻi include several species of Lānaʻi tree snail. These species are near extinction due to loss of habitat, recreational collecting, and predation by non-native carnivorous snails. Waterbirds and migratory shorebirds use remnant wetlands. The ʻuaʻu colony on Lānaʻihale was rediscovered and confirmed active in 2006. Considerable effort to characterize the colony has been ongoing, and nesting has been confirmed on the less accessible steep slopes and ridges of Lānaʻihale. Historically, Lānaʻi was home to eight species of forest birds; although several are now extinct, the possibility exists for the re-introduction of ʻiʻiwi and ʻamakihi (DLNR 2015).

Historically, Kahoʻolawe was home to a range of communities that included dry forest and shrublands, grasslands, coastal vegetation, and possibly a mesic forest. The 200 years of goat and sheep ranching, unmanaged grazing, and mostly unsustainable historical land and resource use practices, followed by decades of military training exercises and bombings, contributed to over 80 percent of Kahoʻolawe being now barren or hardpan soil or alien-dominated vegetation. In addition to two islets, the western coastal area is the only area where native vegetation remains. Despite this, Kahoʻolawe is still home to 14 rare plants as well as a new species, Kanaloa kahoolawensis, in a new genus. Important areas on the island for wildlife include coastal areas such as Honokanaiʻa, Kūheia, Lae o Kuikui, Hakioawa, and the uplands. Vegetation in this area consists of mixed-species, mesic and dry grass, and shrubland communities with a high percentage of non-native vegetation interspersed with native vegetation. There are also several wetland areas on the island (e.g., Lua Keālialalo, Lua Keālialuna, Lua Makika) that can provide habitat for migratory shorebirds and waterbirds. Kahoʻolawe is also home to two islets, Puʻu koae and ʻAleʻale, both of which provide significant habitats for some nesting seabirds and potential habitats for more rare species (e.g., ʻuaʻu, ʻakēʻakē) and migratory birds (e.g., kioea) and contain native shrub coastal dry cliff communities (DLNR 2015).

3.12 CULTURAL AND HISTORIC RESOURCES

The National Park Service's National Register of Historic Places is the official list of the Nation's historic places worthy of preservation. It is part of a national program to support public and private efforts to identify, evaluate, and protect America's historic and archeological resources. The Register lists 68 sites in Maui County: 21 archeological sites and 47 unique structures. Table 3-21 lists the 47 unique structures.

Table 3-21. Maui County National Register of Historic Places

Property Name	Location
Baldwin, Fred C., Memorial Home	Makawao
Baldwin, Henry Perrine, High School	Kahuli
Bank of Hawai'i-Ha'ikū Branch	Ha'ikū
Chee Kung Tong Society Building	Wailuku
Crater Historic District	Kahului
Gomes, Frank and Theresa, House	Makawao
Ha'ikū Mill	Ha'ikū
Hale Pa'i	Lahainaluna
Halekii-Pihana Heiau	Wailuku
Hāna Belt Road	Makawao
Hāna District Police Station and Courthouse	Hāna
Hardy House	Makawao
Hokukano-Ualapue Complex	Ualapue
Holy Ghost Catholic Church	Kula
Honokalani Village	Hāna
Iao Theater	Wailuku
Ka'ahumanu Avenue-Naniloa Drive Overpass	Wailuku
Kaahumanu Church	Wailuku
Kaho'olawe Island Archeological District	Kaho'olawe
Kahului Railroad Administration Building	Kahului
Kalepolepo Fishpond	Kīhei
Kaluakini, William K., House	Lahaina
Kamehameha V Wall	Kawela
Kaunolu Village Site	Lāna'i City
Kaupo School	Kaupo
Keanae School	Keanae
Ket Hing Society Building	Keokea
King Kamehameha III's Royal Residential Complex	Lahaina
Lahaina Historic District	Lahaina
Loaloa Heiau	Kaupo

Property Name	Location
Ma'alaea General Store	Wailuku
Makawao Union Church	Pāʻia
Maui Jinsha Mission	Wailuku
Meyer, R. W., Sugar Mill	Kalae
Old Bailey House	Wailuku
Pāʻia School	Pāʻia
Piilanihale Heiau	Hāna
Puunene School	Puunene
Pu'upehe Platform (50La19)	Lana'i
Southwest Moloka'i Archeological District	Maunaloa
U.S. Coast Guard Molokaʻi Light	Kalaupāpā
Wai'ale Drive Bridge	Wailuku
Waihee Church	Waihee
Wailuku Civic Center Historic District	Wailuku
Wailuku School	Wailuku
Wananalua Congregational Church	Hāna
Wo Hing Society Building	Lahaina

Source: (NPS 2024)

PART 2: RISK ASSESSMENT

4. RISK ASSESSMENT METHODOLOGY AND TOOLS

A risk assessment is the process of evaluating the potential loss of life, personal injury, and economic and property damage that could result from identified hazards. Identifying potential hazards and vulnerable assets allows planning personnel to address and reduce hazard impacts and allows emergency management personnel to establish early response priorities. Results of the risk assessment are used in subsequent mitigation planning processes, including determining and prioritizing mitigation actions that reduce risk from each hazard. Past, present, and future conditions must be evaluated to assess risk most accurately for the county. The process focuses on the following elements:

- **Identify Hazards of Concern**—Use all available information to determine what types of hazards may affect a community.
- **Profile Each Hazard**—Understand each hazard in terms of:
  - Location—Geographic area most likely to be affected by the hazard
  - Extent—The potential severity of each hazard
  - Previous occurrences and losses
  - Probability of future hazard events, including how climate change may influence the probability
- **Assess Vulnerability and Impacts**—Use all available information to estimate to what extent populations and assets may be adversely affected by a hazard now and in the future:
  - Determine vulnerability—Estimate the total number of assets in the community that are likely to experience a hazard event if it occurs by overlaying hazard maps with the asset inventories.
  - Estimate potential impacts/losses—Assess the impact of hazard events on the people, property, economy, and lands of the region, including estimates of the losses associated with potential damage or cost that can be avoided by mitigation.
  - Evaluate future changes that may affect vulnerability and impacts—Analyze how demographic changes, projected development, and climate change can alter current vulnerability and potential impacts.

4.1 PREVIOUS EVENTS AND PROBABILITY OF OCCURRENCE

Based on records of previous hazard events and consideration of potential future changes that could affect the frequency of future events, the risk assessment for each hazard assigns a rating for the probability of occurrence of that hazard in the future. The following were the primary sources for identifying previous occurrences:

- **FEMA disaster declarations**—The President of the United States has the authority to issue disaster declarations for hazard events that cause more damage than state and local governments can manage without assistance from the federal government. The declaration triggers funding for emergency and recovery efforts led by FEMA. The first federal disaster

declaration was issued in 1953. Initially, declarations applied to entire states. Beginning in 1969, the process was refined to specify the individual counties affected by each declaration. Federally disaster declarations are classified as major disaster (DR), emergency declaration (EM), or fire management assistance (FM).

- **Hawai'i Governor's emergency proclamations**—The Governor of Hawai'i is authorized to proclaim an emergency statewide or at local levels. Such proclamations trigger emergency powers and assistance programs. The governor can issue an emergency proclamation when a state of emergency exists, defined in state code as conditions of disaster or extreme peril to people and property that are of a magnitude beyond the control of individual local governments. Emergency proclamations are a prerequisite when requesting a federal disaster declaration.
- **U.S. Department of Agriculture disaster declarations**—The U.S. Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in contiguous counties.
- **Hazard-specific databases**—Sources that provide records of specific types of hazard events include the National Centers for Environmental Information's Storm Events Database, the National Integrated Drought Information System's U.S. Drought Monitor, and the U.S. Geological Survey's Earthquake Catalog.
- **News reports and previously published planning documents** such as the Hawai'i State Hazard Mitigation Plan and the previous Maui County HMP.

The probability of occurrence ratings were assigned as follows:

- Unlikely—hazard event had less than a 1 percent annual probability of occurring.
- Rare—Hazard event has between 1 and 10 percent annual probability of occurring.
- Occasional—Hazard event has between 10 and 100 percent annual probability of occurring.
- Frequent—100 percent annual probability; hazard event is likely to occur multiple times per year.

4.2 ASSET INVENTORIES

The risk assessment included the collection and use of an expanded and enhanced asset inventory to estimate hazard vulnerability and impacts.

Maui County assets were identified to assess potential vulnerability and impacts associated with the hazards of concern. The HMP update assesses vulnerability and potential hazard impacts for the following types of assets: population, buildings, critical facilities/community lifelines, the environment, and new development. Inventories of Maui County assets to be used in the risk assessment were updated using the following best-available information:

- A new building stock inventory was generated using the 2022 U.S. Army Corps of Engineers (USACE) National Structure Inventory (NSI) dataset, 2024 Maui County building footprints (post-wildfires), and 2024 RSMeans cost adjustment values.

- 2020 U.S. Census Bureau Decennial and 2019-2023 American Community Survey 5-year Population Estimates were utilized.
- Critical facilities originally provided by HI-EMA for the 2023 State Hazard Mitigation Plan were used.
- Lifelines were identified in the critical facility inventory to align with FEMA's community lifeline definition.

Each asset type is described below. To protect individual privacy and the security of critical facilities, information on properties assessed is presented in aggregate, without details about specific individual properties.

4.2.1 Population

Statistics from the 2020 U.S. Census Bureau Decennial and 2019-2023 American Community Survey (ACS) 5-year estimate were used to estimate the vulnerability of and potential impacts on the County's population. An area analysis was performed to convert ACS statistics by census tract into population estimates per Community Plan Area. Such analyses have limitations but provide an acceptable estimate for planning purposes. Data on vulnerable populations included in the risk assessment are populations below the poverty level, non-English speaking individuals, persons with a disability, and people younger than 5 or older than 65.

FEMA's Hazus program was used to model estimated potential losses due to dam failure, flood, tsunami, earthquake, and hurricane hazards, as discussed further later in this section. Hazus v6.1 contains 2020 U.S. Census data and was used to estimate shelter needs and injuries as part of the hazard analysis.

4.2.2 General Building Stock

A custom general building stock dataset was created for the County of Maui. The general building stock was updated countywide using the 2022USACE National Structure Inventory (NSI) database. The NSI contains structure inventories of varying quality and spatial coverage. In 2018 and 2019 the NSI team created the data using CoreLogic parcel files for residential structures and the ESRI business layer for non-residential structures. Each data file contains data on the type of development at a given location. Attributes used to define each structure include the year built, number of stories, occupancy class, and square footage. The centroid of each building footprint was used to estimate the building location.

To account for the effects of the 2023 Lahaina wildfires, the County provided an updated building footprint dataset to refine the NSI point data. Any points within the wildfire-affected areas that did not correspond with an updated building footprint were removed from the analysis.

Structural and content replacement cost values (RCV) were calculated for each building using the available assessor data, the building footprint, and RSMeans 2024 values. A regional location cost factor was applied based on zip code. Maui County zip codes begin with 967, for which the location cost factors are as follows:

RCV is the current cost of returning a destroyed asset to its pre-damaged condition using the present-day cost of labor and materials. Total RCV consists of both the structural cost to replace a building and the estimated value of contents of a building.

- Residential – 1.13
- Non-Residential – 1.18

Buildings were categorized by the occupancy classes available in Hazus, condensed into the categories of residential, commercial, industrial, and other (agricultural, religious, governmental, and educational). The residential occupancy includes both multi-family and single-family dwellings.

4.2.3 Critical Facilities and Community Lifelines

A critical facility inventory, which includes essential facilities, utilities, transportation features, and user-defined facilities, was created using HI-EMA data that was generated for the 2023 State HMP. Each facility in Maui County was assigned to one of the categories defined by FEMA as community lifelines or was defined as "other critical facilities."

A lifeline provides an indispensable service that enables the continuous operation of critical business and government functions, and is critical to human health and safety, or economic security (FEMA).

4.2.4 Environment and Land Use

Land use districts from the Hawai'i Statewide GIS Program and State Land Use Commission (2020) were used to assess land use characteristics of the county. This dataset was clipped down to the county boundary and the land use districts were separated into four categories: Urban, Agricultural, Rural, and Conservation Districts.

4.2.5 New Development

The County provided information detailing the current permit status in regard to countywide development since 2020. Issued permits represent a project that has been approved but construction is still ongoing; permits labeled as completed denote a completed project. A GIS analysis was conducted to determine hazard exposure of these development sites. If one point identified within the project boundary intersected a spatial hazard layer, the development site was considered "exposed" to the hazard area of concern. Table 4-1 provides a summary of new development across Maui County and its exposure to key hazard areas.

Table 4-1. Summary of New Development in Maui County per Hazard

Hazard	Exposure	Summary of New Developments
Coastal Erosion	Exposure to coastal erosion under the 3.2 ft sea level rise scenario is limited.	• 16 new developments (0.5 percent) are exposed in Maui County, primarily in Kihei-Makena (eight), Wailuku-Kahului (five), and West Maui (three)
Dam Inundation	Exposure to dam failure risk is notable.	• 284 new developments (8.7 percent) are located in the combined high hazard dam inundation areas, with Wailuku-Kahului (218) and West Maui (34) most impacted
Earthquake (NEHRP Class D)	Soil instability affects a significant portion of new development.	• 1,106 new developments (34.1 percent) are located in the NEHRP (Class D) soils hazard area, with the highest in Wailuku-Kahului (707), West Maui (173), and Kihei-Makena (168)
Flood Hazard Risk	New development in the 1-percent annual chance flood hazard area (also known as the 100-year floodplain) is limited but notable in certain areas.	• Countywide, 67 new developments (2.1 percent) are located within the 1-percent annual chance flood hazard area • Kihei-Makena: 32 developments (6.2 percent) • Wailuku-Kahului: 26 developments (3.5 percent) • Molokai: Seven developments (6.1 percent) • West Maui: Two developments (0.3 percent) • All other community plan areas, reported zero new developments in the flood hazard area

Landslide Susceptibility	Landslide exposure is relatively limited.	• High susceptibility zones contain only nine developments (0.3 percent), mostly in West Maui (six) and Hana (three) • Moderate susceptibility zones include 80 developments (2.5 percent), with the most in West Maui (48) and Paia-Haiku (16)
Tsunami Inundation Zones	New development shows increasing exposure across tsunami scenarios.	• Under the SOEST 400-year scenario, 151 developments (4.6 percent) are exposed, primarily in Wailuku-Kahului (63) and Kihei-Makena (56) • The GAT 1,500-year scenario shows 290 developments (8.9 percent) at risk, with the highest in Wailuku-Kahului (127) and Kihei-Makena (100) • Under the ASCE 3,500-year scenario, exposure rises to 432 developments (13.3 percent), with Kihei-Makena (184) and Wailuku-Kahului (163) most affected
Lava Flow Zones	Lava flow risk is concentrated in a few areas.	• Zone 1 includes 13 developments (0.4 percent), nearly all in Hana (12) • Zone 2 has 475 developments (14.6 percent), with Kihei-Makena (389) and Makawao-Pukalani-Kula (62) most affected

Wildfire Risk Zones	Wildfire risk is a significant concern, especially in high-risk zones.	• Low-risk areas contain 388 developments (11.9 percent), mostly in Paia-Haiku (331) and Hana and Wailuku-Kahului (both with 22) • Moderate-risk areas include 635 developments (19.6 percent), with concentrations in Lanai (255) and Makawao-Pukalani-Kula (239) • High-risk areas account for the largest share, with 1,551 developments (47.8 percent), especially in Kihei-Makena (475), Wailuku-Kahului (357), and West Maui (355)

Source: County of Maui 2025; FEMA 2015; Hawai'i DLNR 2021; AECOM 2013; USGS 2013; SOEST 2021; Pacific Disaster Center 2017; USGS 2016; Hawai'i Wildfire Management Organization 2013; Hawai'i Statewide GIS Program 2017; USGS 1992, 2006; Hawai'i Emergency Management Agency 2022; Niyam IT 2022Vulnerability and Impact Assessment Methodology

Maui County used standardized tools, combined with local, state, and federal data and expertise to assess potential vulnerability and losses associated with hazards of concern. Three levels of analysis were used, depending on the data available for each hazard:

- **Qualitative Review**—This analysis includes an examination of historical impacts to understand potential impacts of future events of similar size. Potential impacts and losses are discussed qualitatively using the best-available data and professional judgment.
- **Vulnerability Analysis**—This analysis involves overlaying available spatial hazard layers, for hazards with defined locations, on asset mapping in GIS to determine which assets are located in the hazard area.
- **Loss Estimation**—The FEMA Hazus modeling software was used to estimate the impact in terms of potential losses for dam, failure, flood, earthquake, tsunami, and hurricane.

Table 4-1 summarizes the type of analysis conducted by hazard of concern.

Table 4-2. Summary of Risk Assessment Analyses

Hazard	Population	General Building Stock	Critical Facilities
Coastal Erosion	V	V	V
Dam and Reservoir Failure	V, L	V, L	V, L
Drought	Q	Q	Q
Earthquake	V, L	V, L	V, L
Flood	V, L	V, L	V, L
High Windstorms	Q	Q	Q
Hurricane	L	L	L

Hazard	Population	General Building Stock	Critical Facilities
Landslides	V	V	V
Tsunami	V, L	V, L	V
Volcano	V	V	V
Wildfire	V	V	V

Note: V = vulnerability analysis; L = loss estimation; Q = qualitative review

4.2.6 Hazus

FEMA's Hazus program was used to estimate potential impacts from dam failure, flood, earthquake, hurricane, and tsunami. Hazus is a GIS-based software tool developed by FEMA that uses engineering and scientific risk calculations to estimate damage and loss. Its use is accepted by FEMA and provides a consistent framework for assessing risk across a variety of hazards. Hazus uses GIS technology to produce maps and reports that estimate direct physical damage to building stock, critical facilities, transportation systems, and utility systems.

Hazus includes default data for inventory, vulnerability, and hazards, but the default data can be supplemented with local data to provide a more refined analysis. Table 4-2 displays the levels of analysis that can be conducted using the Hazus software depending on the hazard and inventory data provided. Hazus' open data architecture can be used to manage community GIS data in a central location. The use of this software promotes consistency of data output now and in the future and standardization of data collection and storage.

Table 4-3. Summary of Hazus Analysis Levels

Level 1	Hazus provides hazard and inventory data with minimal outside data collection or mapping.
Level 2	Hazus-provided hazard and inventory data are augmented with more recent or detailed data for the study region, referred to as "local data"
Level 3	The built-in Hazus loss estimation models are adjusted for the hazard loss analyses, usually in conjunction with the use of local data.

Hazus damage reports can include induced damage (inundation, seismic, wind, and debris) and direct impacts on people (casualties and shelter requirements) depending on the hazard and available local data. For this HMP, losses were estimated in Hazus using depth grids for the flood analysis and probabilistic analyses for hurricane wind and seismic hazards. The probabilistic model generates estimated damage for specified return periods (e.g., 100- and 500-year).

4.2.7 Hazard-Specific Methodologies

Coastal Erosion and Sea Level Rise

To determine the county's risk to the coastal erosion hazard, a vulnerability analysis was conducted using future erosion hazard data for a 3.2-foot sea level rise from the School of Ocean and Earth

Science and Technology (SOEST) at the University of Hawai'i (2017). The county's assets (population, buildings, and critical facilities) were examined to determine if they were built within the boundaries of the coastal erosion hazard area. Assets with their centroid located in the hazard area were totaled to estimate the totals and values at risk from the impacts of coastal erosion.

Dam and Reservoir Failure

Vulnerability Analysis

Dam failure inundation data for the vulnerability analysis was sourced from the Hawai'i Department of Land and Natural Resources (2021) and the County of Maui (2025). The combined high-hazard dam failure inundation mapping was overlaid on the maps of updated assets (population, building stock, critical facilities). Centroids inside the dam failure inundation boundary were totaled to estimate the building RCV and population vulnerable to the dam failure hazard.

Loss Estimation

A Level 2 analysis was performed for the building stock using depth grids generated from the combined high-hazard dam-failure inundation mapping and 1/3 arc-second digital elevation model (DEM) (USGS 2013, 2023) integrated into the Hazus riverine flood model. Buildings located within the combined high-hazard dam-failure inundation areas were imported as user-defined facilities to estimate potential losses at the structural level. Hazus calculated the estimated potential losses to the population (default 2020 U.S. Census data), potential damage to the general building stock, and potential damage to critical facilities based on the depth grids and the default Hazus damage functions in the flood model.

Drought

All of Maui County is at risk from the impacts of drought events. A qualitative analysis was conducted to assess the county's vulnerability to this hazard of concern.

Earthquake

Vulnerability Analysis

Ground shaking is the primary cause of earthquake damage to structures, and soft soils amplify ground shaking. The National Earthquake Hazard Reductions Program (NEHRP) has developed five soil classifications that impact the severity of an earthquake. The soil classification system ranges from A to E, where A represents hard rock that reduces ground motions from an earthquake and E represents soft soils that amplify ground shaking and increase building damage. Class D and E NEHRP soils are the two classes most susceptible to amplified ground motion during an earthquake.

A vulnerability analysis was conducted for the county's assets (population, building stock, critical facilities) using NEHRP soil data provided by AECOM (2013) and USGS (2013). The vulnerability analysis defined the hazard area as all areas with Class D soil types. Assets with their centroid in the hazard area were totaled to estimate the numbers and values vulnerable to these soil types.

Loss Estimation

A Level 2 Hazus probabilistic assessment was conducted for the 500- and 2,500-year mean return period (MRP) seismic events to provide loss estimates for the earthquake hazard. The probabilistic method uses information from historical earthquakes and inferred faults, locations, and magnitudes, and computes the probable ground shaking that may be experienced by census tract.

The default assumption is a magnitude 7.0 earthquake for all return periods. Default NEHRP soils data was used in Hazus. Groundwater was set at a depth of 5 feet (default setting). Although damage is estimated at the census tract level, results are presented by Community Plan Area. An area analysis was performed to convert damage estimates by census tract into estimates per Community Plan Area.

Damage was estimated for buildings (structural and non-structural) and contents. Structural building losses include load-carrying components of the structure. Non-structural building losses include those to architectural, mechanical, and electrical components of the structure, such as nonbearing walls, veneer and finishes, HVAC systems, boilers, etc.

Flood

The 1-percent annual chance flood event was examined to evaluate the county's risk from the flood hazard. This is the event generally considered by planners and evaluated under federal programs such as NFIP. The following data were used to evaluate vulnerability and determine potential future losses for this plan update:

- The Maui County FEMA Effective Digital Flood Insurance Rate Map (DFIRM) dated November 4, 2015—used to evaluate vulnerability and determine potential future losses
- Depth grids created for the riverine and coastal flood zones using the effective DFIRM and the 1/3 arc-second DEM model provided by the U.S. Geological Survey (USGS 2013, 2023)—used to estimate potential losses for the 1-percent annual chance flood event

Vulnerability Analysis

To estimate vulnerability to the 1-percent-chance flood events, the effective DFIRM flood boundaries were overlaid on the centroids of updated assets (population, building stock, critical facilities, and new development). Centroids that intersected the flood boundaries were totaled to estimate the building RCV and population vulnerable to flood inundation areas.

Loss Estimation

The Hazus riverine and coastal flood models were run to estimate potential losses in Maui County for the 1-percent annual chance flood event. A Level 2 analysis was performed for the building stock. Buildings located within the floodplain were imported as user-defined facilities to estimate potential losses at the structural level. Hazus calculated the estimated potential losses to the population (default 2020 U.S. Census data), potential damage to the general building stock, and potential damage to critical facilities based on the depth grids generated and the default Hazus damage functions in the flood model.

High Windstorms

All of Maui County is at risk from the impacts of high winds. A qualitative analysis was conducted to assess the county's vulnerability to this hazard of concern.

Hurricane

A Hazus probabilistic analysis was performed to analyze losses for the 100- and 500-year MRP hurricane events. The probabilistic Hazus hurricane model activates a database of thousands of potential storms that have tracks and intensities reflecting the full spectrum of hurricanes observed since 1886 and identifies those with tracks associated with Maui County. Hazus contains data on historical hurricane events and wind speeds. It also includes surface roughness and vegetation (tree coverage) maps for the area. Surface roughness and vegetation data support the modeling of wind force across various types of land surfaces. Default demographic and updated building and critical facility inventories in Hazus were used for the analysis. An area analysis was performed to convert damage estimates by census tract into estimates per Community Plan Area.

Landslide

A vulnerability analysis was conducted using landslide susceptibility data from the Pacific Disaster Center (2017) and USGS (2016) to determine the county's risk of landslide hazard. The county's assets (population, buildings, and critical facilities) were examined to determine if they were built in areas of the low, moderate, or high susceptibility landslide hazard area. Assets with their centroid located in the hazard area were totaled to estimate the totals and values at risk from the impacts of landslides.

Tsunami

Vulnerability Analysis

A vulnerability analysis was conducted using data provided by Hawai'i Emergency Management Agency (2022) and Niyam IT (2022). Three scenarios were analyzed: The SOEST Standard Evacuation Zone (400-year scenario), the Great Aleutian Tsunami (GAT) extreme evacuation zone (1,500-year scenario), and the American Society of Civil Engineers (ASCE) inundation scenario (3,500-year). The county's assets (population, buildings, and critical facilities) were examined to determine if they are built in the mapped tsunami hazard areas. Assets with their centroid located in the hazard area were totaled to estimate the totals and values at risk from the impacts of landslides.

Loss Estimation

The depth grids generated using the SOEST (standard) and ASCE (extreme) tsunami hazard areas and 1/3 arc-second DEM (USGS 2013, 2023) were integrated into the Hazus coastal flood model to estimate potential losses from tsunami events. A Level 2 analysis was performed for the building stock. As Hazus allows for a maximum scenario of 1,000 years to be analyzed, the extreme scenario was analyzed at the maximum 1,000-year level. Buildings located within the tsunami hazard areas were imported as user-defined facilities to estimate potential losses at the structural level. Hazus calculated the estimated potential losses to the population (default 2020 U.S. Census data), potential damage to

the general building stock, and potential damage to critical facilities based on the depth grids and the default Hazus damage functions in the flood models.

Volcanic Hazards

A vulnerability analysis was conducted using data provided by the Hawai'i Statewide GIS Program (2017) and USGS (1992, 2006) to determine the county's risk of the volcanic hazard. The county's assets (population, buildings, and critical facilities) were examined to determine if they were built in the lava flow zone 1 and zone 2 hazard areas. Assets with their centroid located in the hazard areas were totaled to estimate the numbers and values at risk from volcanic impacts.

Wildfire

A vulnerability analysis was conducted using Communities at Risk from Wildfire data from the Hawai'i Wildfire Management Organization (2013) to determine the county's risk to the wildfire hazard. The county's assets (population, buildings, and critical facilities) were examined to determine if they were built in areas of the low, moderate, or high-risk wildfire hazard areas. Assets with their centroid located in the hazard area were totaled to estimate the totals and values at risk from the impacts of wildfire.

4.3 DATA SOURCE SUMMARY

Table 4-3 summarizes the data sources used for the risk assessment for this plan.

Table 4-4. Risk Assessment Data Documentation

Data	Source	Date	Format
Population data	U.S. Census Bureau; American Community Survey 5-Year Estimates	2022; 2023	Digital (GIS) format
Building Inventory	USACE NSI; Hawai'i Emergency Management Agency; Niyam IT; County of Maui; RSMeans	2022; 2022; 2022; 2024; 2024	Digital (GIS) format
Critical Facilities and Lifelines	Hawai'i Emergency Management Agency	2017	Digital (GIS) format
New Development Sites	County of Maui	2025	CSV format
State Land Use Districts	State Land Use Commission, Hawai'i Statewide GIS Program	2020	Digital (GIS) format
10-Meter Digital Elevation Model	USGS	2013, 2023	TIFF
High Hazard Dam-Failure Inundation Data	Hawai'i Department of Land and Natural Resources; County of Maui	2021; 2025	Digital (GIS) format
NEHRP Soils Data	AECOM; USGS	2013; 2013	Digital (GIS) format

Data	Source	Date	Format
Digitized Preliminary FIRM Data	FEMA	2015	Digital (GIS) format
Coastal Erosion Data	SOEST	2021	Digital (GIS) format
Landslide Susceptibility Data	Pacific Disaster Center; USGS	2017; 2016	Digital (GIS) format
Wildfire Communities at Risk Data	Hawai'i Wildfire Management Organization	2013	Digital (GIS) format
Volcano Lava Flow Zones Data	Hawai'i Statewide GIS Program; USGS	2017; 1992, 2006	Digital (GIS) format
Tsunami Data	Hawai'i Emergency Management Agency; Niyam IT	2022; 2022	Digital (GIS) Format

Note: FEMA = Federal Emergency Management Agency; NSI = National Structure Inventory; SOEST = School of Ocean and Earth Science and Technology; USACE = U.S. Army Corps of Engineers; USGS = U.S. Geological Survey

4.4 LIMITATIONS

Loss estimates, vulnerability analyses, and hazard-specific impact 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. Uncertainties also result from the following:

- Approximations and simplifications necessary to conduct such a study
- Incomplete or dated inventory, demographic, or economic parameter data
- The unique nature, geographic extent, and severity of each hazard
- Mitigation measures already employed by the County
- The amount of advance notice residents have to prepare for a specific hazard event
- Uncertainty of climate change projections

These factors can result in a range of uncertainty in loss estimates, possibly by a factor of two or more. Therefore, potential vulnerability and loss estimates are approximate and should be used only to understand relative risk. Over the long term, Maui County will 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 general building stock using best-available data. The county acknowledges significant impacts may occur to critical facilities and infrastructure as a result of these hazard events, causing great economic loss. 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.

4.5 CONSIDERATIONS FOR MITIGATION AND NEXT STEPS

The following items are to be discussed for consideration for the next plan update to enhance the risk assessment:

- All Hazards
  - Create an updated user-defined general building stock dataset using up-to-date parcels, footprints, and RSMeans values.
  - Consider adding additional information to the County's building footprint dataset required for Hazus analysis (i.e., occupancy type, year built, number of stories, etc.)
  - Utilize updated and current demographic data.
- Coastal Erosion
  - Consider additional future erosion scenarios as part of an updated vulnerability analysis.
- Dam and Reservoir Failure
  - As more current dam failure inundation data becomes available, run the vulnerability analysis on the updated hazard boundaries.
- Earthquake
  - Identify unreinforced masonry in critical facilities and privately owned residences by accessing local knowledge, tax assessor information, and/or pictometry/orthophotos. These buildings may not withstand earthquakes of certain magnitudes, and plans to provide emergency response or recovery efforts at these properties can be developed.
- Hurricane
  - The general building stock inventory can be updated to include attributes regarding protection against strong winds, such as hurricane straps, to enhance loss estimates.
  - Integrate evacuation route data that is currently being developed.
- Flood
  - The general building stock inventory can be updated to include attributes regarding first-floor elevation and foundation type (basement, slab on grade, etc.) to enhance loss estimates.
  - Conduct a Hazus loss analysis for more frequent flood events (e.g., 10- and 50-year flood events).
  - Conduct a repetitive loss area analysis.
  - Continue to expand and update urban flood areas to further inform mitigation.
  - As more current FEMA floodplain data become available (i.e., DFIRMs), update the vulnerability analysis and generate a more detailed flood depth grid that can be integrated into the current Hazus version.
- Landslide
  - Run the vulnerability analysis on the most current landslide hazard data.
- Tsunami

  - As tsunami data becomes available for new scenarios, run the vulnerability analysis on the updated hazard boundaries.
- Volcano
  - Run the vulnerability analysis on the most current lava flow data.
  - Due to Maui's geography, consider running the vulnerability analysis on other types of volcano hazards if data is available.
- Wildfire
  - General building stock inventory can be updated to include attributes such as roofing material, fire detection equipment, or distance to fuels as another measure of vulnerability.
  - Run the vulnerability analysis on the most current wildfire data and expand the analysis beyond Communities at Risk due to Wildfire's persistent impact.

5. IDENTIFICATION OF HAZARDS OF CONCERN

5.1 REVIEW OF POTENTIAL HAZARDS

Hazards of Concern are hazards that are considered most likely to impact a community. These are identified using available data and local knowledge.

Natural Hazards are hazards that are a source of harm or difficulty created by a meteorological, environmental, or geological event.

To provide a strong foundation for mitigation actions in this plan, Maui County considered a full range of hazards that could impact the area and then identified and ranked those that present the greatest concern. These hazards of concern were identified based on the following:

- Input from the HMWG
- Review of the 2023 Hawai'i State Hazard Mitigation Plan
- Review of the 2020 Maui County HMP
- Research on the frequency, magnitude, and costs associated with hazards that have previously or could feasibly impact the region
- Qualitative information regarding natural (not human-caused) hazards and the perceived vulnerability of the study area's assets to them.

Table 5-1 details the consideration of hazards from the State Hazard Mitigation Plan.

Table 5-1. Review of State Hazards

Hazard	May Occur in the County?	Poses Significant Threat to the County?	Why was this determination made?
Climate Change and Sea Level Rise	Yes	Yes	The impact of climate change on natural hazard intensity, frequency, and location is considered in each of the hazard profiles. To maintain consistency with the 2020 and 2015 HMPs, the sea level rise hazard profile continues to be titled coastal erosion. Sixty percent of the HMWG rated coastal erosion as a high-priority hazard of concern.
Cyber Threat	Yes	No	The 2023 State HMP identifies cyber threat as a hazard of concern for the State of Hawai'i. Although a threat, the HMWG determined this hazard is a human-caused hazard best addressed through emergency response and IT disaster recovery planning.
Drought	Yes	Yes	Maui County has been in an almost continual state of drought over the past five years and the USDA issued six drought disaster declarations for the county from 2020 to 2024. Sixty percent of the HMWG rated drought as a high-priority hazard of concern. Drought is included in this plan as a hazard of concern.
Earthquake	Yes	Yes	Maui County is at risk from volcano-generated earthquakes; therefore, earthquake is included in this plan as a hazard of concern. Sixty percent of the HMWG rated earthquake as a medium-priority hazard of concern.

Hazard	May Occur in the County?	Poses Significant Threat to the County?	Why was this determination made?
Extreme Cold	Yes	No	The 2023 State HMP does not identify extreme cold as a hazard of concern for the State of Hawai'i; however, the 2020 Maui HMP did. While snow and ice can occur at the Haleakalā Summit, the infrastructure and equipment are maintained by the National Park Service, not the county. In addition, none of the mitigation actions identified in the 2020 mitigation strategy addressed extreme cold. Although this hazard is a threat, the HMWG determined that it is best addressed by coordination with the National Park Service.
Extreme Heat	Yes	No	The 2023 State HMP does not identify extreme heat as a hazard of concern for the State of Hawai'i; however, the 2020 Maui HMP did. One mitigation action from the 2020 mitigation strategy addressed extreme heat and the county has completed this action. Although this hazard is a threat, the HMWG determined that it is best addressed by coordination with shelter providers and human services organizations.
Flood	Yes	Yes	Maui County is at risk from a variety of flooding hazards; therefore, flood is included in this plan as a hazard of concern.
Hazardous Materials	Yes	No	The 2023 State HMP and the 2020 Maui HMP identified hazardous materials as a hazard of concern. Although this hazard is a threat, the HMWG determined that it is a technological hazard best addressed through emergency response planning.
Health Risks	Yes	No	The 2023 State HMP identifies health risks as a hazard of concern for the State of Hawai'i. Although this hazard is a threat, the HMWG determined that it is a biological hazard best addressed through public health and emergency response planning. Sheltering considerations during times of pandemic will be covered as a cascading impact in the hurricane profile.
Hurricane	Yes	Yes	Maui County is at risk from hurricanes, especially as rising ocean temperatures increase the frequency and intensity of tropical cyclones. Hurricane and wildfire were tied as the highest priority hazard of concern by the HMWG. Hurricane is included in this plan as a hazard of concern.
Infrastructure Failure	Yes	Yes	The State HMP identifies infrastructure failure as a hazard of concern; however, it primarily focuses on dam failure. To maintain consistency with the 2020 and 2015 HMPs, dam and reservoir failure will continue to be used as the title of this hazard profile. Forty-seven percent of the HMWG rated dam and reservoir failure as a high-priority hazard of concern.
Landslide	Yes	Yes	Maui County, especially transportation infrastructure, is at risk from landslides; therefore, landslide is included in this plan as a hazard of concern. Forty percent of the HMWG rated landslide as a high-priority hazard of concern.
Terrorism	Yes	No	The 2023 State HMP identifies terrorism as a hazard of concern for the State of Hawai'i. Although this hazard is a threat, the HMWG determined that it is a human-caused hazard best addressed through emergency response planning and first responder training.
Tsunami	Yes	Yes	Maui County is at risk from tsunamis; therefore, tsunami is included in this plan as a hazard of concern. Sixty-seven percent of the HMWG rated tsunami as a high-priority hazard of concern.

Hazard	May Occur in the County?	Poses Significant Threat to the County?	Why was this determination made?
Volcanic Hazard	Yes	Yes	Haleakalā is an active volcano in Maui County, and the active volcanoes on the Island of Hawai'i routinely disseminate volcanic fog (vog) that is carried to Maui County. Therefore, volcanic hazards are included in this plan as a hazard of concern. Twenty-seven percent of the HMWG rated volcanic hazards as a medium-priority hazard of concern.
Wildfire	Yes	Yes	Maui County is at risk from wildfires; therefore, wildfire is included in this plan as a hazard of concern. Hurricane and wildfire were tied as the highest priority hazard of concern by the HMWG.
Windstorm	Yes	Yes	Maui County is at risk from windstorms that occur outside of hurricanes and tropical storms. Eighty percent of the HMWG rated windstorms as a high-priority hazard of concern. To maintain consistency with the 2020 plan, this hazard profile will continue to be called high windstorms.

5.2 Hazards of Concern Identified for This HMP Update

Based on the review of potential hazards of concern, 11 hazards of concern were identified as significant hazards affecting the County to be addressed in this plan (shown here in alphabetical order):

- Coastal erosion
- Dam and reservoir failure
- Drought
- Earthquake
- Flood
- High windstorm
- Hurricane
- Landslide
- Tsunami
- Volcanic hazards
- Wildfire

Other natural and human-caused hazards of concern have occurred within Maui County but are not addressed in this update because they have a low potential to occur, are addressed by other planning mechanisms, and/or do not result in significant impacts within the County. If deemed necessary by the County, these hazards may be considered in future plan updates.

6. COASTAL EROSION

6.1 HAZARD PROFILE

6.1.1 Hazard Description

Coastal Erosion

Coastal erosion is the process in which rocks, soils, and sands along a coastline are worn away by wave energy. In the U.S., coastal erosion causes approximately $500 million in property loss annually (U.S. Climate Resilience Toolkit n.d.). While coastal erosion affects all shorelines, the impacts and rates of erosion are highly localized. For instance, in Maui County, 85 percent of beaches are eroding, compared to 70 percent of beaches statewide (University of Hawai'i at Mānoa 2012).

Coastal erosion is measured as the rate of change in the position or horizontal displacement of a shoreline and can be chronic or episodic. It is a natural process caused by storm surges, coastal storms/hurricanes, and high waves (such as king tides). A healthy shoreline will naturally recover from erosion events over time. However, it may take months or years for a coastline to recover from a significant episodic erosion event. When shorelines do not recover quickly enough, they retreat inland, potentially damaging buildings, infrastructure, and natural areas. The extent and severity of naturally occurring coastal erosion are accelerated by global sea level rise.

Types of Coastal Erosion in Maui County

Two types of coastal erosion are most significant in Maui County:

- **Beach Erosion**—Occurs when sand is carried from a beach and deposited on sandbars further from shore. On a healthy beach, sand is returned to the beach over time through tidal cycles. Sea level rise, multiple storms over a short period, and/or a shoreline disrupted by hardening can result in shoreline retreat or the narrowing of a beach.
- **Dune Erosion**—Occurs when sand or sediment from areas not typically touched by normal tidal cycles is carried from the mainland and deposited offshore. Often caused by storm surge from severe coastal storms, dune erosion can result in the reshaping of the shoreline when more sand and sediment are removed than can be replenished by regular tidal cycles. This process increases the probability of overwash, or the likelihood that a future storm surge will overtop the dune crest (USGS n.d.). As dunes protect the lands behind them, dune erosion can ultimately make buildings and infrastructure behind impacted dunes more vulnerable to coastal storms and flooding.

Factors Affecting Erosion

The following are factors that affect coastal erosion in Maui County (HI-EMA 2023):

- **High Waves and Strong Currents**—High waves and strong currents typically cause beaches to narrow and steepen as sand is carried offshore or along the coast and deposited in areas

with lower energy. In Hawai'i, fringing reefs play a crucial role in directing and modulating wave and current energy, causing waves to shoal and break further offshore. Erosion trends can vary significantly along the shoreline and from one season to the next.

- **Shoreline Hardening**—Also called coastal armoring, includes structures built along a shoreline (e.g., bulkheads, seawalls, retaining walls) or perpendicular to a shoreline (e.g., jetties, groins). Coastal managers and property owners often attempt to stabilize coastal land and protect infrastructure by constructing shoreline hardening structures to prevent land loss and safeguard shorefront development. While hardening projects can prevent coastal erosion by protecting land directly behind the structure from wave energy, they can also disrupt natural patterns of sand movement and deposition, hindering the replenishment of sand and sediment. Hardening can cause scouring to occur outside of the hardening structure, accelerating coastal erosion on the seaward side of the structure. Often, hardening structures may protect land and structures at the expense of losing beaches and habitat.
- **Dune Leveling or Grading**—The process in which coastal dunes are flattened to create grass lawns or build structures. Coastal dunes are essential to maintaining beaches and providing protection from high waves, rising sea levels, and strong storms. Further, dunes are important for the storage of sand. Flattened dunes fail to provide this critical protection. While dune grading has occurred historically in Maui County, it is currently prohibited through a dune grading ordinance.
- **Sand Mining**—Historically, practiced on the Island of Maui to mine lime to be used as a building material. In past decades, sand mining has been largely responsible for the retreat of both the vegetation line and the beach foreshore on affected beaches. In addition to the loss of vegetation and beach foreshore, sand mining degrades beaches by decreasing sand volumes, steepening the morphology of the shoreline, and reducing the ability of beach profiles to respond to seasonal wave stresses.
- **Canalization**—The process in which many of the intermittent Hawaiian streams that flow from the mountains to the coast have been contained in concrete canals to control flash flooding during heavy rainfall events. Where canals open onto the coast, sand tends to get trapped in the channel mouths as it moves along the shoreline. This trapped sand increases the upstream flood hazard and creates a sand deficiency on the adjacent beach. Often, accumulated sand is trucked off-site for other uses. When cleared sand is taken off-site rather than being returned to the immediate beach, long-term impacts are similar to those of sand mining and can result in chronic erosion. However, when placing sands cleared from channel mouths onto adjacent beaches, it is important to be aware of prevailing sediment transport patterns so that returned sand can provide nourishment.

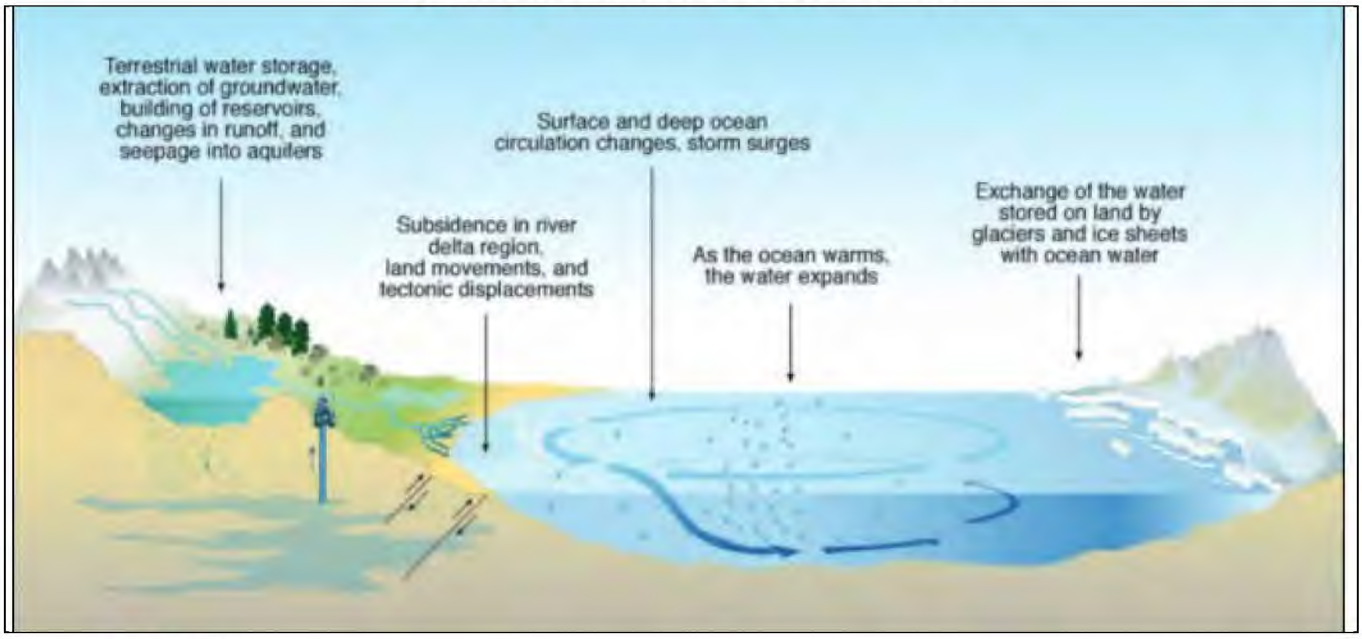
  Coral Reef Degradation—Coral reefs provide a natural buffer to protect coastlines from waves, storms, and floods. When reefs are degraded, the absence of a natural offshore barrier exposes shorelines to wave energy and violent storms. Coral reefs can be degraded by water pollution, turbidity (sediment in water that blocks sunlight from reaching coral), and warming ocean temperatures (NOAA National Ocean Service 2024).

Sea Level Rise

Global mean sea level rise has been observed over the last century through 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, with global mean sea level rising by 8 to 9 inches since 1880. See Figure 6-1 for an illustration of what causes sea level to change. There are two types of sea level rise (NOAA Tides & Currents n.d.):

- **Global Sea Level Rise**—This is the increase observed in the average global sea level. It is primarily attributed to changes in ocean volume due to ice melt and thermal expansion. The melting of glaciers and continental ice masses contributes significant amounts of freshwater to the earth's oceans. Additionally, an increase in global ocean temperature causes seawater to expand, further increasing ocean volume.
- **Relative (Local) Sea Level Rise**—This 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 by referencing water measurements to stable vertical points on the land. These measurements include both global sea level rise and vertical land motion (such as 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.

Figure 6-1 Causes of Sea Level Change



Source: (IPCC 2001)

Changes in sea level can have a profound impact on coastal regions. Higher sea levels can submerge low-lying wetlands and dry land, erode shorelines, lead to coastal flooding, and increase the intrusion of saltwater into estuaries and nearby groundwater sources. Additionally, coastal areas become more

susceptible to storm damage. The rise in sea levels, combined with predictions of more intense and frequent El Niño events and tropical cyclones, pose an increasing risk of coastal flooding and erosion.

6.1.2 Location

All shorelines in Maui County are vulnerable to varying degrees of coastal erosion. Figure 6-2 illustrates the coastal erosion areas for all of Maui County. Maps of coastal erosion by Community Plan Area are provided in Appendix H. According to the National Assessment of Shoreline Change, which utilized aerial imagery, approximately 85 percent of beaches on the Island of Maui are experiencing erosion (USGS 2011). However, certain areas are more prone to erosion than others, particularly beaches within the West Maui, Kīhei-Mākena, and Wailuku-Kahului Community Plan Areas.

The islands of Maui and Molokaʻi provide significant protection to the Island of Lānaʻi from erosion on its northern and northeastern shores. Consequently, most erosion on Lānaʻi occurs on the island's southwest side. On the Island of Molokaʻi, coastal erosion predominantly affects the southern shoreline, which is marked by scarped dunes, fallen trees, and basalt rock outcrops. Coral reefs, which offer natural protection against coastal erosion, are present offshore of all the islands in Maui County. Molokaʻi has the most extensive coral reef within the county.

6.1.3 Extent

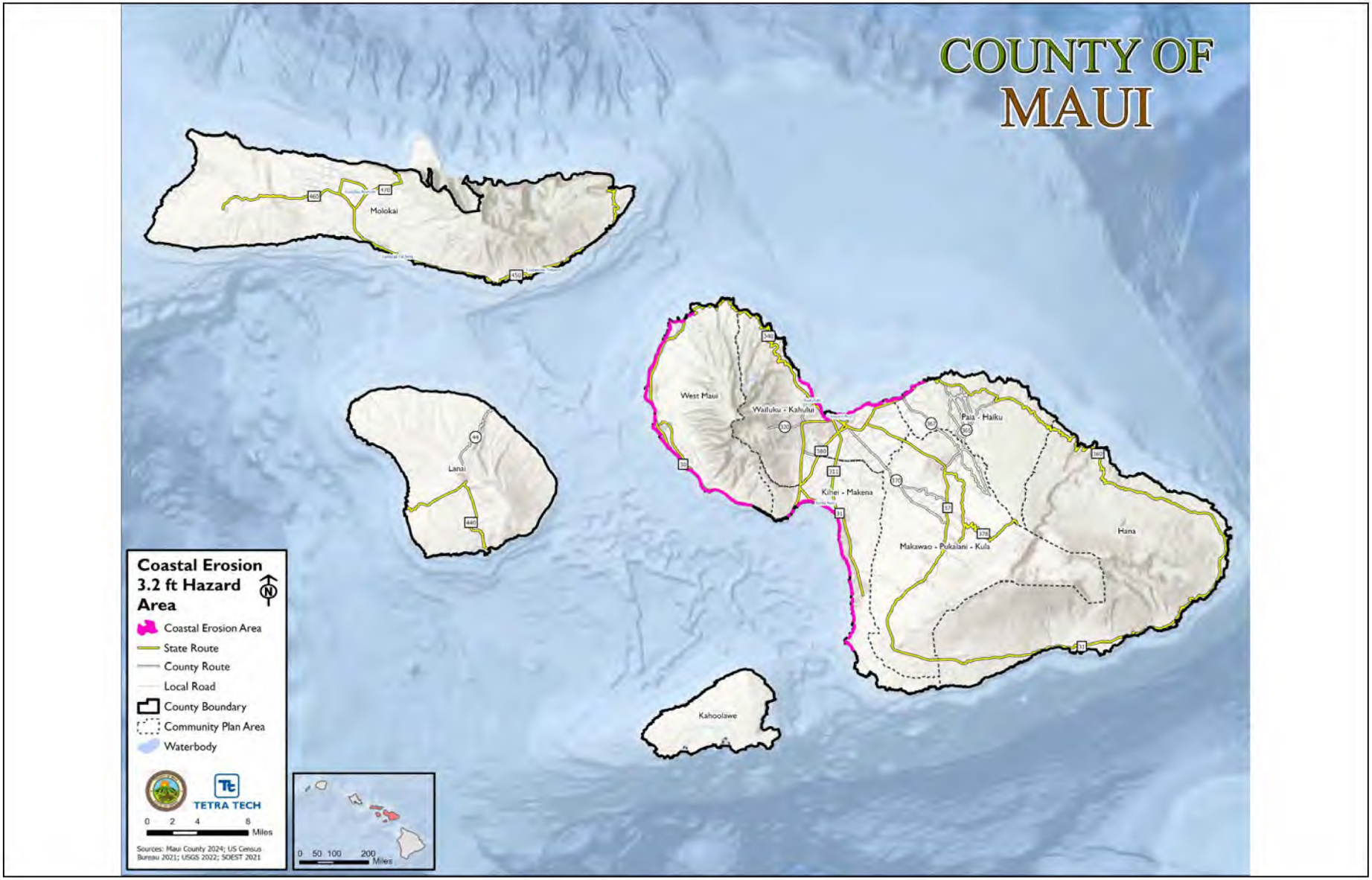
Coastal erosion and sea level rise are significant hazards in Maui County, with varying extents depending on geographic location, local environmental conditions, and human activities. The extent of coastal erosion is typically measured by the rate of change in the position or horizontal displacement of a shoreline. This can be chronic, occurring gradually over time, or episodic, resulting from specific events such as storms or high waves.

Coastal erosion is measured through various techniques, including beach profiles, sediment analysis, longshore drift studies, and historical data analysis (Field Studies Council n.d.). Beach profiles involve measuring the cross-sectional shape of the beach, while sediment analysis examines the size and shape of coarse sediments directly on the beach and fine sediments in a lab. Longshore drift studies assess the direction and strength of sediment movement along the coast, and historical data from maps, aerial photographs, and records provide insights into changes over time.

Sea level rise is monitored using the following technologies (Global Sea Level Change n.d.):

- **Tide Gauges**—These devices measure the height of the water surface relative to the land, offering long-term records of sea level changes at specific locations.
- **Satellite Altimetry**—Satellites equipped with radar altimeters measure sea level from space by sending microwave pulses to the ocean surface and recording the return time, providing precise global sea level measurements.

Figure 6-2. Coastal Erosion 3.2 Feet Hazard Area



Based on the study conducted by the Coastal Geology Group, the Spreckelsville area in Wailuku-Kahului is experiencing the most severe erosion in the county, with an average annual erosion hazard rate of -1.7 feet per year.

It can be expected that sea level rise associated with a changing climate will exacerbate coastal erosion rates by causing shorelines to retreat farther inland. One study found that historically, coastal erosion on the Hawaiian Islands has been two orders of magnitude higher than sea level rise.

Coastal erosion severity may also be measured in terms of the percentage of shoreline within the county experiencing erosion. Coastal erosion is a persistent and escalating issue, with 85 percent of Maui's shorelines experiencing long-term erosion. Sea level rise is a major contributor to the changing size and shape of Hawai'i's shorelines. Research analyzing 100 years of data reveals that Maui is losing beaches to erosion at a faster rate than Oahu and Kaua'i, primarily due to locally higher rates of sea level rise (County of Maui 2024).

6.1.4 Previous Occurrences

Coastal erosion is an ongoing process, typically defined by areas experiencing high rates of erosion over time rather than singular events. However, certain events, such as tsunamis, can drastically alter shorelines. Data from the Hawai'i Shoreline Study, conducted by the University of Hawai'i at Manoa's Coastal Geology Group, and information from the 2020 Maui County Hazard Mitigation Plan Update were used to determine previous occurrences of coastal erosion.

In Maui County, shorelines along West Maui, North Maui/Kahului Harbor, and the Kīhei coast have experienced significant erosion and shoreline movement. Historically, the West Maui shoreline has been subject to varying rates of erosion. From Lahaina to Papalua, the Honoapi`ilani Highway (State Highway 30) runs along the shoreline. Revetments and other armoring constructed to protect the highway have interfered with natural erosion and replenishment processes. Additionally, the degradation of the Mā'alaea Coral Reef over the last several decades has contributed to coastal erosion, with coral cover declining from 50 to 75 percent in 1993 to just 8 percent in 2015.

The University of Hawai'i at Manoa's Coastal Geology Group conducts the Hawai'i Shoreline Study to provide publicly available shoreline change data to assist in decision-making. Erosion maps generated through the study offer annual erosion hazard rates at 20-meter intervals, as well as historic shorelines. Study areas are presented west-east and north-south, as shown in Figure 6-3. The shoreline map is currently available for Maui Island and is not available for Moloka'i or Lāna'i.

FEMA Disaster Declarations

Maui County has not been included in any major disaster (DR) or emergency (EM) declarations for coastal erosion or sea level rise-related events (FEMA 2024).

Figure 6-3. Maui Shoreline Study Erosion Areas

Source: (Coastal Geology Group 2016)

State Emergency Proclamations

The Governor of Hawai'i may declare a state of emergency by proclamation if an emergency or disaster has occurred or there is imminent danger or threat of an emergency or disaster in any portion of the state (Hawai'i State Legislature 2020). Between 2020 and 2024, Maui County was not included in any coastal erosion or sea level rise-related state emergency proclamations.

USDA Declarations

Between 2020 and 2025, Maui County was not included in any USDA coastal erosion or sea level rise-related agricultural disaster declarations (USDA 2024).

All Recent Events

Table 6-1 lists major recorded coastal erosion and sea level rise-related events that impacted Maui County since the previous HMP was developed. For earlier events, refer to the previous HMP.

Table 6-1. Coastal Erosion and Sea Level Rise Events in Maui County, 2020 to 2024

Event Date	FEMA Declaration or State Proclamation Number	Event Description
January 2020	-	Heavy rainfall and isolated thunderstorms developed across much of the state. On January 13, the Department of Public Works reported erosion in the Kaupo at Nuanualoa Gulch due to the recent rain. On January 14, a caller reported damage to property and surrounding homes, extreme surf and rain, coastal erosion, and a flooded stream. In Lahaina, sinkholes occurred on Liloa Street, along with failing drainage pipes. Impacts on nearby homes were low. In Hāna town on-street parking was closed due to the condition of the roadway. Dirt and debris entered the storm drain system, eventually making its way to the ocean.

Source: (NOAA 2024)

6.1.5 Probability of Future Occurrences

Probability Based on Previous Occurrences

Coastal erosion is an ongoing process, making it challenging to quantify exact probabilities. Short-term shoreline changes can be seasonal, with large swells from the north Pacific affecting northern and western shorelines in winter, and swells from the southern hemisphere impacting southern and western shorelines in summer. Additionally, winter storms, hurricane winds, Kona storms, and extended periods of high trade wind waves from the east to northeast contribute to shoreline erosion (Elsevier 2013). Data from the Hawai'i Shoreline Study indicates that many sections of shoreline within the county experience negative average annual erosion rates.

Coastal erosion is a continual process and the receding shoreline has been documented by the County and UH Manoa over several decades. Based on the documentation and input from the HMWG, the probability of occurrence of coastal erosion and sea level rise in the County is considered "frequent."

Effect of Climate Change on Future Probability

Sea level rise associated with climate change may increase the likelihood of long-term erosion. Warmer ocean water will continue to degrade and destroy coral reefs, leaving coastal areas unprotected from coastal erosion. The intermediate scenario for Hawai'i estimates 3.9 feet of sea level rise by 2100, with models indicating that Hawai'i will experience sea level rise 16 to 20 percent higher than the global average (Hawai`i State Climate Commission 2022).

6.1.6 Cascading Impacts on Other Hazards

Coastal erosion and sea level rise have far-reaching impacts on other hazards. Sea level rise can result in inundation and flooding, which may contaminate surface water and groundwater. Polluted runoff from excessive stormwater can contain sewage and chemicals, leading to annual beach closures around the state.

6.2 VULNERABILITY AND IMPACT ASSESSMENT

To assess Maui County's risk to the coastal erosion hazard, a spatial analysis was conducted using future erosion hazard data for a 3.2-foot sea level rise from the School of Ocean and Earth Science and Technology (SOEST) at the University of Hawai'i. The asset inventories prepared for this HMP (population, buildings, critical facilities) were overlaid with coastal erosion hazard area mapping. Assets with their centroid located in the hazard areas were totaled to estimate the numbers and values at risk from the impacts of flood.

6.2.1 Life, Health, and Safety

Overall Population

Coastal erosion and sea level rise significantly affect human activities in coastal areas and can lead to increased morbidity and mortality. All current and future populations within coastal erosion hazard areas are at risk. Potential impacts include reduced access to medical and emergency services due to transportation network disruptions and loss of power necessary for medical equipment.

Eroded beaches and dunes can make people more susceptible to coastal flooding and storm surges. The increased exposure to coastal flooding can necessitate evacuations for households farther inland during hurricanes and coastal storm events. Coastal flooding poses significant risks similar to those associated with general flooding. These include heightened vulnerability to sewage spills and water contamination, particularly if water and wastewater treatment facilities are located within coastal erosion hazard areas.

As shown in Table 6-2, there are 1,496 persons located in the coastal erosion (3.2-foot scenario) hazard area; the West Maui Community Plan Area has the greatest vulnerable population at 763 persons, or 3.5 percent of the total planning area.

Table 6-2.Population in the Coastal Erosion (3.2-Foot Scenario) Hazard Area

Community Plan Area	Total Population (2023 ACS)	Population in the Coastal Erosion (3.2-Foot Scenario) Hazard Area	
		Number of Persons	% of Plan Area Total
Hāna	2,135	0	0.0%
Kīhei-Mākena	29,174	470	1.6%
Lānaʻi	3,333	0	0.0%
Makawao-Pukalani-Kula	24,505	0	0.0%
Molokaʻi	8,092	0	0.0%
Pāʻia-Haʻikū	17,037	86	0.5%
Wailuku-Kahului	58,606	177	0.3%
West Maui	21,749	763	3.5%
Maui County (Total)	164,632	1,496	0.9%

Source: U.S. Census Bureau 2023 ACS; SOEST 2021

Socially Vulnerable Population

Socially vulnerable populations face heightened risks and challenges in adapting to and recovering from the impacts of coastal erosion and sea level rise. Economically disadvantaged individuals and those with physical limitations may struggle to afford or implement necessary adaptations, such as repairs after storms. Those at risk due to inadequate warning include individuals lacking internet access, non-English speakers, and those who do not regularly use communication tools like cell phones or social media. Table 6-3 presents the estimated socially vulnerable populations in the coastal erosion (3.2-foot scenario) hazard area.

Table 6-3. Estimated Populations in the Coastal Erosion (3.2-Foot Scenario) Hazard Area

Community Plan Area	Vulnerable Populations Located in the Coastal Erosion (3.2-Foot Scenario) Hazard Area									
	Persons Over 65		Persons Under 5		Non-English Speaking Persons		Persons with a Disability		Persons in Poverty	
	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total
Hāna	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Kīhei-Mākena	98	1.6%	21	1.6%	13	1.5%	50	1.6%	46	1.6%
Lānaʻi	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Makawao-Pukalani-Kula	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Molokaʻi	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Pāʻia-Haʻikū	14	0.5%	5	0.4%	0	0.0%	7	0.5%	9	0.5%
Wailuku-Kahului	34	0.3%	8	0.3%	9	0.3%	19	0.3%	12	0.3%
West Maui	142	3.5%	51	3.4%	32	3.4%	70	3.5%	73	3.5%
Maui County (Total)	288	0.9%	85	0.9%	54	0.9%	146	0.8%	140	0.9%

Source: U.S. Census Bureau 2023 ACS Vulnerable Population Totals; SOEST 2021

6.2.2 General Building Stock

General building stock in Maui is highly vulnerable to coastal erosion and sea level rise. Coastal erosion can undermine the foundations of buildings and infrastructure, leading to structural failure and increased flooding risks. As shorelines retreat, structures previously considered safe may become exposed to these hazards. Sea level rise exacerbates this vulnerability by increasing the frequency and intensity of coastal flooding and storm surges.

As shown in Table 6-4, there are 366 buildings in the coastal erosion (3.2-foot scenario) hazard area, accounting for 0.8 percent of the County's total general building stock. The replacement cost value for these buildings is an estimated $1.2 billion, which constitutes 2.3 percent of the County's total inventory replacement cost value. West Maui has the greatest amount of exposure, with 162 buildings in the coastal erosion (3.2-foot scenario) hazard area, or 4.0 percent of all buildings in the Community Plan Area. These buildings account for $752 million in replacement cost value, or 8.5 percent of the Community Plan Area total.

Table 6-4 Buildings in the Coastal Erosion (3.2-Foot Scenario) Hazard Area

Community Plan Area	Community Plan Area Total Buildings		Buildings in the Coastal Erosion (3.2-Foot Scenario) Hazard Area			
			Number of Buildings		Replacement Cost Value	
	Count	Replacement Cost Value	Count	% of Plan Area Total	Value	% of Plan Area Total
Hāna	930	$741,266,476	0	0.0%	$0	0.0%
Kīhei-Mākena	7,613	$11,692,760,990	137	1.8%	$381,046,148	3.3%
Lānaʻi	1,258	$1,012,846,136	0	0.0%	$0	0.0%
Makawao-Pukalani-Kula	8,868	$6,037,317,698	0	0.0%	$0	0.0%
Molokaʻi	3,056	$2,384,451,998	0	0.0%	$0	0.0%
Pāʻia-Haʻikū	4,316	$2,686,054,376	23	0.5%	$18,383,514	0.7%
Wailuku-Kahului	15,444	$18,302,375,352	44	0.3%	$34,104,359	0.2%
West Maui	4,063	$8,896,487,618	162	4.0%	$752,005,051	8.5%
Maui County (Total)	45,548	$51,753,560,644	366	0.8%	$1,185,539,072	2.3%

Source: USACE NSI 2022; Hawaiʻi Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; RSMeans 2024; SOEST 2021

Table 6-5 presents the buildings in the hazard area categorized by general occupancy class. Nearly 80 percent of buildings in the hazard area are residential. The Community Plan Area of West Maui has the highest number of residential (124) and commercial (36) buildings in this hazard area. The Community Plan Areas of Kīhei-Mākena and Wailuku-Kahului have the only industrial buildings (two each) in this hazard area. Kīhei-Mākena has the highest number of buildings classified as government, religious, agricultural, or educational (four).

Table 6-5. Buildings in the Coastal Erosion (3.2-Foot Scenario) Hazard Area by Occupancy Class

Community Plan Area	Buildings in the Coastal Erosion (3.2-Foot Scenario) Hazard Area by General Occupancy Class			
	Residential	Commercial	Industrial	Other[a]
Hāna	0	0	0	0
Kīhei-Mākena	107	24	2	4
Lānaʻi	0	0	0	0
Makawao-Pukalani-Kula	0	0	0	0
Molokaʻi	0	0	0	0
Pāʻia-Haʻikū	20	1	0	2
Wailuku-Kahului	40	2	2	0
West Maui	124	36	0	2
Maui County (Total)	291	63	4	8

Source: USACE NSI 2022; Hawai'i Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; SOEST 2021

a. Other = Government, Religion, Agricultural, and Education

6.2.3 Community Lifelines and Other Critical Facilities

Coastal erosion and sea level rise pose significant threats to community lifelines and critical facilities. They can undermine roads, scour bridges, and expose underground utilities, leading to destabilization and damage.

In many coastal areas, major roads and highways are vulnerable due to their proximity to the shoreline. For example, Honoapi`ilani Highway, Lower Honoapi`ilani Road, Kahului Beach Road, and North and South Kīhei Roads are located within coastal erosion hazard areas. These roads are essential for transportation and connectivity, and their exposure to erosion can lead to severe disruptions. If coastal erosion renders a section of a road or bridge impassable, it can block access to other roads or critical locations, disrupting transportation and emergency response efforts.

When utility lines are compromised, the functionality of water, sewer, gas, and electricity systems may be affected, impacting the entire community. The extensive geographic spread of roads and utility lines increases their likelihood of being impacted by coastal erosion, and relocating them out of hazard areas is often challenging.

Table 6-6 summarizes the number of community lifelines in the coastal erosion (3.2-foot scenario) hazard area. Overall, in Maui County, there are eight facilities in the coastal erosion hazard area. Five of those eight are in the West Maui Community Plan Area.

Table 6-6. Number of Facilities in the Coastal Erosion (3.2-Foot Scenario) Hazard Area

Community Plan Area	Number of Facilities in the Coastal Erosion (3.2-Foot Scenario) Hazard Area, by Lifeline Category									Total Facilities in Hazard Area	
	Communications	Energy	Food, Hydration, Shelter	Hazardous Materials	Health & Medical	Safety & Security	Transportation	Water Systems	Other Critical Facilities	Count	% of Plan Area Total
Hāna	0	0	0	0	0	0	0	0	0	0	0.0%
Kīhei-Mākena	1	0	0	0	0	0	0	0	0	1	2.9%
Lānaʻi	0	0	0	0	0	0	0	0	0	0	0.0%
Makawao-Pukalani-Kula	0	0	0	0	0	0	0	0	0	0	0.0%
Molokaʻi	0	0	0	0	0	0	0	0	0	0	0.0%
Pāʻia-Haʻikū	0	0	0	0	0	0	0	0	0	0	0.0%
Wailuku-Kahului	0	0	0	0	0	0	0	2	0	2	2.0%
West Maui	0	0	0	0	0	2	0	3	0	5	12.5%
Maui County (Total)	1	0	0	0	0	2	0	5	0	8	2.9%

Source: Hawaiʻi Emergency Management Agency 2017; SOEST 2021

6.2.4 Economy

Coastal erosion and sea level rise can have extensive economic impacts in Maui County. According to the Hawai'i Climate Change Mitigation and Adaptation Commission 2017 report, potential economic losses (including all structures and land) across the island could be $4.1 billion with 1.1 feet of sea level rise and $12.9 billion with 3.2 feet of sea level rise (HCCMAC 2017).

Losses occur directly due to damaged structures and infrastructure. Business disruptions can occur even if the business is not located directly on the coastline, as customers and employees may be unable to reach them. This leads to forgone sales for the business and tourism taxes for the county. Loss of sandy beaches due to coastal erosion can negatively impact tourism, as visitors tend to avoid shrinking, narrow beaches due to crowding.

Coastal erosion may cause beachfront property values to decline as the beach is lost and the building becomes at risk of flooding or structural damage. Declining property values may impact the county's tax base. Additionally, the county may need to allocate increasing amounts of funding toward beach renourishment or hardening structures to protect beaches, roads, and structures as the shoreline retreats inland.

6.2.5 Natural, Historic and Cultural Resources

Natural Resources

Rising sea levels, increased temperatures, and changing precipitation patterns can lead to habitat loss and degradation, affecting species that depend on these areas, such as native fish, birds, and plants. Endemic species, which have evolved in specific microclimates, face increased stress and potential extinction. Coastal erosion worsens habitat loss by eroding shorelines and altering coastal ecosystems. Sea level rise can inundate coastal habitats, further stressing native species and ecosystems.

Historic Resources

Historic resources, including historic buildings, structures, and archaeological sites, are at risk from rising sea levels and resulting increased flooding, which can cause structural damage. Coastal erosion can undermine foundations and lead to the collapse of historic structures. Increased flooding and erosion can wash away archaeological sites and artifacts.

Cultural Resources

The health of natural landscapes is closely tied to Native Hawaiian cultural identity and heritage, and changes to these landscapes can disrupt cultural connections and practices. Resources such as freshwater streams and springs hold significant value for Native Hawaiian communities. Coastal erosion and sea level rise can degrade sacred sites and cultural landscapes, leading to ground instability and loss of culturally significant areas. The availability of native plants and materials essential for cultural practices may decline, affecting cultural continuity. Erosion can degrade sacred sites and cultural landscapes.

6.2.6 Identified Vulnerability Issues

The County has identified the following vulnerabilities related to this hazard:

- High tides and annual high surf exacerbate coastal erosion, especially in areas with structures and infrastructure located at sea level. Potential solutions include moving roads inland, raising roadways, or providing shoreline protection; however, all of these options come with a significant cost to the County.
- Critical facilities located along the shore are not flood-proofed to prevent water damage from flooding or the ocean. These facilities will eventually need to be relocated to a higher elevation.
- 87 percent of public survey respondents indicated that they are concerned about coastal erosion but solutions are handicapped by funding gaps, state and local laws, and negative public perception of available solutions.

6.3 FUTURE CHANGES THAT MAY AFFECT RISK

6.3.1 Potential or Planned Development

Development in coastal areas can significantly increase the risk of coastal erosion and sea level rise. Construction activities, such as building homes, roads, and infrastructure, disrupt natural coastal processes and can accelerate erosion. Increased development often leads to the removal of vegetation that stabilizes shorelines, further exacerbating erosion. Additionally, development can contribute to climate change through increased greenhouse gas emissions, which accelerate sea level rise. As sea levels rise, coastal areas become more vulnerable to flooding and erosion, posing greater risks to both natural ecosystems and human communities.

In a 3.2-foot coastal erosion scenario, only 16 new developments across Maui County are located within the hazard area, representing 0.5 percent of all new development Countywide. The planning area of Kihei-Makena has the highest number with eight developments (1.6 percent), followed by Wailuku-Kahului with five (0.7 percent), and West Maui with three (0.5 percent). All other planning areas report no new development in the hazard zone. Table 6-7 breaks down the number of new developments by community planning area.

Table 6-7. Number of New Developments in the Coastal Erosion Hazard Area

Community Plan Area	Number of New Development in the Coastal Erosion (3.2ft Scenario) Hazard Area	
Hana	0	0.0%
Kahoolawe	0	0.0%
Kihei - Makena	8	1.6%

Lanai	0	0.0%
Makawao - Pukalani - Kula	0	0.0%
Molokai	0	0.0%
Paia - Haiku	0	0.0%
Wailuku - Kahului	5	0.7%
West Maui	3	0.5%
Maui County (Total)	**16**	**0.5%**

Source: *County of Maui 2025; SOEST 2021*

6.3.2 Projected Changes in Population

Population growth in coastal areas increases development, resource use, pollution, and pressure on natural defenses, intensifying coastal erosion and accelerating sea level rise. The Department of Business, Economic Development and Tourism (DBEDT) produced population projections for the County from 2030 to 2050. According to these projections, Maui County's population is projected to grow to 173,520 by 2030, 181,000 by 2040, and 184,870 by 2050.

6.3.3 Climate Change

Future climate change will significantly impact coastal erosion and sea level rise in Maui County. Higher sea surface temperatures will cause irregular patterns of heavy rainstorms and intense hurricanes, stressing coastal areas. Warmer ocean waters will degrade coral reefs, making coastal regions more vulnerable to flooding. Sea level rise, driven by melting ice and expanding ocean volume, is projected to reach 3.9 feet by 2100, increasing the risk of coastal erosion and flooding.

6.3.4 Other Identified Conditions

The geographic and environmental characteristics of the shoreline, including sandy beaches, rocky coasts, and cliffs, play a crucial role in determining susceptibility to erosion. Wave energy and current patterns further impact different parts of the coastline, while the availability and movement of sediments contribute to beach replenishment.

Human activities such as coastal development, shoreline hardening, sand mining, and dredging significantly influence erosion rates. Buildings, infrastructure, and hard structures like seawalls and groins can disrupt natural sediment movement, accelerating erosion and reducing the resilience of coastal areas.

Natural defenses, including coral reefs and wetlands, play a vital role in protecting shorelines from wave energy and erosion. Dune systems provide a buffer against coastal erosion and storm surge,

helping to maintain the integrity of the coastline. Preserving and restoring these natural features is essential for mitigating the impacts of coastal erosion and sea level rise.

7. DAM AND RESERVOIR FAILURE

7.1 HAZARD PROFILE

7.1.1 Hazard Description

A dam is an artificial barrier allowing storage of water, wastewater, or liquid-borne materials for purposes such as flood control, water supply, irrigation, energy generation, recreation, or pollution control (ASDSO 2023). Over 80 percent of dams and reservoirs in Hawai'i were built before 1940 to support sugarcane plantations (DLNR 2025). Today, these dams and reservoirs provide storage for irrigation, flood control, hydropower, and recreation.

Dam failure occurs when a dam is damaged or destroyed, releasing water or other liquid stored behind the dam and causing property and environmental damage, injuries, and fatalities. According to the Association of State Dam Safety Officials, the following have been the most common causes of dam failures in the United States (ASDSO 2021):

- Overtopping caused by water spilling over the top of a dam has accounted for 34 percent of all U.S. dam failures.
- Foundation defects, including settlement and slope instability, cause about 30 percent of all dam failures.
- Piping—when water seeping through a dam forms sink holes in the dam—has caused 20 percent of U.S. dam failures.
- Cracking caused by movements like the natural settling of a dam.
- Inadequate maintenance and upkeep.

The threat of dam failure increases as dams get older. Common problems of older dams include deteriorating metal pipes and structural components. It is not unusual for metal to rust and lose its structural integrity after 50 years (ASDSO 2015).

Regulatory Oversight of Dams

State and federal initiatives have been established to reduce the potential of full or partial failures.

National Dam Safety Program

Grant assistance from FEMA provides support for the improvement of dam safety programs that regulate most dams in the United States. The National Dam Safety Program, established by the National Dam Safety Act (Public Law 92-367), is a partnership among states, federal agencies, and other stakeholders that encourages individual and community responsibility for dam safety. Assistance funds from the program have allowed participating states to improve their programs through increased inspections, emergency action planning, and purchases of needed equipment.

U.S. Army Corps of Engineers Dam Safety Program

The U.S. Army Corps of Engineers (USACE) is responsible for safety inspections of some federal and non-federal dams in the United States that meet the size and storage limitations specified in the National Dam Safety Act. USACE maintains an inventory of dams and has surveyed each state and federal agency's capabilities, practices, and regulations regarding the design, construction, operation, and maintenance of the dams. USACE has also developed guidelines for inspection and evaluation of dam safety (USACE 2014).

Federal Energy Regulatory Commission Dam Safety Program

The Federal Energy Regulatory Commission (FERC) has the largest dam safety program in the United States. FERC cooperates with a large number of federal and state agencies to ensure and promote dam safety. A total of 3,036 dams are part of regulated hydroelectric projects included in the FERC program. Two-thirds of these dams are more than 50 years old. Concern about their safety and integrity grows as dams age, rendering oversight and regular inspection especially important. FERC staff inspect hydroelectric projects on an unscheduled basis to investigate the following (FERC 2020):

- Potential dam safety problems
- Complaints about constructing and operating a project
- Safety concerns related to natural disasters
- Issues concerning compliance with terms and conditions of a license.

Every five years, an independent consulting engineer approved by FERC must inspect and evaluate projects with dams higher than 32.8 feet (10 meters) or with a total storage capacity of more than 2,000 acre-feet (FERC 2020).

Hawai'i Dam and Reservoir Safety Program

The Hawai'i Department of Land and Natural Resources (DLNR) oversees the Hawai'i Dam and Reservoir Safety Program, which was established in 1987. Dams that meet specific size criteria are regulated by the program: those with artificial barriers 25 feet or more in height or with an impounding capacity of 50 acre-feet (approximately 17 million gallons) or more (DLNR 2024). Each county has a designated DLNR dam safety engineer. Key activities of the program include the following:

- Conducting safety inspections of all regulated dams
- Working with owners to develop remediation plans for deficiencies identified in the safety inspections
- Conducting additional inspections as needed after natural disasters
- Preparing hazard classification studies for all regulated dams.
- Working with owners to develop or update emergency action plans (EAPs) for each facility
- Updating the State Legislature on issues pertaining to dam safety
- Reviewing permit applications and working with owners who are constructing or modifying dam facilities to comply with dam safety standards

- Providing technical training to dam owners and operators, including topics like preparing EAPs and dam facility maintenance

In general accordance with dam safety practices nationally, the State of Hawai'i classifies dam hazards in a three-tier rating system: low, significant, and high (DLNR 2024). The hazard potential classification system provides a means of categorizing the consequences of dam failure, prioritizing dam safety activities, and identifying additional regulatory requirements or actions. The ratings are based on the downstream damage that would result if a dam were to fail. The hazard classification has no relationship to the condition of the dam, its structural integrity, operational status, or flood storage capability. Table 7-1 describes the three classifications.

Table 7-1. Hazard Classification Definitions

Hazard Rating	Expected Impacts If Dam Should Fail
Low	Loss of life is not expected. Economic and environmental losses are low and generally limited to the owner's property.
Significant	Loss of life is not expected, but major economic loss, environmental damage, disruption of lifeline facilities, or impacts of other concerns are possible.
High	Loss of life is probable, one or more expected. Economic and environmental losses are expected.

Source: (DLNR 2024)

7.1.2 Location

Maui County is home to 53 state-regulated dams and reservoirs, the majority of regulated dams in the state. Many of the County's streams are dammed for flood control or water storage purposes. According to the National Inventory of Dams, of the 53 state-regulated dams in the County, 50 are considered high hazard, two are considered significant hazard, and one is considered low hazard. There are 37 dams assessed as being in poor condition, and 34 of them are high hazard dams. Two high-hazard reservoirs were removed in 2024: the Ukumehame Reservoir, which was in unsatisfactory condition, and the Kapalaalaea Reservoir, which was in poor condition (DLNR 2024).

Figure 7-1 shows the dams by class throughout the County. Table 7-2 provides detailed information on all state-regulated dams in Maui County.

The combined area of expected inundation that would result from failure of high-hazard dams in the County is 30.1 square miles, 2.56 percent of the county's total area (HI-EMA 2023). The size of a dam failure inundation zone is generally much larger than the area affected by normal river or stream flood events, highlighting the significant impact a dam failure could have on the surrounding communities. See Figure 7-2 for high-hazard dam-failure inundation areas in Maui County. Maps of dam failure inundation by Community Plan Area are provided in Appendix H.

Figure 7-1. Dams in Maui County

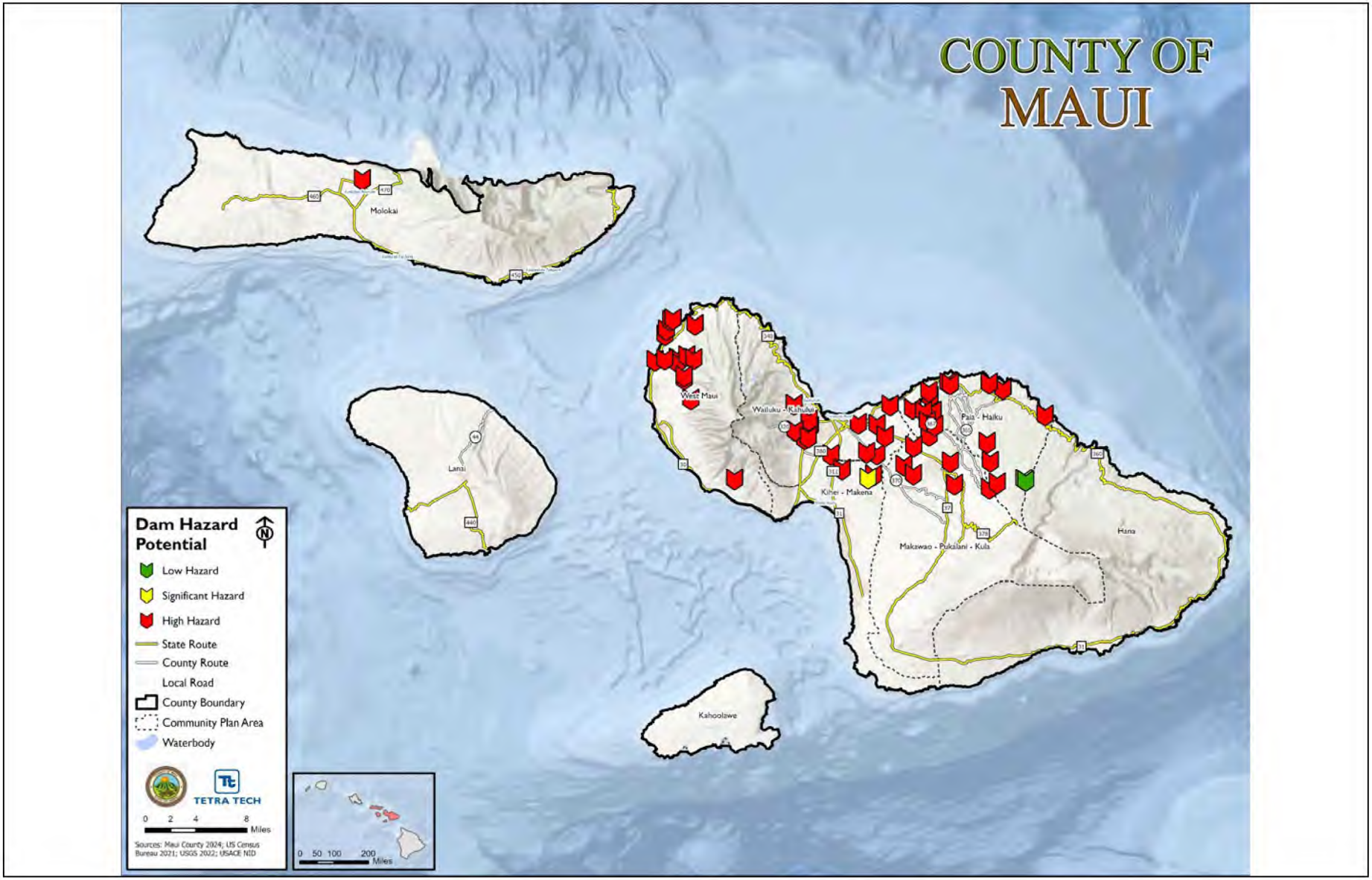


Table 7-2. State-Regulated Dams in Maui County

Dam Name	National Inventory of Dams ID	Primary Purpose	City	State Regulated Dam	Primary Dam Type	Year Completed	Last Inspection Date	Condition Assessment	Condition Assessment Date	EAP Prepared	EAP Last Revision Date
High Hazard											
Mahinahina Reservoir	HI00144	Water Supply	Honokowai	Yes	Earth	1995	12/8/2022	Poor	7/25/2022	Yes	6/12/2024
Maui Field 290 Reservoir	HI00139	Irrigation	Pukalani	Yes	Earth	1997	10/30/2024	Poor	4/13/2023	Yes	7/12/2022
Maui Reservoir 21	HI00071	Irrigation	Upper Pāʻia	Yes	Earth	1913	10/18/2021	Poor	11/1/2022	Yes	6/19/2024
Maui Reservoir 25	HI00074	Irrigation	Upper Pāʻia	Yes	Earth	1917	10/19/2021	Poor	11/1/2022	Yes	6/19/2024
Maui Reservoir 92	HI00090	Irrigation	Waikapu	Yes	Earth	1967	10/25/2021	Poor	11/1/2022	Yes	6/20/2024
Maui Reservoir 90	HI00089	Irrigation	Waiakoa Homesteads	Yes	Earth	1917	10/25/2021	Poor	11/1/2022	Yes	6/20/2024
Maui Reservoir 81	HI00086	Irrigation	Waiakoa Homesteads	Yes	Earth	1920	10/25/2021	Poor	11/1/2022	Yes	6/20/2024
Maui Reservoir 80	HI00085	Irrigation	Puunene	Yes	Earth	1917	10/21/2021	Fair	11/1/2022	Yes	6/20/2024
Maui Reservoir 61	HI00081	Irrigation	Kahului Airport	Yes	Earth	1917	10/20/2021	Poor	11/1/2022	Yes	6/20/2024
Maui Reservoir 84	HI00088	Irrigation	Puunene	Yes	Earth	1918	10/21/2021	Poor	11/1/2022	Yes	6/20/2024
Maui Reservoir 15	HI00069	Irrigation	Kuau	Yes	Earth	1917	12/7/2022	Poor	7/25/2022	Yes	6/19/2024
Maui Reservoir 74	HI00084	Irrigation	Kahului	Yes	Earth	1916	10/14/2022	Poor	7/26/2022	Yes	6/20/2024
Maui Reservoir 73	HI00083	Irrigation	Kahului	Yes	Earth	1908	8/10/2022	Poor	7/20/2022	Yes	6/20/2024
Maui Reservoir 42	HI00078	Irrigation	Kahului	Yes	Earth	1917	10/21/2021	Poor	11/1/2022	Yes	6/20/2024

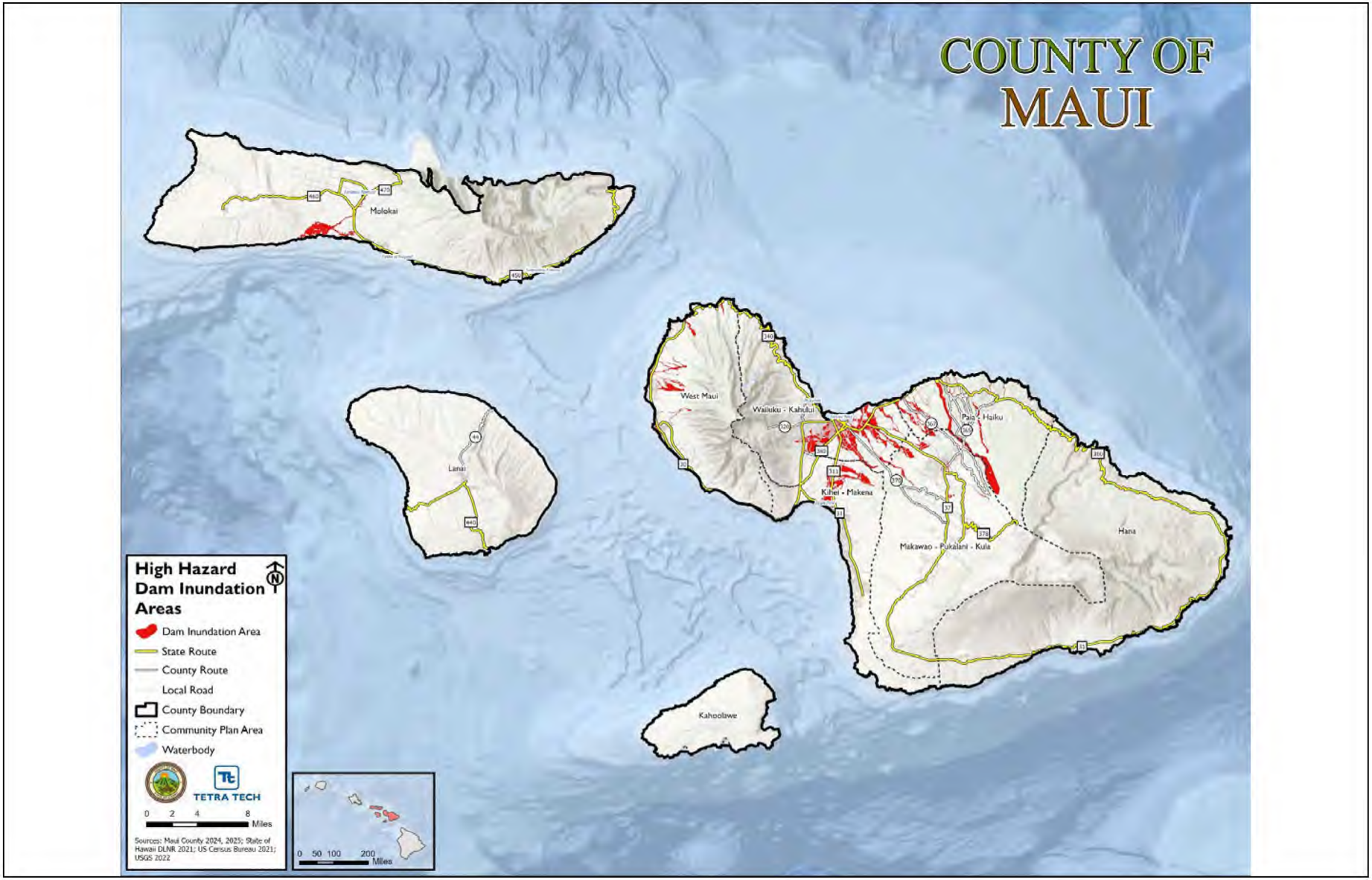
Dam Name	National Inventory of Dams ID	Primary Purpose	City	State Regulated Dam	Primary Dam Type	Year Completed	Last Inspection Date	Condition Assessment	Condition Assessment Date	EAP Prepared	EAP Last Revision Date
Maui Reservoir 60	HI00080	Irrigation	Spreckelsville	Yes	Earth	1917	10/19/2021	Poor	11/1/2022	Yes	6/20/2024
Maui Reservoir 30	HI00075	Irrigation	Haliimaile	Yes	Earth	1917	10/19/2021	Poor	11/1/2022	Yes	6/19/2024
Maui Reservoir 14	HI00068	Irrigation	Kuau	Yes	Earth	1913	12/14/2022	Unsatisfac-tory	7/25/2022	Yes	6/19/2024
Maui Reservoir 40	HI00077	Irrigation	Pukalani	Yes	Earth	1926	10/21/2021	Fair	11/1/2022	Yes	6/20/2024
Maui Reservoir 33	HI00076	Irrigation	Pukalani	Yes	Earth	1910	10/20/2021	Poor	11/1/2022	Yes	6/20/2024
Maui Reservoir 70	HI00082	Irrigation	Kahului	Yes	Earth	1917	10/20/2021	Poor	11/1/2022	Yes	6/20/2024
Maui Reservoir 52	HI00079	Irrigation	Spreckelsville	Yes	Earth	1917	10/20/2021	Poor	11/1/2022	Yes	6/20/2024
Maui Reservoir 24	HI00073	Irrigation	Upper Pāʻia	Yes	Earth	1917	12/15/2022	Poor	7/20/2022	Yes	6/19/2024
Maui Reservoir 22	HI00072	Irrigation	Haliimaile	Yes	Earth	1917	10/18/2021	Fair	11/1/2022	Yes	6/19/2024
Maui Reservoir 20	HI00070	Irrigation	Haliimaile	Yes	Earth	1913	10/18/2021	Poor	11/1/2022	Yes	6/19/2024
Kahana Nui Dam	HI00126	Flood Risk Reduction	Kahana	Yes	Earth	1984	4/1/2022	Poor	7/19/2022	Yes	5/31/2024
Honokowai - Structure #8	HI00130	Flood Risk Reduction	Honokowai	Yes	Earth	1995	2/28/2024	Fair	11/1/2022	Yes	5/31/2024
Kaopala Basin	HI00134	Flood Risk Reduction	Napili	Yes	Earth	1998	2/28/2024	Fair	9/1/2022	Yes	5/31/2024
Napili 4-5 Desilting Basin	HI00127	Flood Risk Reduction	Napili	Yes	Earth	1985	2/21/2024	Fair	11/1/2022	Yes	5/31/2024
Haʻikū Reservoir	HI00095	Irrigation	Haʻikū	Yes	Earth	1904	10/12/2022	Unsatisfact ory	7/19/2022	Yes	8/21/2024

Dam Name	National Inventory of Dams ID	Primary Purpose	City	State Regulated Dam	Primary Dam Type	Year Completed	Last Inspection Date	Condition Assessment	Condition Assessment Date	EAP Prepared	EAP Last Revision Date
Pauwela Reservoir	HI00096	Irrigation	Haʻikū	Yes	Earth	1904	10/12/2022	Poor	7/19/2022	Yes	8/21/2024
Puu Koa Reservoir	HI00133	Irrigation	Pukalani	Yes	Earth	1985	12/15/2022	Poor	6/25/2022	Yes	7/12/2022
Plantation Reservoir	HI00153	Irrigation	Honokahua	Yes	Earth	1989	2/21/2024	Fair	9/1/2022	Yes	8/21/2024
Papaaea Reservoir	HI00092	Irrigation	Kailua	Yes	Earth	1902	10/15/2021	Poor	4/12/2023	Yes	8/21/2024
Reservoir 140	HI00059	Irrigation	Honokowai	Yes	Earth	1926	12/8/2022	Poor	7/25/2022	Yes	8/21/2024
Olinda Reservoir	HI00048	Water Supply	Haleakalā Homesteads	Yes	Earth	1918	10/14/2022	Poor	7/25/2022	Yes	6/12/2024
Honokowai Reservoir	HI00058	Irrigation	Honokowai	Yes	Earth	1918	8/11/2022	Poor	7/22/2022	Yes	8/25/2022
Wailuku Water Reservoir 6	HI00150	Irrigation	Waikapu	Yes	Earth		10/26/2021	Fair	11/1/2022	Yes	6/21/2023
Kahoma Reservoir	HI00057	Irrigation	Lahaina	Yes	Earth	1918	8/11/2022	Poor	7/19/2022	Yes	8/23/2024
Napili 2-3 Desilting Basin	HI00128	Flood Risk Reduction	Napili	Yes	Earth	1988	2/21/2024	Fair	11/1/2022	Yes	5/31/2024
Piiholo 50 Mg Reservoir	HI00047	Water Supply	Kokomo	Yes	Earth	1971	12/1/2022	Unsatisfactory	7/25/2022	Yes	6/12/2024
Kahakapao Reservoirs	HI00138	Water Supply	Makawao	Yes	Earth	1990	12/1/2022	Poor	7/22/2022	Yes	6/12/2024
Kaili Ili Reservoir	HI00143	Irrigation	Makawao	Yes	Earth	1984	10/30/2024	Fair	11/1/2022	Yes	7/12/2022
Middle Field 14 Reservoir	HI00142	Irrigation	Kahana	Yes	Earth	2006	6/5/2024	Unsatisfactory	9/1/2022	Yes	8/21/2024
Upper Field 14 Reservoir	HI00132	Irrigation	Honokowai	Yes	Earth	1985	6/5/2024	Poor	11/1/2022	Yes	8/21/2024
Peahi Reservoir	HI00091	Irrigation	Ulumalu	Yes	Earth	1924	12/7/2022	Poor	7/20/2022	Yes	8/21/2024

Dam Name	National Inventory of Dams ID	Primary Purpose	City	State Regulated Dam	Primary Dam Type	Year Completed	Last Inspection Date	Condition Assessment	Condition Assessment Date	EAP Prepared	EAP Last Revision Date
Kualapuu Reservoir	HI00041	Irrigation	Hoolehua Palaau Homestead	Yes	Earth	1969	1/25/2023	Fair	7/26/2022	Yes	6/28/2024
Wailuku Water Reservoir 10	HI00151	Irrigation	Wailuku Heights	Yes	Earth		8/10/2022	Unsatisfactory	7/20/2022	Yes	6/6/2024
Horner Reservoir	HI00054	Irrigation	Puukolii	Yes	Earth	1926	7/26/2024	Poor	7/19/2022	Yes	5/31/2024
Hanakaoo Reservoir	HI00056	Irrigation	Puukolii	Yes	Earth	1918	7/26/2024	Fair	9/1/2022	Yes	5/31/2024
Kehalani Offsite Retention Basin	HI00141	Flood Risk Reduction	Wailuku	Yes	Earth	2003	12/14/2022	Poor	7/19/2022	Yes	7/15/2022
Significant Hazard											
Maui Reservoir 82	HI00087	Irrigation	Waiakoa Homesteads	Yes	Earth	1917	10/25/2021	Poor	11/1/2022	Yes	6/20/2024
Waikamoi Reservoirs	HI00152	Water Supply	Kailua	Yes	Earth	1980	10/24/2022	Poor	7/26/2022	Yes	6/12/2024
Low Hazard											
Waikamoi Dam No. 2	HI00046	Water Supply	KAILUA	Yes	Concrete	1956	10/24/2022	Poor	6/24/2022	Yes	6/12/2024

Source: (USACE n.d.)

Figure 7-2. High Hazard Dam-Failure Inundation Areas in Maui County



7.1.3 Extent

Potential Impacts of Failure

The extent of the dam failure hazard is indicated by each dam's hazard rating, which indicates the potential severity of a failure. In Maui County, all but three dams are ranked as high hazard, meaning a failure would likely result in loss of human life.

Potential impacts can be inferred from failures of similar dams. For instance, in 2006, the privately owned Ka Loko Dam on the Island of Kaua'i failed. This dam had similarities in construction, ground topography, and rainfall intensity to dams in Maui County. During the failure event, a 120-foot-long portion of the dam breached after an unusually long period of torrential rainfall. Approximately 300 million gallons of water and debris destroyed several homes, devastated a 300-foot-long portion of state highway, overturned several utility poles and lines, and killed seven people. The failure of a dam or reservoir in Maui County could have similar impacts.

Warning Time

High and significant hazard dam owners are required to prepare and maintain an EAP. In the event of a potential dam failure or uncontrolled release of stored water, the EAP is activated. EAPs are required to have established protocols for flood warning and response to imminent dam failure. These documents are customarily maintained as confidential information, although copies are required to be provided to DLNR for every regulated high hazard dam within the State of Hawai'i.

The warning time for dam failure varies based on the cause. During extreme precipitation events, evacuations can be planned with sufficient time. However, in the case of structural failure due to an earthquake, warning time may be limited. Seepages in earthen dams usually develop gradually, and if detected early, downstream residents have anywhere from a few hours to a few days to evacuate. A catastrophic failure is characterized by the sudden, rapid, and uncontrolled release of water from a dammed impoundment. Such failures can occur suddenly and without warning during normal operating conditions, which is referred to as a "sunny day" failure.

The type of dam structure also impacts warning time. Earthen dams tend not to fail completely or instantaneously; once a breach begins, water erosion continues until either the reservoir water is depleted, or the breach resists further erosion. The time for breach formation can range from minutes to hours (USACE 2024).

7.1.4 Previous Occurrences

FEMA Disaster Declarations

Maui County has not been included in any major disaster (DR) or emergency (EM) declarations for dam and reservoir failure-related events (FEMA 2024).

State Emergency Proclamations

The Governor of Hawai'i may declare a state of emergency by proclamation if an emergency or disaster has occurred or there is imminent danger or threat of an emergency or disaster in any portion of the state (Hawai'i State Legislature 2020). Between 2020 and 2024, Maui County was not included in any dam and reservoir failure-related state emergency proclamations. However, a heavy rain event for which an emergency was proclaimed in 2021 did result in overtopping of one dam in the County, as listed in Table 7-3.

Table 7-3. State Emergency Proclamations for Dam Failure Events in Maui County, 2020 to 2024

Declaration Date	Description
March 9, 2021	Emergency Proclamation Related to Heavy Rains and Flooding: resulted in the overtopping of the century-old Kaupakalua Dam

Source: (HI-EMA 2024)

USDA Declarations

Between 2020 and 2024, Maui County was not included in any USDA dam and reservoir failure-related agricultural disaster declarations (USDA 2024).

All Recent Events

There have been two recorded dam failure incidents in Maui County. The first occurred on November 13, 1994, when the Horner Reservoir, located in the West Maui Community Plan Area, failed. Detailed information regarding the impacts of this event is not available. The second incident took place on March 8, 2021, when heavy rainfall caused the Kaupakalua Dam near Ha'ikū to overtop. This event led to emergency evacuations for everyone downstream of the reservoir (Flood List 2021).

7.1.5 Probability of Future Occurrences

Probability Based on Previous Occurrences

Information on previous dam and reservoir failure occurrences in the County was used to calculate the probability of future occurrence of such events. Table 7-4 lists the number of events from various sources during the 30-year period from 1994 to 2024, which is the most complete period of record for all sources reviewed. Based on these records and input from the HMWG, the probability of occurrence of dam and reservoir failure in the County is considered "rare."

Table 7-4. Probability of Future Dam and Reservoir Failure Events in Maui County

Hazard Type	Number of Occurrences Between 1994 and 2024	Percent Chance of Occurring in Any Given Year
Dam and Reservoir Failure	2	6.67 %

Source: (County of Maui 2020); (Flood List 2021)
Note: The time period presented in this table is the most complete period of record for the various data sources reviewed.

Effect of Climate Change on Future Probability

Dams are designed partly based on assumptions about a river'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. Loss of the designed margin of safety may cause floodwaters more readily to overtop the dam or create unintended loads. Such situations could lead to a dam failure.

The frequency and duration of extreme precipitation events directly correspond to the frequency and duration of potential dam failure incidents. Since dams in Hawai'i were primarily built for irrigation purposes before regulatory construction standards were established and long before the anticipated impacts of climate change, the probable maximum flood used to design each dam may not be able to accommodate changes in climate (HI-EMA 2023).

7.1.6 Cascading Impacts on Other Hazards

Dam failures often occur as a secondary consequence of significant rainfall and flooding, which can cause excessive water to enter the spillway. These failures can happen with little to no warning. Other potential cascading impacts from other hazards associated with dam failure include landslides around the reservoir's perimeter. Furthermore, dam failure may exacerbate drought conditions by discharging water that could have otherwise served as a potable water source.

7.2 VULNERABILITY AND IMPACT ASSESSMENT

The asset inventories prepared for this HMP (population, buildings, critical facilities) were overlaid with the combined high-hazard dam failure inundation hazard area mapping. Assets with their centroid located in the hazard areas were totaled to estimate the numbers and values at risk from the impacts of dam failure. To estimate potential losses associated with dam failure, a Level 2 Hazus riverine flood analysis was performed using asset inventories prepared for this HMP and the combined high-hazard dam-failure inundation depth grids.

7.2.1 Life, Health, and Safety

Overall Population

The population living in or near the inundation areas is considered exposed to the hazard, along with people traveling in those areas at the time of a dam failure or whose access to emergency services is compromised by such failures. The potential for loss of life is affected by the capacity and number of evacuation routes available to these populations. The population adversely affected by a dam failure may also include those beyond the disaster area who rely on the dam for providing potable water.

The entire population residing within a dam failure inundation zone is considered vulnerable to the dam failure hazard. As shown in Table 7-5, there are 21,802 persons living in the combined high hazard

dam-failure inundation area. The Wailuku-Kahului Community Plan Area has the greatest population in the dam-failure inundation area: 18,087 persons, or 30.9 percent of the total planning area population.

Table 7-5. Population in the Combined High Hazard Dam-Failure Inundation Area

Community Plan Area	Total Population (2023 ACS)	Population in the Combined High Hazard Dam-Failure Inundation Area	
		Number of Persons	% of Plan Area Total
Hāna	2,135	0	0.0%
Kīhei-Mākena	29,174	4	<0.1%
Lānaʻi	3,333	0	0.0%
Makawao-Pukalani-Kula	24,505	289	1.2%
Molokaʻi	8,092	5	0.1%
Pāʻia-Haʻikū	17,037	1,104	6.5%
Wailuku-Kahului	58,606	18,087	30.9%
West Maui	21,749	2,313	10.6%
Maui County (Total)	164,632	21,802	13.2%

Source: U.S. Census Bureau 2023 ACS; Hawaiʻi DLNR 2021; County of Maui 2025

The sudden release of water resulting from a dam failure can lead to rapid flooding, forcing residents to evacuate their homes to avoid life-threatening conditions. Displaced individuals often seek shelter in designated emergency shelters, which are set up by local authorities and relief organizations. These shelters provide a safe haven, offering essential services such as food, water, medical care, and temporary accommodation. In some cases, residents may also seek refuge with family or friends in safer locations. Table 7-6 presents the number of individuals who would be displaced or require short-term shelter in the event of a dam or reservoir failure, categorized by Community Plan Area.

Table 7-6. Persons Displaced or Seeking Short-Term Shelter Due to Dam Failure

Community Plan Area	Total Population (2023 ACS)	Displaced Population	Persons Seeking Short-Term Sheltering
Hāna	2,135	0	0
Kīhei-Mākena	29,174	0	0
Lānaʻi	3,333	0	0
Makawao-Pukalani-Kula	24,505	136	42
Molokaʻi	8,092	0	0
Pāʻia-Haʻikū	17,037	432	128
Wailuku-Kahului	58,606	7,878	827
West Maui	21,749	1,232	285
Maui County (Total)	164,632	9,678	1,282

Source: U.S. Census Bureau 2023 ACS; Hawaiʻi DLNR 2021; County of Maui 2025; Hazus v6.1

Socially Vulnerable Population

Older adults, children, individuals with disabilities, access, or functional needs, and economically disadvantaged individuals may be unable to get themselves out of the inundation area or may require additional time and resources to recover. The vulnerable population also includes individuals who would not have adequate warning from the emergency warning system due to limited access to technology or limited English proficiency. Table 7-7 presents the estimated socially vulnerable populations living in the combined dam-failure inundation hazard area.

Table 7-7. Estimated Populations in the Dam Failure Hazard Area

	Vulnerable Populations Located in the Combined High Hazard Dam-Failure Inundation Area									
	Persons Over 65		Persons Under 5		Non-English Speaking Persons		Persons with a Disability		Persons in Poverty	
Community Plan Area	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total
Hāna	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Kīhei-Mākena	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Lānaʻi	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Makawao-Pukalani-Kula	64	1.2%	16	1.2%	5	1.0%	28	1.2%	31	1.2%
Molokaʻi	1	0.1%	0	0.0%	0	0.0%	0	0.0%	1	0.1%
Pāʻia-Haʻikū	183	6.5%	73	6.5%	10	6.1%	92	6.5%	126	6.4%
Wailuku-Kahului	3,557	30.9%	912	30.8%	982	30.9%	1,992	30.9%	1,323	30.8%
West Maui	431	10.6%	157	10.6%	98	10.5%	215	10.6%	221	10.6%
Maui County (Total)	4,236	12.8%	1,158	12.9%	1,095	18.0%	2,327	13.2%	1,702	10.7%

Source: U.S. Census Bureau 2023 ACS Vulnerable Population Totals; Hawai'i DLNR 2021; County of Maui 2025

7.2.2 General Building Stock

As shown in Table 7-8, there are 5,908 buildings in the combined high hazard dam-failure inundation area, accounting for 13.0 percent of the County's total general building stock. The replacement cost value (RCV) for these buildings is $8.9 billion, or 17.4 percent of the County total. Wailuku-Kahului has the greatest amount of exposure, with 4,984 buildings, 32.3 percent of the Community Plan Area total; these account for $7 billion in RCV, 38.3 percent of the Community Plan Area total. Table 7-9 presents the buildings categorized by general occupancy class.

The impact of damage caused by dam failure will depend on the depth and velocity of the flooding. Properties closest to the dam have the greatest potential to experience the largest, most destructive surge of water. Table 7-10 provides an overview of the potential impacts of a dam failure on buildings in Maui County. Overall, Maui County faces an estimated loss of $461 million, which is 0.9 percent of the total RCV. In Hāna, Kīhei-Mākena, and Lānaʻi, there are no estimated losses, indicating these areas are not significantly impacted by high hazard dam-failure inundation. Makawao-Pukalani-Kula has a small estimated loss of $1 million, which is less than 0.1 percent of the total RCV. The Wailuku-Kahului Community Plan Area shows an estimated loss of $420 million, which is 2.3 percent of the total RCV.

Table 7-8. Buildings in the Dam Failure Hazard Area

Community Plan Area	Community Plan Area Total Buildings		Buildings in the Combined High Hazard Dam-Failure Inundation Area			
			Number of Buildings		RCV	
	Count	RCV	Count	% of Plan Area Total	Value	% of Plan Area Total
Hāna	930	$741,266,476	0	0.0%	$0	0.0%
Kīhei-Mākena	7,613	$11,692,760,990	2	<0.1%	$3,654,464	<0.1%
Lānaʻi	1,258	$1,012,846,136	0	0.0%	$0	0.0%
Makawao-Pukalani-Kula	8,868	$6,037,317,698	103	1.2%	$51,044,440	0.8%
Molokaʻi	3,056	$2,384,451,998	5	0.2%	$27,177,118	1.1%
Pāʻia-Haʻikū	4,316	$2,686,054,376	346	8.0%	$351,683,881	13.1%
Wailuku-Kahului	15,444	$18,302,375,352	4,984	32.3%	$7,009,203,170	38.3%
West Maui	4,063	$8,896,487,618	468	11.5%	$1,547,544,820	17.4%
Maui County (Total)	45,548	$51,753,560,644	5,908	13.0%	$8,990,307,892	17.4%

Source: USACE NSI 2022; Hawaiʻi Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; RSMeans 2024; Hawaiʻi DLNR 2021; County of Maui 2025

Table 7-9. Buildings in the Dam Failure Hazard Area by General Occupancy Class

Community Plan Area	Buildings in the Combined High Hazard Dam-Failure Inundation Area			
	Residential	Commercial	Industrial	Other[a]
Hāna	0	0	0	0
Kīhei-Mākena	1	0	1	0
Lānaʻi	0	0	0	0
Makawao-Pukalani-Kula	98	4	1	0
Molokaʻi	2	0	3	0
Pāʻia-Haʻikū	255	82	6	3
Wailuku-Kahului	4,076	656	177	75
West Maui	376	75	9	8
Maui County (Total)	4,808	817	197	86

Source: USACE NSI 2022; Hawaiʻi Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; RSMeans 2024; Hawaiʻi DLNR 2021; County of Maui 2025

a. Other = Government, Religion, Agricultural, and Education

7.2.3 Community Lifelines and Other Critical Facilities

Table 7-11 summarizes the number of community lifelines located in the combined high hazard dam-failure inundation area. Overall, there are 47 potentially at-risk critical facilities in Maui County's combined high hazard dam-failure inundation areas. Water systems are the category with the greatest number of locations in the hazard area (11), followed by safety and security (10). The majority of the critical facilities are in the Wailuku–Kahului Community Plan Area, with a total of 35 facilities.

Table 7-10. Combined High Hazard Dam-Failure Inundation Hazard Area Impacts on Buildings

Community Plan Area	Total RCV	Combined High Hazard Dam-Failure Inundation Hazard Area Impacts on Buildings				
		Estimated Loss for All Occupancies	Percent of Total	Estimated Loss for Residential Properties	Estimated Loss for Commercial Properties	Estimated Loss for All Other Occupancies
Hāna	$741,266,476	$0	0.0%	$0	$0	$0
Kīhei-Mākena	$11,692,760,990	$0	0.0%	$0	$0	$0
Lānaʻi	$1,012,846,136	$0	0.0%	$0	$0	$0
Makawao-Pukalani-Kula	$6,037,317,698	$1,618,085	<0.1%	$1,551,498	$0	$66,586
Molokaʻi	$2,384,451,998	$192,804	<0.1%	$182,279	$0	$10,525
Pāʻia-Haʻikū	$2,686,054,376	$17,198,777	0.6%	$8,309,670	$1,493,133	$7,395,974
Wailuku-Kahului	$18,302,375,352	$419,777,794	2.3%	$253,348,348	$72,358,921	$94,070,525
West Maui	$8,896,487,618	$22,191,285	0.2%	$21,793,911	$258,957	$138,416
Maui County (Total)	$51,753,560,644	$460,978,744	0.9%	$285,185,706	$74,111,011	$101,682,026

Source: USACE NSI 2022; Hawaiʻi Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024, 2025; Hawaiʻi DLNR 2021; Hazus v6.1; RSMeans 2024

Table 7-11. Number of Facilities in the Dam Failure Inundation Area, by Lifeline Category

Community Plan Area	Number of Facilities in the Combined High Hazard Dam-Failure Inundation Area, by Lifeline Category									Total Facilities in Hazard Area	
	Communications	Energy	Food, Hydration, Shelter	Hazardous Materials	Health & Medical	Safety & Security	Transportation	Water Systems	Other Critical Facilities	Count	% of Plan Area Total
Hāna	0	0	0	0	0	0	0	0	0	0	0.0%
Kīhei-Mākena	2	0	0	0	0	0	0	0	1	3	8.8%
Lānaʻi	0	0	0	0	0	0	0	0	0	0	0.0%
Makawao-Pukalani-Kula	0	0	0	0	0	0	0	1	0	1	4.2%
Molokaʻi	0	0	0	0	0	0	0	0	0	0	0.0%
Pāʻia-Haʻikū	0	1	0	0	0	1	0	0	0	2	14.3%
Wailuku-Kahului	2	1	0	0	3	7	9	6	7	35	34.3%
West Maui	0	0	0	0	0	2	0	4	0	6	15.0%
Maui County (Total)	4	2	0	0	3	10	9	11	8	47	17.1%

Source: Hawaiʻi Emergency Management Agency 2017; Hawaiʻi DLNR 2021; County of Maui 2025

Several major roads in Maui County are within dam-failure inundation areas, including Honoapi`ilani Highway in the West Maui Community Plan Area, portions of Kahului Beach Road in the Wailuku-Kahului Community Plan Area, and sections of North and South Kīhei Road in the Kīhei-Mākena Community Plan Area. Two bridges from the National Bridge Inventory (NBI) are in dam-failure inundation areas—one in the West Maui Community Plan Area and one on Molokaʻi Island.

Flooding from dam-failure inundation can undermine roads, scour bridges, and expose underground utilities. Inundation that renders any portion of a road or bridge impassable can block access to other roads or locations. The functionality of water, sewer, gas, and electricity systems may be compromised. Due to their extensive geographic reach, roads and utility lines are more likely to be impacted by dam failure and are challenging to relocate out of hazard areas. Rushing water from a failed dam can also overwhelm any dams downstream, potentially resulting in additional dam failures.

7.2.4 Economy

Dam failures can significantly impact the local and regional economy. Potential losses include damage to buildings and infrastructure, agricultural losses, business interruption, and impacts on the tax base. Flooding because of dam failure can cause extensive damage to public utilities and disruptions in the delivery of services. Loss of power and communications may occur and drinking water and wastewater treatment facilities may be temporarily out of operation. Combined, these impacts may lead to extended business closures or transportation inconveniences, like closed roads, which may discourage tourism or individuals looking to move to or do business in the area.

Debris management may also be a large expense after a dam failure event. Hazus estimates the amount of debris generated from the combined dam-failure inundation hazard event in three categories: finishes (drywall, insulation, etc.); structural (wood, brick, etc.) and foundations (concrete slab and block, rebar, etc.). The distinction is made because of the different types of equipment needed to handle the debris. Table 7-12 summarizes the debris Hazus estimates for these events.

Table 7-12. Estimated Debris Created in the High-Hazard Dam-Failure Inundation Hazard Area

Community Plan Area	Estimated Debris Created in the High-Hazard Dam-Failure Inundation Hazard Area			
	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Hāna	0	0	0	0
Kīhei-Mākena	0	0	0	0
Lānaʻi	0	0	0	0
Makawao-Pukalani-Kula	24	23	0	0
Molokaʻi	0	0	0	0
Pāʻia-Haʻikū	442	202	121	119
Wailuku-Kahului	3,377	2,163	636	577
West Maui	654	642	7	4
Maui County (Total)	4,496	3,032	764	700

Source: USACE NSI 2022; Hawai'i Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024, 2025; Hawai'i DLNR 2021; Hazus v6.1

7.2.5 Natural, Historic and Cultural Resources

Natural

The environmental impacts of dam and reservoir failure can include significant water quality and debris-disposal issues or severe erosion that can impact local ecosystems. Flood waters can back up sanitary sewer systems and inundate wastewater treatment plants, causing raw sewage to contaminate the flooded waterway. The contents of unsecured containers of hazardous materials may get added to flood waters and distributed widely across the floodplain. After the flood waters subside, contaminated sediment must be removed (EPA 2024).

Historic

Dam and reservoir failures can significantly affect historical resources due to the resulting floodwaters. Historic buildings, structures, sites, monuments, districts, and documents may incur damage or be destroyed in the aftermath of a dam and reservoir failure.

Cultural

Cultural resources such as artifacts, statuary, artwork, and important documents are housed in libraries, museums, archives, repositories, or historic properties. Flood waters following a dam failure pose a risk to these resources.

7.2.6 Identified Vulnerability Issues

The County has identified the following vulnerabilities related to this hazard:

- Dam and reservoir failure was the hazard that survey respondents were least concerned about; 54 percent of public respondents were not concerned about this hazard. This could indicate that the public is unaware of the risk posed by dams and reservoirs.
- New homes are being built in the areas downstream of dams and reservoirs, which puts them at risk in the event of a dam failure.
- The accuracy of dam failure inundation maps is crucial for effective hazard mitigation planning in Maui County. These maps vary in precision based on the methods and data used. Detailed hydrology and engineering studies provide highly accurate maps, though they can be resource-intensive. Simplified methods offer a cost-effective alternative for smaller dams, albeit with less precision. A significant number of dams and reservoirs in Maui County have no hydrologic and hydraulic modeling or the modeling is based on old information. These need to be updated to provide the downstream community with an accurate risk of inundation.
- To ensure community safety, it is essential to inform residents about properties within hazard areas. This is achieved through EAPs that include inundation maps and notification procedures. Local authorities and emergency management offices play a pivotal role in disseminating information and coordinating evacuation efforts, ensuring that the community is well-prepared for potential flooding events.

- An independent civil investigation identified conditions and practices that could have contributed to the failure of the privately owned Ka Loko Dam on the Island of Kaua'i: inadequate inspections, non-permitted grading operations, inadequate maintenance, and non-enforcement of regulations. Attention to these issues is important for mitigating the dam failure hazard in Maui County.

7.3 FUTURE CHANGES THAT MAY AFFECT RISK

7.3.1 Potential or Planned Development

Any new development within the dam-failure inundation area could be impacted by a dam failure event if mitigation measures are not considered. Therefore, it is the intention of the County to discourage development in vulnerable areas or to encourage higher regulatory standards for construction in these areas.

In the combined high hazard dam inundation area, 284 new developments across Maui County fall within the risk zone, representing 8.7 percent of all new development. The Wailuku-Kahului planning area accounts for the vast majority with 218 developments (29.0 percent), followed by West Maui with 34 (5.9 percent), and Paia-Haiku with 20 (5.6 percent). The remaining planning areas report no new development in the hazard area. Table 7-13 displays the number of new development by community planning area.

Table 7-13. Number of New Development in the Combined High Hazard Dam Inundation Area

Community Plan Area	Number of New Development in the Combined High Hazard Dam Inundation Area	
	[illegible]	[illegible]
Hana	0	0.0%
Kahoolawe	0	0.0%
Kihei - Makena	6	1.2%
Lanai	0	0.0%
Makawao - Pukalani - Kula	6	1.0%
Molokai	0	0.0%
Paia - Haiku	20	5.6%
Wailuku - Kahului	218	29.0%
West Maui	34	5.9%
Maui County (Total)	**284**	**8.7%**

Source: *County of Maui 2025; Hawai'i DLNR 2021*

7.3.2 Projected Changes in Population

If population growth leads to heightened demand on dams, it could intensify wear and tear, potentially leading to more frequent maintenance issues and failures. Additionally, increased population density in areas downstream of dams could elevate the consequences of a dam failure, as more people and properties would be at risk. Therefore, it is crucial to consider these issues in future infrastructure planning and maintenance to mitigate potential risks effectively.

The Department of Business, Economic Development and Tourism (DBEDT) produced population projections for the County from 2030 to 2050. According to these projections, Maui County's population is projected to grow to 173,520 by 2030, 181,000 by 2040, and 184,870 by 2050.

7.3.3 Climate Change

Future climate changes may significantly impact the risk of dam failure. Changes in rainfall and runoff patterns can alter the hydrographs used in dam design, potentially reducing the designed margin of safety and increasing the risk of overtopping or unintended loads. Many dams, built before modern regulatory standards and the anticipated impacts of climate change, may face higher failure risks due to more frequent and intense precipitation events. Increased spillway flows due to climate change can lead to higher downstream discharges and flooding potential.

7.3.4 Other Identified Conditions

The following conditions need to be considered in mitigation planning for the dam failure hazard:

- The concept of residual risk associated with dams should be considered in the design of dam-related capital projects.
- Addressing dam security concerns while keeping the public informed of the risk associated with dam failure is a challenge for public officials.
- A significant number of structures in the dam-failure inundation zone are outside of special flood hazard areas, meaning they are not constructed to withstand floodwaters and are less likely to be covered by flood insurance.
- Even structures designed with flood hazards in mind may not be able to withstand the height and velocity of flow from a dam failure event.

8. DROUGHT

8.1 HAZARD PROFILE

8.1.1 Hazard Description

A drought is a period of moisture deficiency that is extensive in both space and time. It results from a natural reduction in precipitation over an extended period, usually lasting a season or more. It diminishes natural stream flow and depletes soil moisture, leading to social, cultural, environmental, and economic consequences (HI-EMA 2023). The National Centers for Environmental Information (NCEI) describes drought as a phenomenon that impacts many sectors of the economy and operates on many different time scales (NCEI 2025).

Drought Types

Drought is a normal occurrence in virtually all climatic regions, regardless of average rainfall. Lack of rainfall is not the only factor contributing to the impacts of drought. High temperatures, high winds, and low humidity can intensify drought conditions, as can human actions and water demand. Both natural events and human activities, such as expanding populations, irrigation, and environmental needs, put pressure on water supplies. The combination of insufficient rainfall and societal demands on water systems and supplies exacerbates drought impacts. The National Drought Mitigation Center has categorized droughts into five types, described in Table 8-1.

Table 8-1. National Drought Mitigation Center Drought Types

Drought Type	Description
Meteorological Drought	The degree of dryness or departure of actual precipitation from an expected average or normal amount based on monthly, seasonal, or annual time scales. (Dry weather patterns dominate an area; can begin/end rapidly).
Hydrological Drought	The effects of precipitation shortfalls on stream flows and reservoir, lake, and groundwater levels. (Low water supply is evident; conditions take longer to develop and then recover.)
Agricultural Drought	Soil moisture deficiencies relative to water demands of plant life, usually crops. (Crops significantly affected).
Socioeconomic Drought	The effect of demands for water exceeding the supply because of a weather-related supply shortfall.
Ecological Drought	A prolonged and widespread deficit in naturally available water supplies — including changes in natural and managed hydrology — that creates multiple stresses across ecosystems.

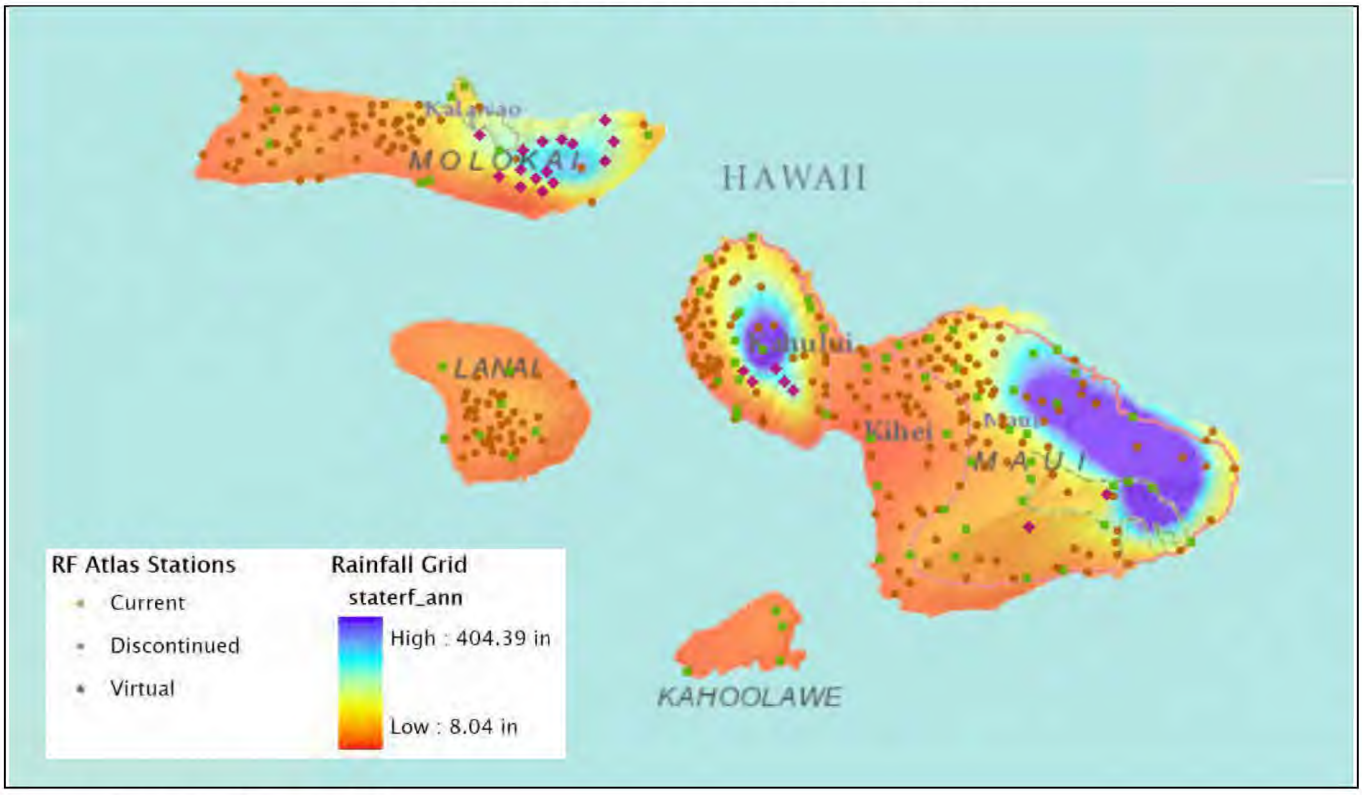
Source: (NDMC 2025)

Average Rainfall

In order to understand the conditions of past drought, it can be helpful to understand the typical precipitation of the planning area. According to the Rainfall Atlas of Hawai'i, rainfall rates throughout Maui County are highly variable. Rainfall is highest on windward-facing mountain slopes, and most of

the county's rainfall is attributed to northeasterly trade winds. The windward side of Haleakalā in East Maui receives the highest amount of rainfall in Hawai'i, with an average annual rainfall of 404 inches. In contrast, the Kīhei area and parts of eastern Moloka'i receive as little as 10 inches of rainfall per year (University of Hawai'i 2011). Figure 8-1 shows a map of annual rainfall for Maui County.

Figure 8-1. Annual Rainfall for Maui County



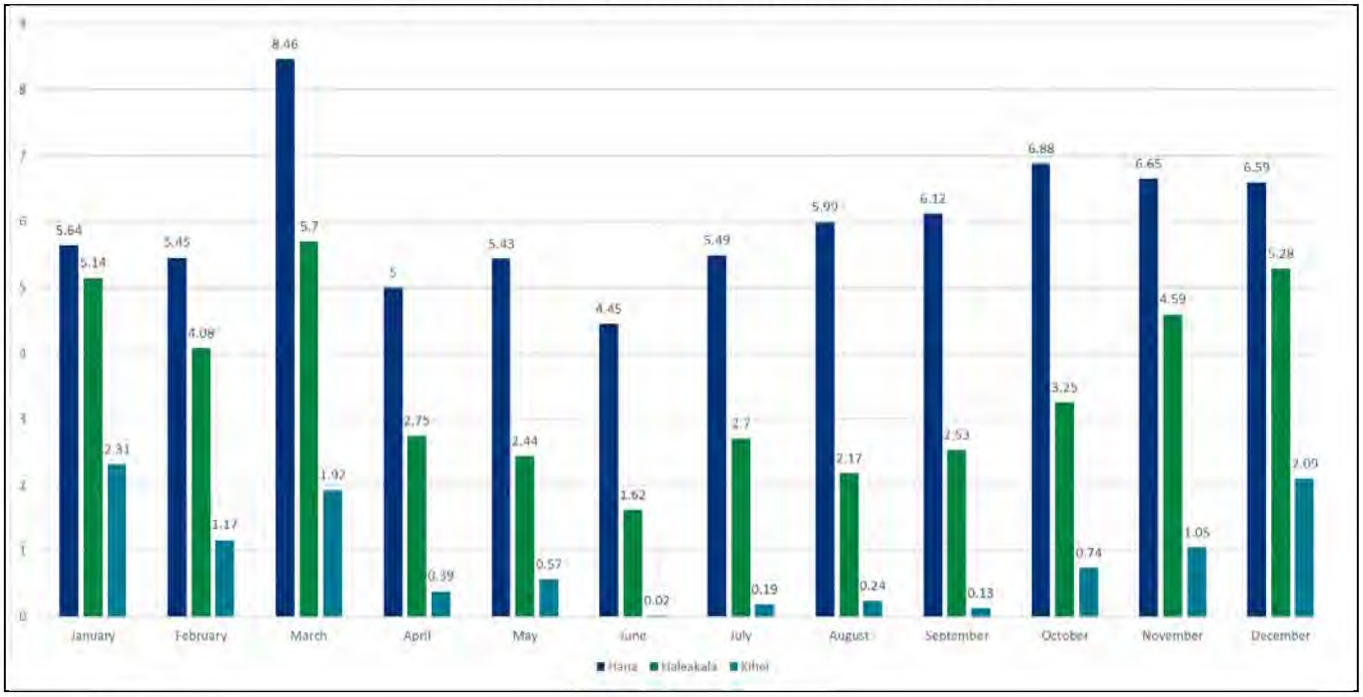
Source: (University of Hawai'i 2011)

Figure 8-2 shows monthly rainfall amounts recorded in Hāna, Haleakalā, and Kīhei; these locations they demonstrate the highest and lowest average rainfall recordings in the county. As shown, the majority of the area's rainfall is received in the winter, with the summer being the driest. A more detailed assessment of rainfall totals is available in Section 3.5.3.

8.1.2 Location

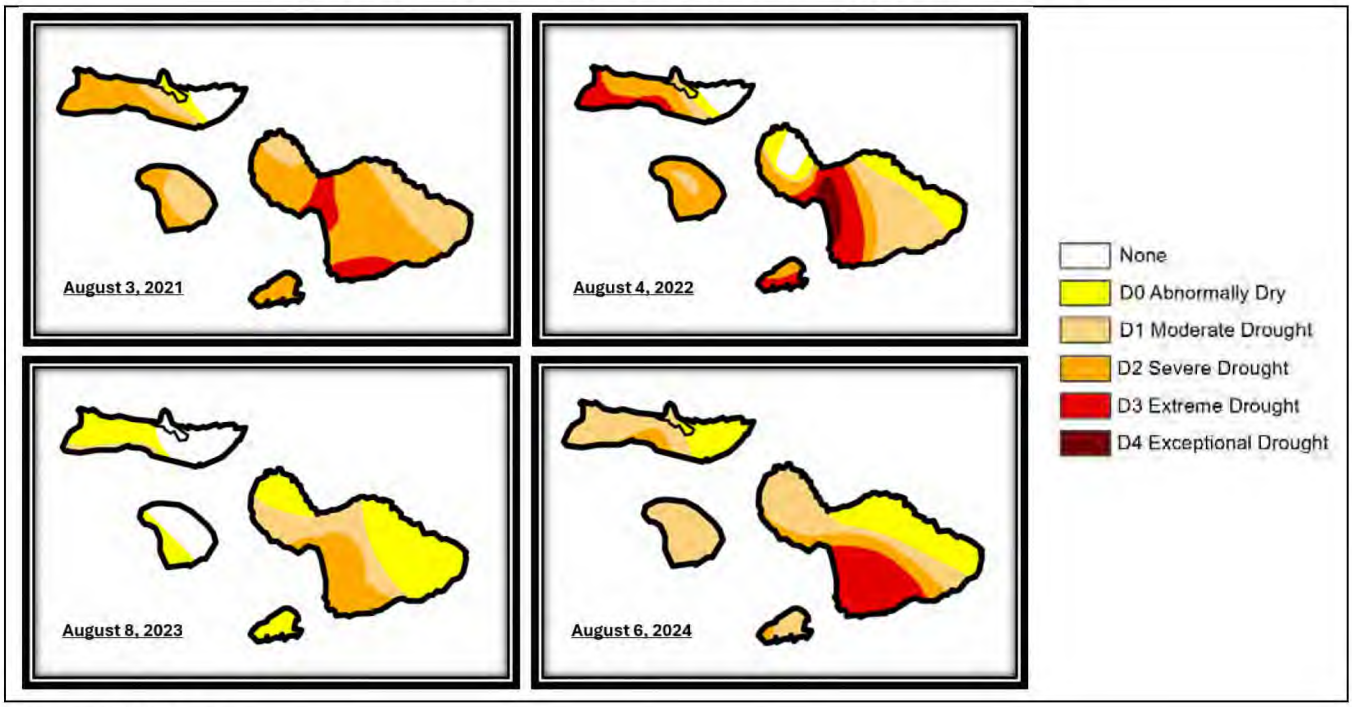
A drought is a regional event that can affect several areas at once, sometimes varying in severity across those areas. Figure 8-3 shows a series of drought maps for the first week of August from 2021 to 2024. The maps show that drought conditions are often relatively worse in the Kīhei and Western Moloka'i areas of the county, although drought conditions can exist across the entire county at one time, as displayed in the 2024 map.

Figure 8-2. Average Monthly Rainfall Amounts



Source: (NOAA n.d.)

Figure 8-3. Maui County Drought Conditions, 2021 to 2024



Source: (USDM n.d.)

8.1.3 Extent

Droughts in Maui County can vary significantly in duration and severity. 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 drought and the larger the area impacted, the more severe the potential impacts (NOAA 2022).

Maui County, along with the State of Hawai'i, uses a combination of resources for monitoring drought conditions year-round. These resources include partnerships with the National Weather Service (NWS), the U.S. Drought Monitor (USDM), Hawai'i Wildfire Management Organization (HWMO), and others.

U.S. Drought Monitor

Drought conditions and drought intensity are often communicated through the use of the USDM, which publishes weekly maps that identify general areas of drought and categorize them by intensity. These maps categorize drought as described in Table 8-2.

Table 8-2. Drought Classification of the U.S. Drought Monitor

Category	Description	Examples of historically observed impacts
None	Normal or wet conditions	N/A
D0	Abnormally Dry	• Corn quality declines; less water is available for irrigation. • Hiking trails are noticeably dry with soil erosion.
D1	Moderate Drought	• Concerns about fire danger increase • More bugs observed than normal • Pasture and crop growth is stunted; farmers are not allowed to use reservoir water for irrigation • Water levels decline; voluntary water restrictions are issued; reservoir levels are depleted in high elevations
D2	Severe Drought	• Fire danger is high • Pasture conditions are very dry/poor; cattle health is poor; protea, coffee bean, and sugar cane crops struggle • Reservoir levels are low; springs are dried up; mandatory water restrictions are implemented
D3	Extreme Drought	• Fires spread rapidly; outdoor burn bans are implemented • Producers cull cattle, buy supplements, and haul water for livestock • Sugar cane producer lays off many employees • Trees are dry and dropping leaves • Water production is reduced
D4	Exceptional Drought	• Cattle die; cattle conception rates are reduced • Hunting areas and hiking trails may be closed due to increased fire danger • Specialty crops and orchards are dying • Surface water is severely impacted

Source: (USDM 2024)

Standardized Precipitation Index

A second index used to monitor droughts in Maui is the Standardized Precipitation Index (SPI). This index considers only precipitation, and the SPI values range is broken down into categories as shown in Table 8-3. The zero mark on the SPI scale refers to the median precipitation amount. Negative values correlate with drought conditions, while positive values signal various levels of wetness. Serving as a statistical method for assessing rainfall, the SPI incorporates data so that it is independent of both the location and the range of values, ensuring that different seasons and climate areas are represented on an equal basis (NOAA/NWS Honolulu 2020). Historically, the extent of SPI for Maui ranges between -2.00 and 2.00.

Table 8-3. SPI Values and Description

SPI Value	Description
≥ 2.00	Extremely Wet
1.50 to 1.99	Very Wet
1.00 to 1.49	Moderately Wet
0.99 to -0.99	Near Normal
-1.00 to -1.49	Moderately Dry
-1.50 to -1.99	Very Dry
≤ -2.00	Extremely Dry

Source: (NOAA/NWS Honolulu 2020)

Declaration of Water Shortage

The director of the Maui Department of Water Supply, with the approval of the mayor, has the authority to declare a water shortage whenever the water supply becomes inadequate in any area of the County or County water system. This declaration can be made due to various factors, including periods of drought, infrastructure or mechanical malfunctions, natural disasters, or other events causing a water shortage. Before declaring a water shortage, the director will evaluate the following factors (Maui County Code 2024):

- **Current and Predicted Weather Patterns**—Assessing weather forecasts and trends to anticipate future conditions that may impact water availability
- **Reservoir Water Levels**—Monitoring the levels of water stored in reservoirs to determine the capacity to meet demand
- **Surface Water Flow**—Evaluating the flow of streams and rivers that contribute to the water supply
- **Current and Predicted Water Usage**—Analyzing water consumption patterns and projecting future usage to identify potential shortages
- **Operational Status of Water Production Facilities**—Reviewing the functionality and capacity of water production facilities to ensure they can meet the community's needs

The Maui Department of Water Supply prepared a Water Shortage and Conservation Plan to enhance long-term water conservation planning in the region and establish a framework for mitigation actions during water shortages. The plan outlines procedures for declaring water shortages, water shortage stages, and corresponding response actions (Maui County Department of Water Supply 2024).

Warning Time

Drought is a slow-developing hazard, with impacts that may take months to years to be felt, depending on the sector affected. Scientists generally cannot predict drought more than one month in advance for most locations (Beckly Water n.d.). Predicting drought depends on forecasting precipitation and temperature, which can vary from several months to decades due to interactions between the atmosphere and oceans, soil moisture, land surface processes, topography, internal dynamics, and the accumulated influence of weather systems on a global scale.

Flash droughts present a different challenge. These occur when the rain stops and it gets so hot that the atmosphere quickly evaporates the moisture out of the ground and plants, making them more likely to catch fire. Maui experienced a two-category increase in drought severity in just three weeks from May to June 2023, with that rapid intensification fitting the definition of a flash drought (AP News 2023).

El Niño events are key indicators for forecasting drought in Hawai‘i. There is approximately a 70 percent chance of a drier-than-normal winter season during an El Niño event. Scientists monitor various oceanic and atmospheric elements and use complex computer models to forecast El Niño events. NOAA produces a monthly El Niño/Southern Oscillation (ENSO) Diagnostic Discussion, providing analysis of current conditions and projection summaries (HI-EMA 2023).

8.1.4 Previous Occurrences

FEMA Disaster Declarations

Maui County has not been included in any major disaster (DR) or emergency (EM) declarations for drought-related events (FEMA 2024).

State Emergency Proclamations

The Governor of Hawai‘i may declare a state of emergency by proclamation if an emergency or disaster has occurred or there is imminent danger or threat of an emergency or disaster in any portion of the state (Hawai‘i State Legislature 2020). Between 2020 and 2024, Maui County was included in one state emergency proclamation for a drought-related event, as shown in Table 8-4 (HI-EMA 2024).

Table 8-4. State Emergency Proclamations for Drought Events in Maui County, 2020 – 2024

Event Date	State Proclamation Number	Description
January 27, 2021	2101163-ATG	Emergency Proclamation for Maui Drought and Axis Deer

Source: (HI-EMA 2024)

USDA Declarations

The U.S. Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties contiguous to them. Between 2020 and 2024, Maui County was included in six USDA drought-related agricultural disaster declarations, summarized in Table 8-5.

Table 8-5. USDA Declarations for Drought Events in Maui County, 2020 to 2024

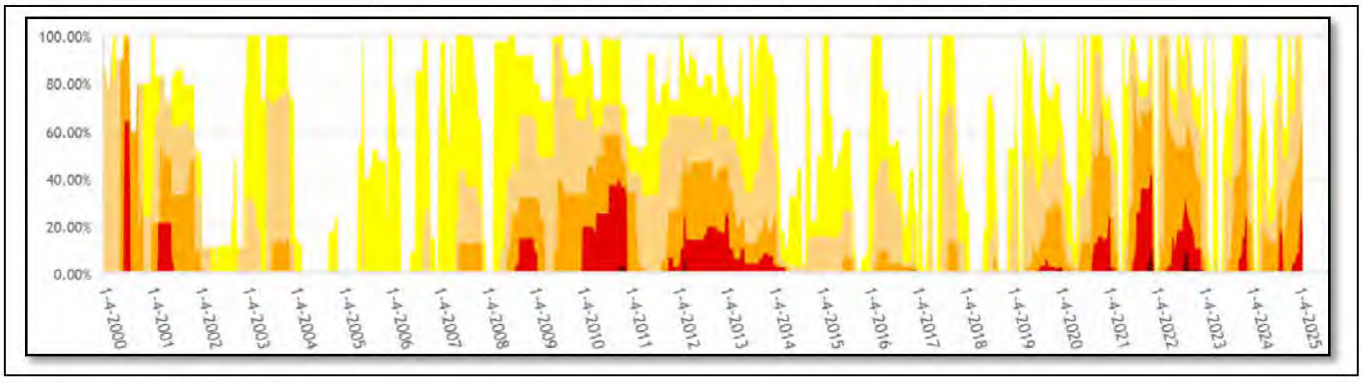
Event Date	USDA Declaration Number	Description
January 1, 2020	S4649	Drought-FAST TRACK
January 1, 2021	S4918	Drought-FAST TRACK
February 8, 2022	S5148	Drought-FAST TRACK
March 15, 2022	S5185	Drought-FAST TRACK
January 1, 2023	S5374	Drought-FAST TRACK
April 2, 2024	S5694	Drought-FAST TRACK

Source: (USDA 2024)

All Recent Events

Maui County has a history of being in a continual state of drought for the past 25 years. Figure 8-4 displays the history of D0 to D4 drought conditions in Maui County from 2000 to 2024.

Figure 8-4. Maui County Percent Area in Drought



Source: (USDM 2024)

Table 8-6 lists major recorded drought-related events that impacted Maui County since the previous HMP was developed. For earlier events, refer to the previous HMP.

Table 8-6. Drought Events in Maui County, 2020 to 2024

Event Date	FEMA Declaration or State Proclamation Number	Location Impacted	Description
January 1-21, 2020	S4649	Lānaʻi Makai, Leeward Haleakalā, Maui Central Valley, Molokaʻi Leeward Kahoʻolawe, Maui Leeward West	D1, moderate drought to D2, severe drought conditions. USDA declaration issued.
February 1-29, 2020	N/A	Maui Central Valley, Molokaʻi Leeward, Leeward Haleakalā	D1, moderate drought conditions. Portions of Maui remained in D2 category of severe drought.
March 1 – June 30, 2020	N/A	Molokaʻi Leeward	A portion of the area remained in the D2 category of severe drought throughout March. After rainfall in the area, drought conditions improved to D1 category of moderate drought in April. The area fell back into the D2 category of severe drought in Ma and June.
July 1-31, 2020	N/A	Molokaʻi Leeward, Lānaʻi Makai, Maui Central Valley; Upcountry and West Maui	Dry conditions persisted; areas remained in D2 category of severe drought. The Maui Department of Water Supply requested that customers in the Upcountry and West Maui areas be frugal with water, due to low rainfall.
August 1-31, 2020	N/A	Molokaʻi Leeward, Lānaʻi Makai, Maui Central Valley	Rainfall lacked in the area causing D2 category of severe drought conditions.
September 1-30, 2020	N/A	Molokaʻi Leeward, Maui Central Valley, Lānaʻi Makai, Leeward Haleakalā, Lānaʻi Mauka, Kahoʻolawe, Windward Haleakalā, Haleakalā Summit	Little to no rainfall kept these areas in the D2 to D3 categories of severe to extreme drought.
October 1-31, 2020	N/A	Upcountry Maui, West Maui, Molokaʻi Leeward, Haleakalā Summit, Leeward Haleakalā, Windward Haleakalā, Maui Central Valley, Kahoʻolawe, Lānaʻi Mauka, and Lānaʻi Makai	These areas were mainly in the D2 category of severe drought with Molokaʻi Leeward and Maui Central Valley falling into the D3 category of extreme drought. Maui County's Department of Water Supply announced Stage 1 water restrictions, due to a water shortage in Upcountry and West Maui.

Event Date	FEMA Declaration or State Proclamation Number	Location Impacted	Description
November 1-30, 2020	N/A	Molokaʻi Leeward, Haleakalā Summit, Leeward Haleakalā, Windward Haleakalā, Maui Central Valley, Kahoʻolawe, Lānaʻi Mauka, and Lānaʻi Makai, Maui Leeward West, Maui Windward West	Severe to extreme drought (D2 to D3 categories) conditions.
December 1 – 31, 2020	N/A	Molokaʻi Leeward, Haleakalā Summit, Leeward Haleakalā, Windward Haleakalā, Maui Central Valley, Maui Windward West, Kahoʻolawe, Lānaʻi Mauka, and Lānaʻi Makai	All areas were either at D2, severe, or D3, extreme drought conditions.
January 1 – 31, 2021	S4918	Lānaʻi Mauka, Leeward Haleakalā, Maui Central Valley, Maui Leeward West, Kahoʻolawe, Lānaʻi Makai, Molokaʻi Leeward, Haleakalā Summit, Maui Windward West	Most areas were in D2 category of severe drought, with a few areas improving to D1 as rainfall increased. USDA declaration issued.
February 1-28, 2021	N/A	Lānaʻi Makai, Maui Central Valley, Maui Leeward West, Molokaʻi Leeward, Leeward Haleakalā, Kahoʻolawe	Areas remained at the D1 level of drought, with a few areas staying at D2 category of severe drought.
March 1-23, 2021	N/A	Molokaʻi Leeward, Maui Central Valley, Maui Leeward West	With the help of rainfall, these areas remained either D0 category of abnormally dry, or D1 category of moderate drought.
June 8-30, 2021	N/A	Molokaʻi West, Maui Central Valley South, Kahoʻolawe, Molokaʻi Leeward South, Molokaʻi North, Lānaʻi South, Lānaʻi Leeward, Maui Central Valley North	A lack of rainfall caused these areas to fall into the D2 category of severe drought.
July 1- 31,2021	N/A	Kahoʻolawe, Maui Central Valley South, Maui Central Valley North, Lānaʻi South, Lānaʻi Leeward, Molokaʻi Leeward South, Molokaʻi West, Molokaʻi North, Maui Windward West, South Maui/Upcountry, Kipahulu, Windward Haleakalā, Haleakalā Summit, Maui Leeward West	Dry conditions continued causing D2, severe drought and D3, extreme drought conditions. A Stage 1 water shortage took effect for Upcountry on July 2. Water users were prohibited from using water for irrigation, watering lawns, washing vehicles, and other non-essential uses. Fields were dry, mountainsides were dry and brown, the fire danger was high, and water availability was a growing concern. The water supply for West Maui was also low, and voluntary conservation was encouraged.

Event Date	FEMA Declaration or State Proclamation Number	Location Impacted	Description
August 1-31, 2021	N/A	Kipahulu, Lānaʻi Windward, South Maui/Upcountry, Windward Haleakalā, Maui Central Valley South, Maui Central Valley North, Lānaʻi South, Lānaʻi Leeward, Molokaʻi Leeward South, Molokaʻi West, Molokaʻi North, Haleakalā Summit, Maui Leeward West, Maui Windward West, Kahoʻolawe	Ongoing drought conditions due to insufficient rainfall.
September 1-30, 2021	N/A	Kahoʻolawe, South Maui/Upcountry, Windward Haleakalā, Maui Central Valley South, Maui Central Valley North, Lānaʻi South, Lānaʻi Leeward, Lānaʻi Windward, Molokaʻi Leeward South, Molokaʻi West, Molokaʻi North, Haleakalā Summit, Maui Leeward West, Maui Windward West, Lānaʻi Mauka	A deficit in rainfall kept many areas in the D2 category of severe drought, or the D3 category of extreme drought.
October 1-31, 2021	N/A	Lānaʻi Mauka, Windward Haleakalā, Maui Central Valley South, South Maui/Upcountry, Maui Central Valley North, Lānaʻi South, Lānaʻi Leeward, Lānaʻi Windward, Molokaʻi Leeward South, Molokaʻi West, Molokaʻi North, Haleakalā Summit, Maui Leeward West, Maui Windward West, Kahoʻolawe	Areas remained in D2 category of severe drought, or D3 category of severe drought.
November 1-30, 2021	N/A	South Maui/Upcountry, Maui Central Valley South, Maui Central Wally North, Lānaʻi South, Lānaʻi Leeward, Lānaʻi Windward, Molokaʻi Leeward South, Molokaʻi North, Molokaʻi West, Haleakalā Summit, Maui Leeward West, Maui Windward West, Kahoʻolawe, Lānaʻi Mauka, Windward Haleakalā	Areas remained dry and fell into the D4 category of exceptional drought.
December 1-28,2021	N/A	South Maui/Upcountry, Maui Central Valley South, Maui Central Wally North, Lānaʻi South, Lānaʻi Leeward, Lānaʻi Windward, Molokaʻi Leeward South, Molokaʻi North, Molokaʻi West, Haleakalā Summit, Maui Leeward West, Maui Windward West, Kahoʻolawe, Lānaʻi Mauka, Windward Haleakalā	Portions of Maui remained in D2 category of severe drought.
February 8-22, 2022	S5148	Maui Central Valley North, Maui Windward West, Windward Haleakalā, Molokaʻi Southeast, Molokaʻi Windward	Lack of rainfall leading to D2 category of severe drought. USDA declaration issued.

Event Date	FEMA Declaration or State Proclamation Number	Location Impacted	Description
March 1-31, 2022	S5185	Maui Windward West, Maui Central Valley North, Maui Leeward West, South Maui/Upcountry, Kipahulu, Windward Haleakalā, Maui Central Valley South, Lānaʻi South, Molokaʻi Leeward South, Molokaʻi West, Molokaʻi North, Molokaʻi Southeast, Molokaʻi Windward, Kahoʻolawe, Haleakalā Summit	D2 conditions of severe drought. The state Commission of Water Resource Management urged the public to reduce water use during these drought conditions. USDA declaration issued.
April 1-30, 2022	N/A	South Maui/Upcountry, Kipahulu, Windward Haleakalā, Maui Central Valley South, Lānaʻi South, Molokaʻi Leeward South, Molokaʻi West, Molokaʻi North, Molokaʻi Southeast, Molokaʻi Windward, Kahoʻolawe, Haleakalā Summit, Lānaʻi Mauka	A dry spell continued across the area, causing D2 or D3 category of severe or extreme drought conditions.
May 1-31, 2022	N/A	Lānaʻi Mauka, Molokaʻi Windward, South Maui/Upcountry, Maui Central Valley South, Maui Central Valley North, Lānaʻi South, Lānaʻi Leeward, Lānaʻi Windward, Molokaʻi Leeward South, Molokaʻi North, Molokaʻi West, Haleakalā Summit, Maui Leeward West, Maui Windward West, Kahoʻolawe	Little rainfall contributed to D2 category of severe drought or worse throughout the month.
June 1- 30, 2022	N/A	Maui Windward West, Kahoʻolawe, Lānaʻi Mauka, Maui Central Valley South, Maui Central Valley North, Lānaʻi South, Lānaʻi Leeward, Molokaʻi Leeward South, Molokaʻi West, Molokaʻi North, Haleakalā Summit, South Maui/Upcountry, Maui Leeward West	Dry conditions continued contributing to D2 category of severe drought or worse throughout the month. Maui Fire Department officials reported that brush fires were occurring more frequently due to D1 conditions.
July 1-31, 2022	N/A	Lānaʻi Mauka, South Maui/Upcountry, Maui Central Valley South, Maui Central Valley North, Lānaʻi South, Lānaʻi Leeward, Molokaʻi Leeward South, Molokaʻi West, Molokaʻi North, Haleakalā Summit, Maui Leeward West, Maui Windward West, Kahoʻolawe	Very dry conditions persisted causing D2 to D4 categories, severe to exceptional drought.
October 1-31, 2022	N/A	Lānaʻi Windward, Maui Central Valley South, Maui Central Valley North, Molokaʻi Leeward South, Molokaʻi West, Haleakalā Summit, South Maui/Upcountry, Maui Leeward West, Kahoʻolawe, Lānaʻi Mauka, Lānaʻi Leeward, Lānaʻi South	Dry conditions persisted with locations experiencing extreme to exception drought (D3-D4).
November 1-30, 2022	N/A	Kahoʻolawe, South Maui/Upcountry, Maui Central Valley South, Maui Central Valley North, Lānaʻi South, Lānaʻi Leeward, Lānaʻi Windward, Molokaʻi Leeward South, Molokaʻi West, Molokaʻi North, Maui Leeward West	Severe drought conditions throughout November due to limited summer and autumn rainfall.

Event Date	FEMA Declaration or State Proclamation Number	Location Impacted	Description
December 1-31, 2022	N/A	Molokaʻi Leeward South, Maui Central Valley South, Maui Central Valley North, Molokaʻi West	Extreme drought conditions for the first half of the month, then improving to severe drought conditions for the remainder of the month. Residents in West Maui were asked to conserve water due to insufficient levels of source water for the Mahinahina facility, which was closed until there was more water to treat.
January 1, 2023	S5374	Maui County	USDA declaration was issued for drought.
July 1-31, 2023	N/A	South Maui/Upcountry, Maui Central Valley South	Little rainfall leading to severe drought conditions.
August 1-31, 2023	N/A	Maui Leeward West, Maui Windward West, Molokaʻi Leeward South, Maui Central Valley North, South Maui/Upcountry, Maui Central Valley South	Severe drought conditions persisted throughout Maui.
September 1-30, 2023	N/A	Maui Leeward West, Molokaʻi West, Molokaʻi Leeward South, South Maui/Upcountry, Maui Central Valley North, Maui Central Valley South, Maui Windward West	Severe to extreme drought conditions throughout Maui.
October 1-31, 2023	N/A	Maui Central Valley South, Kahoʻolawe, Lānaʻi Leeward, Lānaʻi Mauka, Lānaʻi South Kipahulum Haleakalā Summit, Windward Haleakalā, South Maui/Upcountry, Maui Central Valley North, Maui Leeward West, Maui Windward West, Molokaʻi North, Molokaʻi West, Molokaʻi Leeward South	Dry conditions due to low rainfall led to severe to extreme drought conditions.
November 1-30, 2023	N/A	Molokaʻi West, Maui Leeward West, Maui Central Valley South, South Maui/Upcountry, Molokaʻi Leeward South	Dry conditions due to low rainfall led to severe to extreme (D2-D3) drought conditions.
December 1-31, 2023	N/A	Maui Central Valley South, Maui Central Valley North, South Maui/Upcountry	Severe D2 drought conditions.
April 1-30,2024	S5694	South Maui/Upcountry, Maui Central Valley South, Haleakalā Summit	Below average rainfall causing severe drought conditions. USDA declaration issued.
May 1-31, 2024	N/A	South Maui/Upcountry, Haleakalā Summit	Below average rainfall leading to severe drought (D2) conditions.
June 1-30,2024	N/A	South Maui/Upcountry, Haleakalā Summit	Below average rainfall led to severe drought conditions.

Event Date	FEMA Declaration or State Proclamation Number	Location Impacted	Description
July 1-31, 2024	N/A	South Maui/Upcountry, Haleakalā Summit, Maui Leeward West, Maui Central Valley South	Below average rainfall led to severe drought conditions.
August 1-31, 2024	N/A	South Maui/Upcountry, Molokaʻi Leeward South, Maui Central Valley South	Below average rainfall led to dry severe drought conditions.
September 1-30, 2024	N/A	Molokaʻi West, Molokaʻi Leeward South, South Maui/Upcountry	Below average rainfall led to dry severe drought conditions.
October 1-31,2024	N/A	Molokaʻi West, Molokaʻi Leeward South, South Maui/Upcountry, Molokaʻi North, Maui Central Valley South	Below average rainfall led to severe drought conditions.

Source: (NOAA 2024) (USDA 2024)

8.1.5 Probability of Future Occurrences

Probability Based on Previous Occurrences

Information on previous drought occurrences in the County was used to calculate the probability of future occurrence of such events. Table 8-7 lists the number of events from various sources from 1996 to 2024, which is the most complete period of record for all sources reviewed. Due to the regional nature of drought and the water cycle, all of Maui County, including all Community Plan Areas, are considered to have the same drought probability. Based on historic data and information regarding future conditions, the probability of occurrence for drought in the County is considered "frequent." Drought events are likely to span several months or even years, adding to the probability of occurrence.

Table 8-7. Probability of Future Drought Events in Maui County

Hazard Type	Number of Occurrences Between 2020 and 2024	Percent Chance of Occurring in Any Given Year
Drought	757	100%

Source: (NOAA 2024) (USDA 2024)

Note: The time period presented in this table is the most complete period of record for the various data sources reviewed. 100% probability indicates that it is statistically likely for an event to occur every year. It does not indicate that the occurrence of an event is a certainty in any given year.

Effect of Climate Change on Future Probability

Climate change affects drought conditions, with rising temperatures, heavy rainfall leading to nutrient and sediment loading, and reduced dilution of pollutants during droughts. Over the past 30 years, rainfall in Hawaiʻi has declined by about 25 percent, impacting stream base flows and water availability during droughts. Intense rainfalls, more frequent due to climate change, can cause flash floods, mudslides, and infrastructure damage, with runoff flowing into the ocean rather than recharging

aquifers. The IPCC reports that climate change will likely increase the frequency of meteorological and agricultural droughts, leading to more frequent and severe hydrological droughts (DLNR 2017).

8.1.6 Cascading Impacts on Other Hazards

Droughts in Maui County can trigger a range of cascading impacts on other hazards. Prolonged droughts can lead to significant water shortages, affecting both drinking water supplies and agricultural needs, which in turn stress local water resources. The lack of moisture can weaken soil structure, leading to increased erosion and potential landslides, especially in areas with steep terrain.

Dry conditions increase the risk of wildfires by making vegetation more flammable. Limited water supply presents wildfire management vulnerability. Substantial water is needed to fight wildfires, which are more frequent in dry conditions.

Agriculture can be severely impacted during a drought, with reduced crop yields affecting the food supply and the local economy. Drought conditions often coincide with heat waves, increasing the risk of heat-related illnesses and straining energy resources due to higher demand for cooling. Furthermore, drought can stress local ecosystems, affecting wildlife and plant species, leading to a loss of biodiversity and disrupting the balance of local habitats.

8.2 VULNERABILITY AND IMPACT ASSESSMENT

8.2.1 Life, Health, and Safety

Drought has the potential to impact public health by reducing the quality and quantity of available drinking water. The State of Hawai'i, including Maui County, consists of isolated land masses with limited freshwater resources. Drought may substantially reduce surface water stream flows or result in saltwater intrusion into groundwater and other freshwater sources. While drought has never been severe enough to fully deprive the county of water, it is possible.

Overall Population

Drought conditions can cause a shortage of water available for human consumption and can reduce local firefighting capabilities. In areas such as Kahikinui, rainwater catchment systems are highly dependent on precipitation, and drought conditions can lead to water shortages. These systems supplement water supply for drinking and household purposes, and the lack of rainfall during drought periods can result in significant water scarcity.

Social impacts of drought include mental and physical stress, public safety threats (increased threat from forest/grass fires), health threats, conflicts among water users, reduced quality of life, and inequities in the distribution of impacts and disaster relief. For this plan, the entire population of the County (164,754) is considered vulnerable to drought events.

Socially Vulnerable Population

Some populations are particularly susceptible to drought and the extreme temperatures sometimes associated with drought due to their age, health conditions, or limited ability to access shelters, cooling, and medical resources. Elderly individuals and those with disabilities may have difficulty accessing emergency services, alternative water supplies, and medical care during drought conditions. They are also more susceptible to heat-related illnesses and dehydration.

Low-income households may have limited access to alternative water sources, such as bottled water, and fewer financial resources to cope with increased costs for food, utilities, and health care. These households may also lack the ability to afford necessary adaptations, such as installing water-saving devices or purchasing air conditioning units during heat waves. They may lack the financial resources to repair foundation damage, replace lost landscaping, or pay higher utility bills. They may also have fewer resources to cope with job losses, reduced income, or property damage resulting from drought-related impacts.

Rural areas may be more reliant on limited water resources and decentralized water systems (e.g., rainwater catchment or small community systems), making them more vulnerable to drought-related water shortages and quality issues. Limited access to emergency services and infrastructure can also increase vulnerability.

8.2.2 General Building Stock

A drought is not expected to directly affect any structures, and all are expected to be operational during a drought event. However, droughts contribute to conditions conducive to wildfires. Risk to life and property is greatest in regions where forested areas adjoin urbanized areas (high-density residential, commercial, and industrial). All assets in and adjacent to these areas are vulnerable to impacts associated with the drought hazard.

8.2.3 Community Lifelines and Other Critical Facilities

Drought significantly impacts Maui County's water supply systems. The Maui Department of Water Supply's Central, Upcountry, and Lahaina systems, which depend partially on surface water sources like streams and ditches, face challenges during droughts due to reduced flows and infrastructure limitations. These systems serve large populations, and the decreased availability of surface water can lead to water shortages and necessitate infrastructure upgrades to manage the limited supply effectively.

Under extreme drought conditions, where local water supplies are depleted and water utilities are unable to maintain adequate water pressure, essential services such as fire stations and health care facilities could be compromised. 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 hazardous material decontamination.

Critical facility elements such as landscaping may not be maintained due to limited water resources. However, the risk to the facilities' functionality will be largely aesthetic. For example, when water conservation measures are in place, landscaped areas may not be watered and could die, but 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. Additionally, the shrink-swell cycle of expansive soils can affect the concrete components and foundations of structures. Tertiary impacts include sediment runoff during severe rainfall events in areas where vegetation and ground cover have been burned by wildfire. This sediment runoff can reduce the recharge of underlying aquifers (HI-EMA 2023).

8.2.4 Economy

Drought has the potential to impact Maui County economically in several ways. Water shortages can affect businesses ranging from restaurants to manufacturing, which rely on a steady water supply. Maui's robust tourism industry could suffer, particularly eco-tourism, if drought significantly impacts ecosystems. Additionally, water shortages may lead to increased water costs, or the county may need to import water or establish expensive desalination facilities, causing ripple effects on the local economy.

Drought has historically negatively impacted agricultural holdings. From 2008 to 2017, the USDA paid $50 million in livestock insurance claims to Hawaiian ranchers for grazing losses, and since 1996, farmers in Hawai'i have received $10 million in federal crop insurance payments due to drought losses (Hawai'i Public Radio 2019). The cultivation of traditional, culturally significant crops such as taro can also be affected.

The severity of drought can be measured in terms of economic damages. For instance, the 2007 to 2014 drought period in Hawai'i caused $44.5 million in losses for the ranching industry alone, with recovery expected to take 10 to 14 years at a cost of $4 to $6 million per year. More intense, prolonged droughts than those experienced in the past are possible.

Hawai'i Water Service in Lahaina often restricts customer water usage during drought periods to manage the decreased availability. This affects residential, commercial, and agricultural users, leading to economic disruptions and lifestyle changes. The East Maui Irrigation System experiences service interruptions and reduced water supply during droughts, impacting agricultural productivity. Farmers and other agricultural users rely on this system for irrigation, and reduced water availability can lead to lower crop yields and financial losses. Effective drought management strategies are crucial to mitigate these impacts and support the agricultural sector. Moloka'i's irrigation system is also vulnerable to drought, necessitating voluntary and potentially mandatory water conservation measures. The system has experienced low water levels in its reservoir due to prolonged dry conditions, affecting farmers and ranchers who depend on it for their crops and livestock. Conservation measures help manage the limited water supply and ensure it can sustain agricultural activities.

Since 2019, the USDA has provided Maui County with $2,468,838 in payouts through the Farm Service Agency (FSA) for USDA Secretarial Drought Disaster Designations. These financial assistance

programs are designed to support farmers and ranchers in areas designated as drought disaster zones by the U.S. Secretary of Agriculture. When a county receives such a designation, producers in that county, as well as in contiguous counties, become eligible for various forms of emergency assistance. This includes emergency loans and other disaster relief programs aimed at helping them recover from losses caused by drought conditions. See Table 8-8 for a breakdown of these payouts to Maui County.

Table 8-8. USDA FSA Payouts for USDA Secretarial Drought Disaster Designations, 2019 to 2024

Year	Applications	Total Payout
Noninsured Crops Disaster Assistance Program		
2019	5	$16,483
2020	12	$30,287
2021	11	$57,004
2022	24	$221,948
2023	7	$6,829
Livestock Forage Disaster Program		
2019	48	$236,465
2020	53	$320,805
2021	50	$337,451
2022	50	$496,820
2023	50	$418,711
2024	50	$326,035
Total	360	$2,468,838

Source: USDA 2024
Note: Year 2024 for Noninsured Crops Disaster Assistance Program was not provided.

8.2.5 Natural, Historic and Cultural Resources

Natural

Environmental losses from drought in the County are associated with damage to plants, animals, wildlife habitat, and air and water quality. This includes forest and range fires, degradation of landscape quality, loss of biodiversity, and soil erosion. Some effects are short-term, while others may linger or become permanent (HI-EMA 2023).

Watersheds in Maui County are crucial for replenishing groundwater aquifers, which supply the county's drinking water. Healthy watersheds also help reduce polluted runoff into nearshore waters and support healthy stream ecosystems. Drought-induced ecosystem damage or wildfires can decrease ground and surface water supplies and harm nearshore waters and reef ecosystems.

Wildlife habitat may be degraded through the loss of wetlands, lakes, and vegetation. Many species will eventually recover, but the degradation of landscape quality, including increased soil erosion, may lead to a more permanent loss of biological productivity. Vegetation and wildlife impacts can include death

from dehydration and the spread of invasive species or diseases due to stressed conditions. Invasive species pose both direct and indirect impacts for the ecosystems in which they are introduced.

When groundwater is not replenished, aquifer and well water levels diminish. Contamination of surface water sources can occur during drought conditions, leading to increased pollutant levels and lower oxygen levels in reservoirs. This contributes to higher concentrations of illness-causing bacteria, protozoa, and toxic blue-green algae blooms. Reduced aquifer recharge and depletion of aquifer storage may affect groundwater discharge to coastal nearshore waters, negatively impacting groundwater-dependent ecosystems.

Historic

Drought can cause soil desiccation, leading to the destabilization of foundations and structures. This can result in cracks and other structural damage to historic buildings. Additionally, drought can increase the risk of wildfires, which can threaten historic sites and artifacts. The lack of moisture can also accelerate the deterioration of materials such as wood, stone, and adobe, further compromising the integrity of historic resources (NIDIS n.d.).

Cultural

The primary impacts on cultural assets from drought include an increased risk of wildfires, which could threaten these assets, and damage 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. Drought and its secondary impacts can damage watersheds and nearshore waters, impairing or impeding the exercise of traditional and customary practices (HI-EMA 2023).

Kalo (taro) is an important cultural food central to Native Hawaiian identity, with deep connections to their genealogy and traditions (Ka'ula, et. al 2023). Drought conditions adversely affect the cultivation of kalo by reducing water availability, which is essential for its growth. This leads to decreased yields and irregular shapes of the taro roots, impacting both the quantity and quality of this culturally significant crop (Yamanouchi, et. al 2021). The challenges posed by drought threaten not only the agricultural productivity but also the cultural heritage and practices associated with kalo cultivation.

8.2.6 Identified Vulnerability Issues

The County has identified the following vulnerabilities related to this hazard:

- Drought creates conditions that increase the frequency, severity, and intensity of wildfires.
- Drought leads to water shortages that can impact the health and safety of the general population when water is not available for drinking, agriculture, or fighting wildfires.
- There is a need for water storage infrastructure in areas prone to wildfires and drought.
- While drought mitigation is recommended in many state and County planning documents, project implementation is difficult due to a lack of funding options.

- The 2024 Maui Water Shortage and Conservation Plan recommends WaterSense fixtures and measures to reduce commercial and residential water use and draw on water storage resources, but there are no County ordinances that require these recommendations.

8.3 FUTURE CHANGES THAT MAY AFFECT RISK

8.3.1 Potential or Planned Development

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. Additionally, newly developed land or expansion into upland forested areas may reduce groundwater recharge as more land becomes impermeable. This development can lead to decreased natural water infiltration, further stressing water resources and increasing the risk of drought.

8.3.2 Projected Changes in Population

As the resident and visitor populations in Maui County continue to increase, the stresses on the County's water sources will also rise. More resources will be needed for human use and consumption, further taxing these resources amid changing climate conditions. Increased population growth will demand more water, intensifying the risk of drought (HI-EMA 2023).

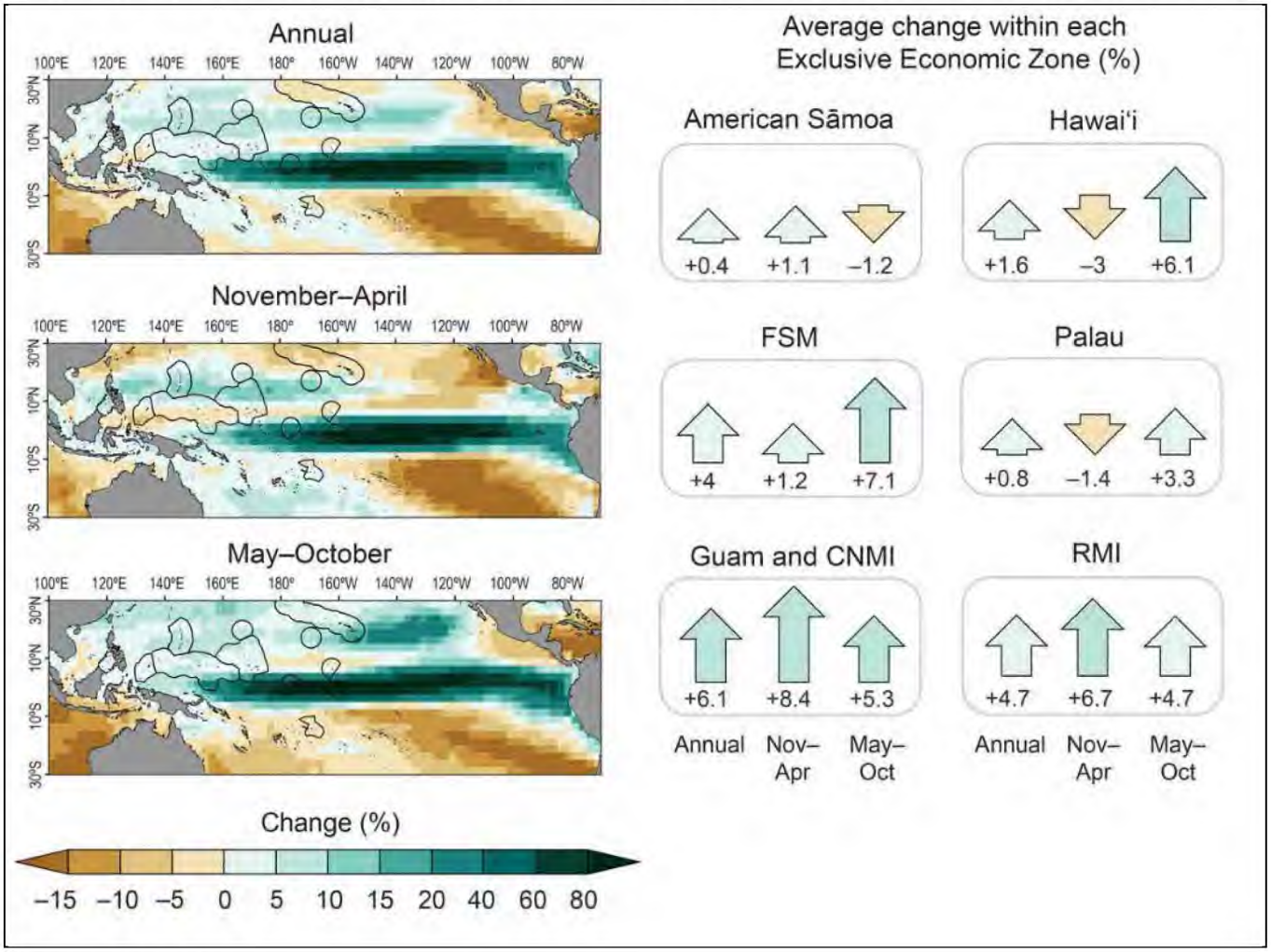
The Department of Business, Economic Development and Tourism (DBEDT) produced population projections for the County from 2030 to 2050. According to these projections, Maui County's population is projected to grow to 173,520 by 2030, 181,000 by 2040, and 184,870 by 2050.

8.3.3 Climate Change

Climate change poses significant risks to Maui County, including higher temperatures and reduced freshwater availability. Rising temperatures and declining precipitation, particularly in leeward areas, exacerbate the vulnerability of Maui's freshwater resources. Climate change impacts drought conditions, with reduced rainfall over the past 30 years impacting stream base flows and water availability. Intense rainfalls can cause flash floods, mudslides, and infrastructure damage, with runoff flowing into the ocean rather than recharging aquifers. The IPCC reports that climate change will likely increase the frequency of meteorological and agricultural droughts, leading to more frequent and severe hydrological droughts.

Figure 8-5 illustrates the projected percentage change in annual and seasonal rainfall across the Pacific Islands region by 2100, under a global warming scenario of 5.4 °F. Hawai'i is expected to experience a decrease in rainfall from November to April and an increase in rainfall from May to October (NCA5 2023).

Figure 8-5. Projected Changes in Rainfall at 5.4°F of Global Warming (Relative to 1985 to 2014)



Source: (NCA5 2023)

8.3.4 Other Identified Conditions

Native Hawaiian cultural practices are closely tied to the natural environment. Together, drought, wildfire, and invasive species threaten many of Hawai'i's endemic plants and animals. When coupled with land use change and the spread of diseases facilitated by warming temperatures, impacts on native species and their habitat may occur (HI-EMA 2023).

9. EARTHQUAKE

9.1 HAZARD PROFILE

9.1.1 Hazard Description

An earthquake is the shaking of the earth's surface by energy waves emitted from the movement of tectonic plates or a volcanic eruption (FEMA 2023). The slip of one block of rock over another inside the earth releases energy that makes the ground vibrate. That vibration pushes the adjoining piece of ground and causes it to vibrate, and thus the energy travels out in waves from the initial point of movement (called the earthquake hypocenter). Most earthquakes occur at the boundaries where the earth's tectonic plates meet (faults), fewer than 10 percent occur within plate interiors (USGS 2016).

Earthquakes in Hawai'i are caused by eruptive processes within 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 (USGS 2023). Hawaiian earthquakes fall into three main categories (USGS 2023):

- **Volcanic**—Magma movement within, and eruptions from, volcanoes on the islands of Maui and Hawai'i are usually accompanied by hundreds to thousands of small earthquakes that rarely cause significant damage. These small earthquakes often occur in shallow swarms, especially after an eruption. They are important for monitoring volcanic activity.
- **Tectonic**—Earthquakes on major faults within and at the base of the volcanoes are driven by the 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. The largest and most damaging tectonic earthquakes are those that occur right at the base of a volcano, where it sits on a preexisting sea floor.
- **Mantle**—This type of earthquake reflects the flexing/bending of the earth's crust and upper mantle due to the weight of the islands above. This is the most common source of damaging earthquakes north of the Island of Hawai'i. This type of earthquake generally occurs more than 12 miles below sea level.

Earthquake Classifications

Earthquakes are typically classified in one of two ways: By the amount of energy released, measured as magnitude; or by the impact on people and structures, measured as intensity.

Magnitude

An earthquake's magnitude is a measure of the energy released at the source of the earthquake. Magnitude is most commonly expressed by ratings on the moment magnitude scale (Mw) (USGS 2021). This scale is based on the total moment release of the earthquake (the product of the distance a fault moved, and the force required to move it). Magnitude is measured by a seismographic network

maintained by the USGS. Each seismic station in the network measures the movement of the ground at that site. The moment magnitude scale is presented in Table 9-1.

Table 9-1. Moment Magnitude (Mw) Scale

Classification	Mw Scale
Great	Greater than 8
Major	7.0 to 7.9
Strong	6.0 to 6.9
Moderate	5.0 to 5.9
Light	4.0 to 4.9
Minor	3.0 to 3.9
Micro	Less than 3.0

Source: (USGS 2021)

Intensity

Perceived Shaking and Building Damage

The Modified Mercalli Intensity (MMI) scale is the most commonly used intensity scale. It defines 10 ratings based on the level of shaking perceived by people and the damage that occurs to buildings. The ratings are from I to X, with I representing the weakest shaking and X being catastrophic destruction. Table 9-2 lists the MMI ratings and the associated perceived shaking and damage potential for structures.

Peak Ground Acceleration

Intensity can also be measured using instruments that measure ground movement. The ground experiences acceleration when it shakes during an earthquake, and peak ground acceleration (PGA) is a measure of how hard the earth shakes in a given geographic area. PGA is the fastest measured change in speed for a particle at ground level moving horizontally due to an earthquake. It is commonly expressed as a percent of g (the acceleration due to gravity) (%g), with higher values indicating stronger shaking.

Instruments called accelerographs record ground acceleration levels due to earthquakes at stations throughout a region. These measurements are valuable for building design and infrastructure planning, as well as understanding how different materials react to seismic waves (AF8 2023). Table 9-2 includes the range of PGA generally associated with each rating level of the MMI.

PGA is often stated as a probability of exceedance over a specific period, such as a “10 percent probability of exceedance in 50 years.” This means there is a 10 percent chance that a location will experience shaking equal to or greater than the specified PGA value within 50 years (USGS 2019).

Table 9-2. Modified Mercalli Intensity Scale for Earthquake Intensity and Associated PGA

MMI Scale	Shaking	Description/Damage	Estimated PGA (%g)
I	Not felt	Not felt except by a very few under especially favorable conditions.	< 0.17
II	Weak	Felt only by a few persons at rest, especially on upper floors of buildings.	0.17 - 1.4
III	Weak	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.	
IV	Light	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.	1.4 - 3.9
V	Moderate	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.	3.9 - 9.2
VI	Strong	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.	9.2 - 18
VII	Very strong	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.	18 - 34
VIII	Severe	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.	34 - 65
IX	Violent	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great insubstantial buildings, with partial collapse. Buildings shifted off foundations.	65 - 124
X	Extreme	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.	> 124

Source: (USGS 2021)
Note: PGA = peak ground acceleration, measured in percent of "g", where "g" is the acceleration of gravity

Maps of PGA values form the basis of seismic maps that are included in building codes such as the International Building Code. Building codes that include seismic provisions specify the horizontal force due to lateral acceleration that a building should be able to withstand during an earthquake. PGA values are directly related to these lateral forces that could damage "short-period structures" (e.g., single-family dwellings). Longer period response components determine the lateral forces that damage larger structures with longer natural periods (apartment buildings, factories, high-rises, bridges).

Spectral Acceleration

Spectral acceleration (SA) is another measure of earthquake intensity. The USGS describes it as the maximum acceleration experienced by a building, modeled as the movement of a particle on a vertical rod with the same natural period of vibration as the building. Like PGA, SA is expressed as a percentage of the acceleration of gravity (%g). It is particularly useful for assessing the impact on taller buildings, while PGA is more relevant for shorter buildings (less than seven stories).

Liquefaction

Soil liquefaction occurs when water-saturated sands, silts or gravelly soils are shaken so violently that the individual grains lose contact with one another and float freely in the water, turning the ground into a pudding-like liquid. Building and road foundations lose load-bearing strength and may sink into the ground. Liquefaction susceptibility is determined by the geological history, depositional setting, and topographic position of the soil. Liquefaction effects may occur along the shorelines of the ocean, rivers, and lakes and they can also happen in low-lying areas away from water bodies in locations where the groundwater is near the earth's surface.

Some soft soils amplify ground shaking, and a contributor to that amplification is the velocity at which the soil transmits seismic waves of energy called shear waves. The National Earthquake Hazard Reduction Program (NEHRP) has developed soil classifications defined by their shear wave velocity as listed in Table 9-3.

Table 9-3. NEHRP Soil Classification System

NEHRP Soil Type	Soil Description	Mean Shear Velocity (meters/second)
A	Hard Rock	1,500
B	Firm to Hard Rock	760-1,500
C	Dense Soil/Soft Rock	360-760
D	Stiff Soil	180-360
E	Soft Clays	< 180
F	Special Study Soils (liquefiable soils, sensitive clays, organic soils, soft clays >36 m thick)	

Source: (FEMA n.d.)

NEHRP soil types define the locations that will be significantly affected by an earthquake. NEHRP Soils B and C typically can sustain ground shaking without much effect, dependent on the earthquake magnitude. The areas that are commonly affected by ground shaking have NEHRP Soils D and E. In general, these areas are also most susceptible to liquefaction.

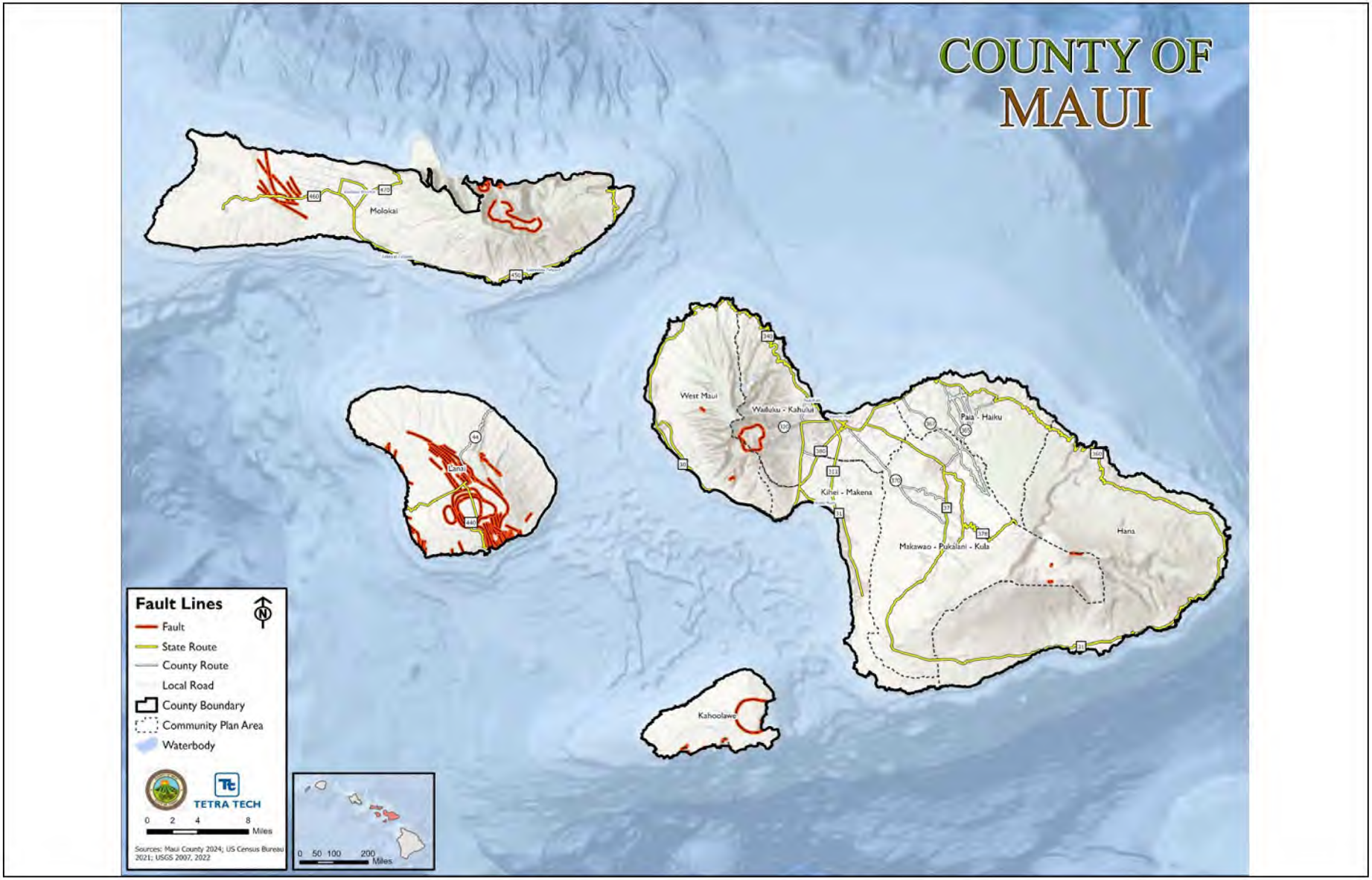
9.1.2 Location

Volcanoes and Faults

Shaking from earthquakes associated with volcanic activity in Hawai'i is typically too small to cause damage. In Maui County, these small earthquakes, often referred to as swarms, are located around the Haleakalā volcano in eastern Maui.

However, a major earthquake event could impact the entire county. Fault locations and earthquake risk areas help define location. Notable faults within Maui County include the West Maui Fault, East Moloka'i Fault, and an extensive fault system on Lāna'i. These faults are shown in Figure 9-1. Earthquakes occurring on other Hawaiian Islands, such as the Big Island of Hawai'i, or in the Pacific Ocean, also have the potential to impact Maui County.

Figure 9-1. Active Fault Lines and Zones in Maui County



National Seismic Hazard Map

The USGS last updated its National Seismic Hazard Model maps in 2023. The newest seismic, geologic, and geodetic information on earthquake rates and associated ground shaking were incorporated into these revised maps. The 2023 National Seismic Hazard Model map is shown in Figure 9-2 (USGS 2023).

In Maui County, the new seismic hazard model map shows that the probability of an earthquake with an MMI of VI or greater occurring in 100 years ranges from 25 to 95 percent. The areas of lowest probability are on the eastern side of Molokaʻi, and the areas of highest probability are on the Island of Maui around the easter coastline and in the central lowland areas. High probabilities are also predicted on Kahoʻolawe .

Liquefaction and Soil Types

Maui County has areas of NEHRP Class D soils, as shown in Figure 9-3. In addition, the NOAA Coastal Service Center sponsored a project in 2005 to identify areas with the potential for soil liquefaction in Maui County and Hawaiʻi County. The results of the study showed small areas of high liquefaction susceptibility in Maui, including the Community Plan Areas of West Maui (from Lahaina to Nāpili), the south Maui area (Kīhei to Mākena), and the central Maui region (Wailuku and Kahului) (HI-EMA 2023).

9.1.3 Extent

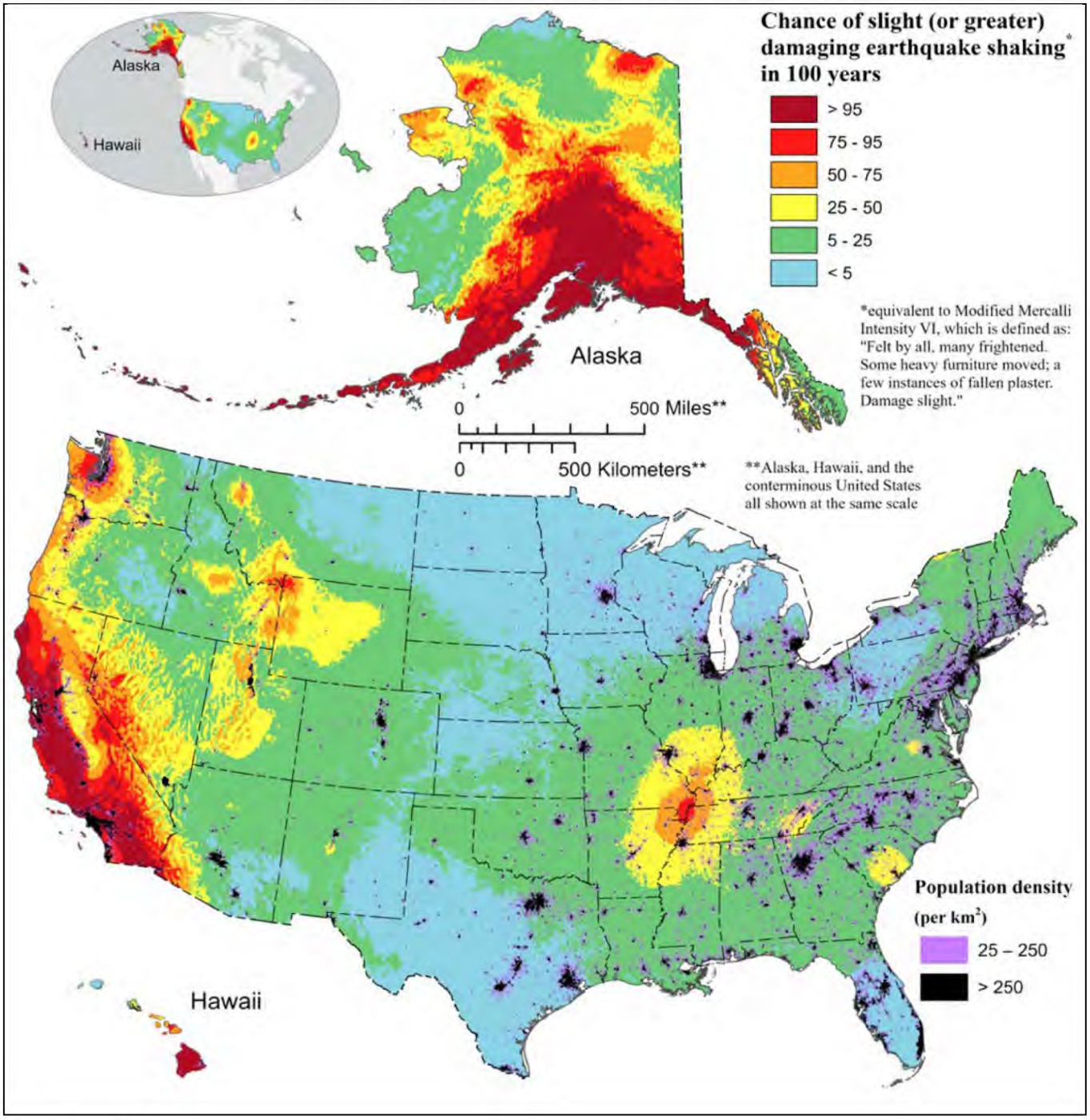
The diverse landscapes of Maui County, from coastal areas to inland communities, face potential risks from the earthquake hazard. This section describes the extent of these risks, examining the geological factors that contribute to vulnerability and the potential for ground shaking and other impacts.

Ground Motion

Figure 9-4 and Figure 9-5 display the MMI rating and PGA across Maui County for the 500-year and 2,500-year mean return period (MRP) events. PGA was evaluated instead of SA because most buildings in Maui County are less than seven stories tall. These figures show that the entire County will experience very strong to severe PGA, ranging from 18%g to 34%g for the 500-year MRP event and 35%g to 65%g for the 2,500-year MRP event.

For most of Maui County, including the Island of Maui and part of eastern Molokaʻi, the PGA value with a 2 percent probability of exceedance in 50 years is 33%g, indicating strong shaking. This level of shaking would cause negligible damage to well-designed buildings, slight to moderate damage to well-built ordinary structures, and considerable damage to poorly built structures. In the remainder of the County, including most of Molokaʻi and all of Lānaʻi, the PGA value with a 2 percent probability of exceedance in 50 years is 17%g, indicating moderate shaking.

Figure 9-2. National Seismic Hazard Model, 2023



Source: (USGS 2023)

Figure 9-3. NEHRP Soil Hazard Area, Maui County

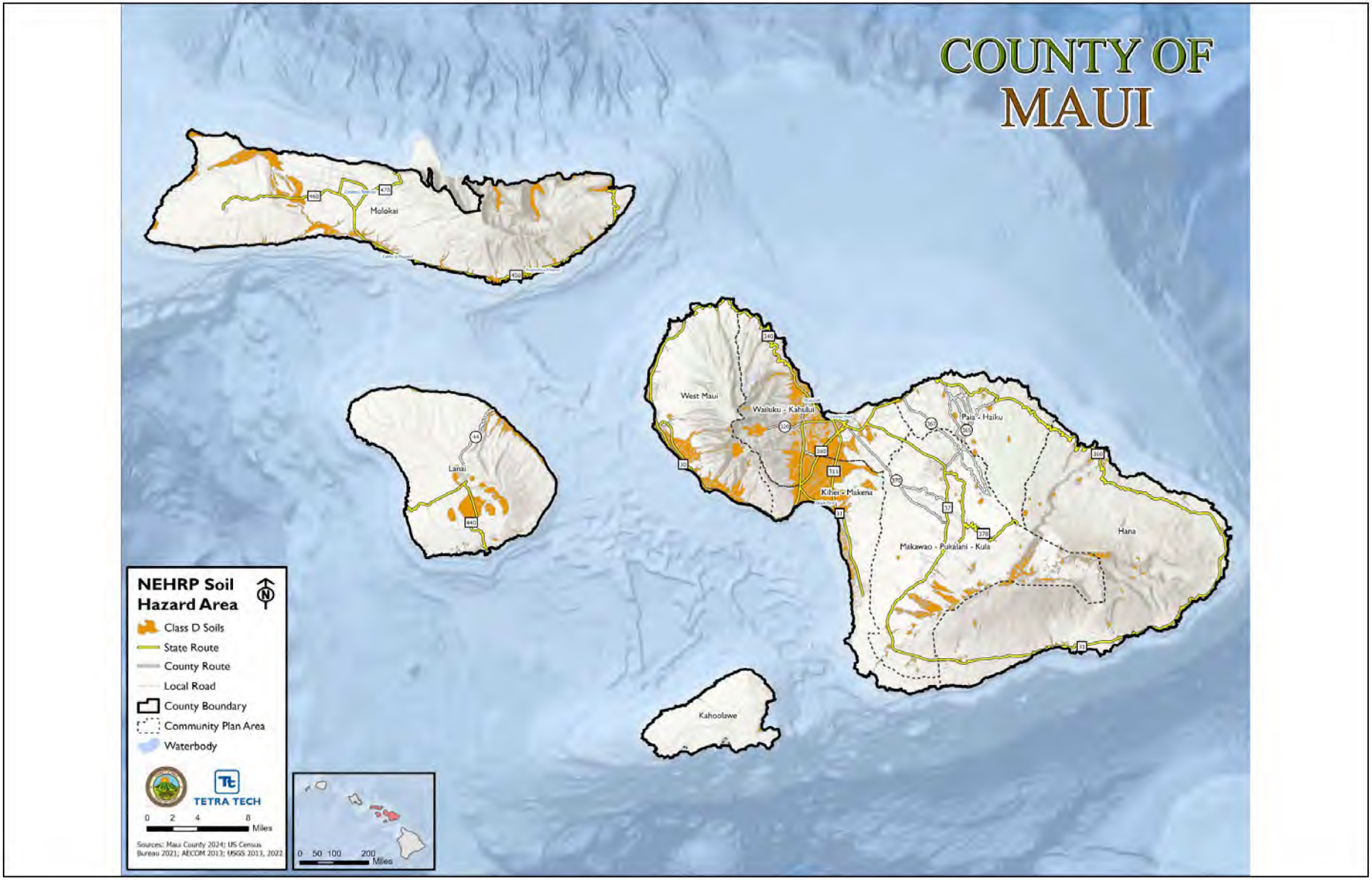


Figure 9-4. Impacts of a 500-Year MRP Earthquake in Maui County

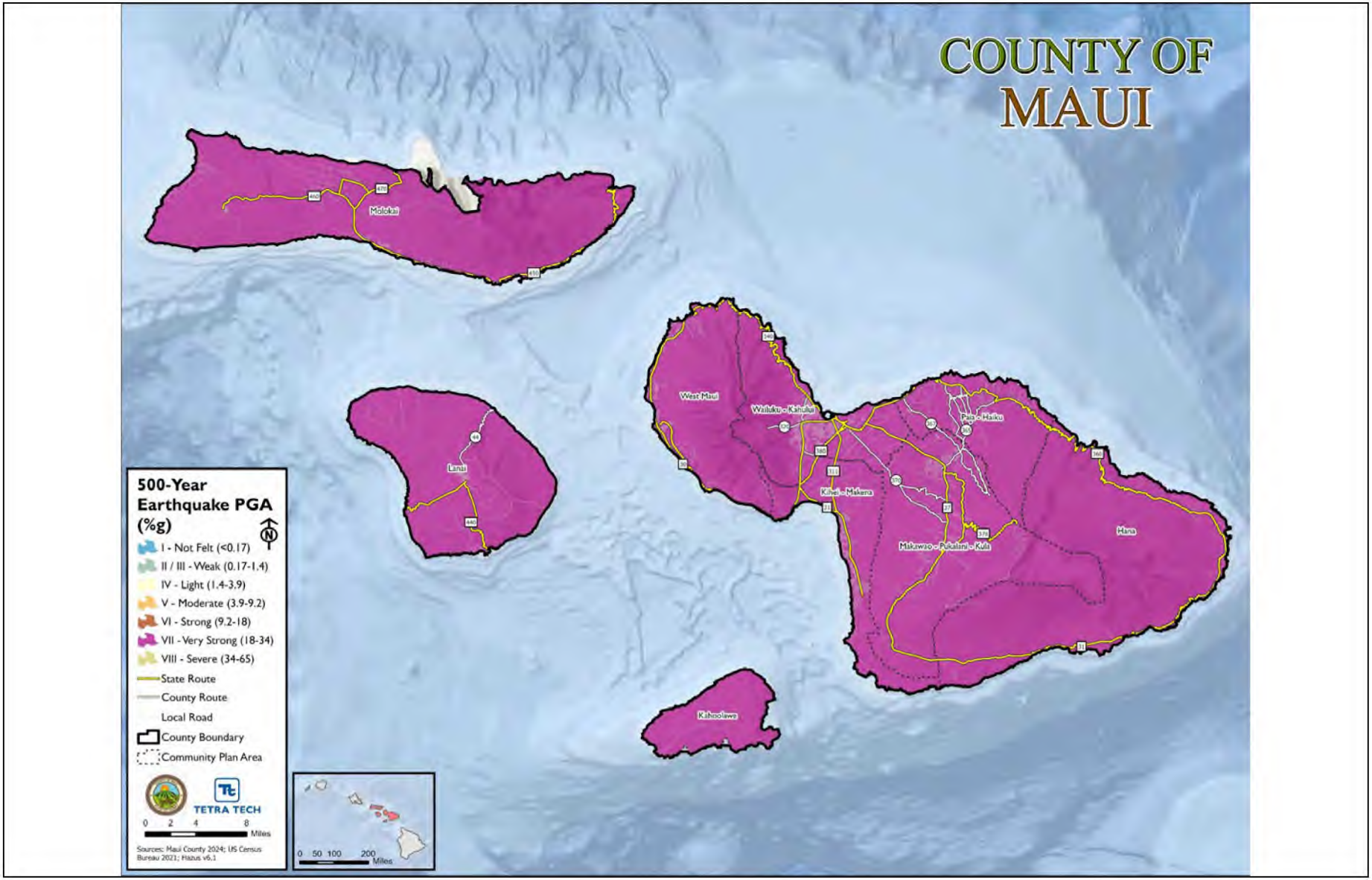
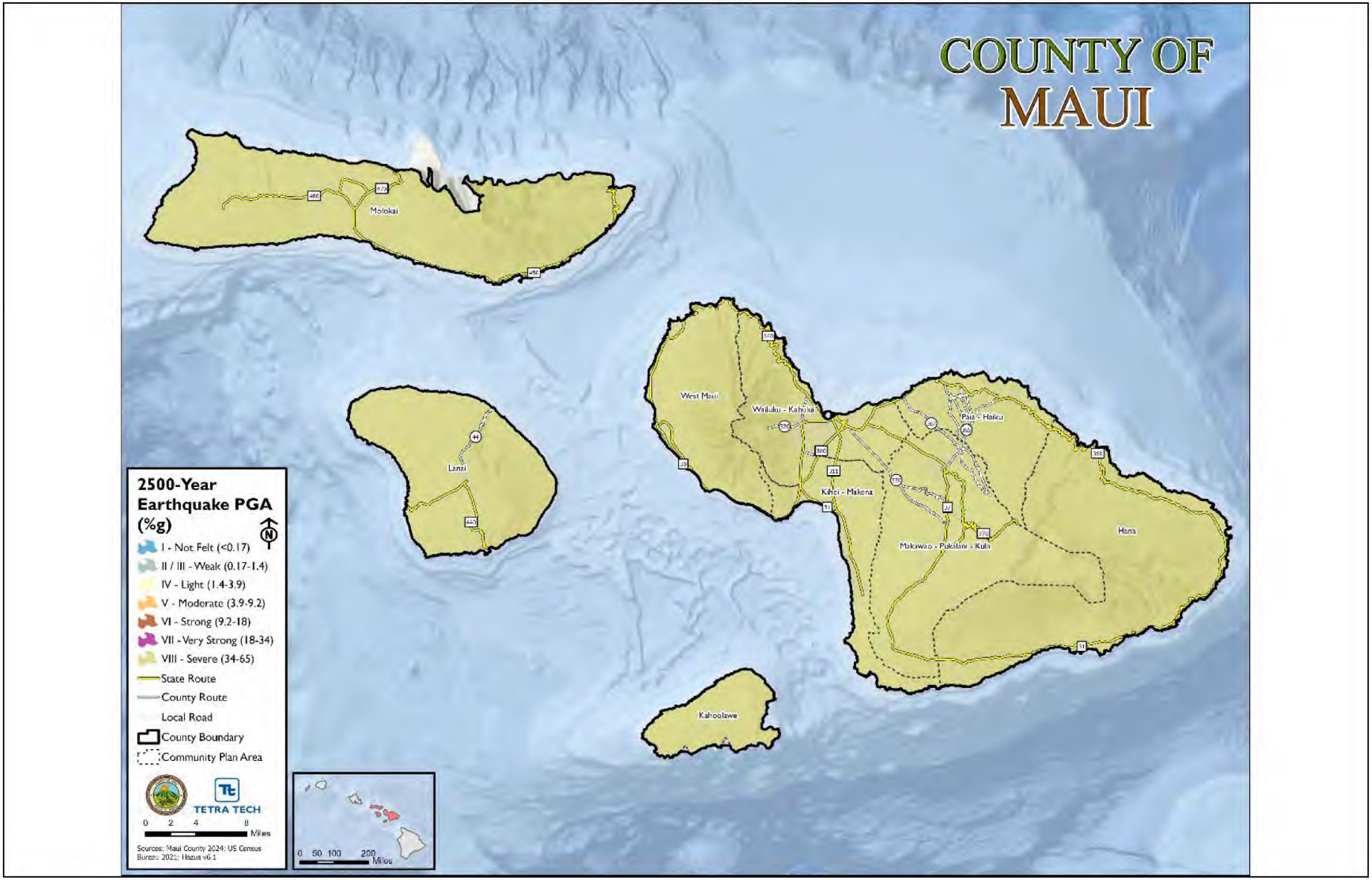


Figure 9-5. Impacts of a 2,500-Year MRP Earthquake in Maui County



Warning Time

The USGS issues rapid, automatic earthquake information via the internet, email messages, text messages, and social media (USGS 2022). However, at present, there is no reliable way to predict the day or month that an earthquake will occur at any given location.

Hawai'i has the world's largest single integrated public safety outdoor siren warning system. The sirens' output is 121 decibels, with a range of 3,400 feet. This range may vary due to environmental and surrounding physical conditions. The sirens are battery-powered and use a photovoltaic charging system. The sirens are part of the larger Hawai'i Statewide Alert and Warning System, including FEMA's Integrated Public Alert & Warning System, which uses both the Emergency Alert System and Wireless Emergency Alerts to alert the public.

9.1.4 Previous Occurrences

Maui County has been included in two major disaster (DR) or emergency (EM) declarations for earthquake-related events (FEMA 2024). Table 9-4 provides an overview of these declarations.

Table 9-4. FEMA Disaster Declarations for Earthquake Events in Maui County

Event Date	Declaration Date	Declaration Number	Description
January 21, 1960	January 21, 1960	DR-96	Earthquakes & Volcanic Disturbances
October 15, 2006 to January 15, 2007	October 17, 2006	DR-1664	Earthquake

Source: (FEMA 2024)

State Emergency Proclamations

The Governor of Hawai'i may declare a state of emergency by proclamation if an emergency or disaster has occurred or there is imminent danger or threat of an emergency or disaster in any portion of the state (Hawai'i State Legislature 2020). Between 2020 and 2024, Maui County was not included in any state emergency proclamation for an earthquake-related event.

USDA Declarations

Between 2020 and 2024, Maui County was not included in any USDA earthquake-related agricultural disaster declarations (USDA 2024).

All Recent Events

Maui County earthquake events between December 2020 and December 2024 with a magnitude of 4 or higher are listed in Table 9-5. For earlier earthquake events, refer to the 2020 HMP.

Table 9-5. Earthquake Events of Magnitude 4 or Greater in Maui County, 2020 to 2024

Event Date	Counties Affected	Event Description
December 4, 2020	Hawai‘i, Maui, Honolulu	Nearly 700 people felt the earthquake as far away as O‘ahu. 12 miles SSE of Waimea, Hawai‘i, 4.4 magnitude.
December 21, 2020	Hawai‘i, Maui	More than 450 people felt the earthquake, which hit about an hour after Kīlauea volcano began to erupt. 2 miles S of Fern Forest, Hawai‘i, 4.4 magnitude.
March 11, 2021	Hawai‘i, Maui	More than 300 people as far away as Maui felt the earthquake. 11 miles NNE of Pāhala, Hawai‘i, 4.2 magnitude
March 14, 2021	Hawai‘i, Maui	About 180 people as far away as Maui felt the earthquake. 7 miles SSE of Volcano, Hawai‘i, 4.1 magnitude
April 3, 2021	Hawai‘i, Maui	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. 3 miles NW of Pāhala, Hawai‘i, 4.3 magnitude
June 18,2021	Hawai‘i, Maui, Honolulu	Nearly 500 people felt the earthquake as far away as O‘ahu. The earthquake was part of an ongoing seismic swarm under the Pāhala area, which started in August 2019. 5 miles ENE of Pāhala, Hawai‘i
July 5,2021	Hawai‘i, Maui, Honolulu	More than 1,300 people felt the earthquake as far away as O‘ahu. 7 miles NNW of Kukuihaele, Hawai‘i, 5.2 magnitude
July 7, 2021	Hawai‘i, Maui, Honolulu	About 100 people felt the earthquake as far away as O‘ahu. 45 miles WNW of Kalaoa, Hawai‘i, 4.2 magnitude
October 5, 2021	Hawai‘i, Maui, Honolulu	More than 250 people felt the earthquake as far away as O‘ahu. 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. 5 miles ENE of Pāhala, Hawai‘i
October 10, 2021	Hawai‘i, Maui, Honolulu, Kaua‘i	First reported: More than 3,400 people felt the earthquake across the entire state. 4 miles SSE of Nā‘ālehu, Hawai‘i, 6.2 magnitude Second reported: About 20 people felt the earthquake as far away as Maui. 14 miles S of Nā‘ālehu, Hawai‘i, 4.3 magnitude
December 24, 2021	Hawai‘i, Maui	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 Kama‘ehuakanaloa over the previous two weeks. 26 miles ESE of Nā‘ālehu, Hawai‘i, 4.9 magnitude
January 25, 2022	Maui, Honolulu, Hawai‘i	About 850 people felt the earthquake. 6 miles NNE of Wailua, Hawai‘i, 4.7 magnitude
March 20, 2022	Hawai‘i, Maui, Honolulu	About 750 people felt the earthquake as far away as O‘ahu. 13 miles SSE of Waimea, Hawai‘i, 4.5 magnitude
April 15, 2022	Hawai‘i, Maui, Honolulu	More than 500 people felt the earthquake as far away as O‘ahu. The earthquake appeared to be part of the ongoing seismic swarm under the Pāhala area. 6 miles E of Pāhala, Hawai‘i, 4.6 magnitude
May 21, 2022	Hawai‘i, Maui, Honolulu	More than 1,600 people felt the earthquake as far away as O‘ahu. 2 miles NW of Hōlualoa, Hawai‘i, 4.7 magnitude
July 27, 2022	Hawai‘i, Maui	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. 27 miles ESE of Nā‘ālehu, Hawai‘i, 4.6 magnitude

Event Date	Counties Affected	Event Description
September 27, 2022	Hawai'i, Maui, Honolulu	More than 350 people felt the earthquake as far away as O'ahu. This earthquake was part of the seismic swarm under the Pāhala area. 6 miles ENE of Pāhala, Hawai'i, 4.5 magnitude
October 14, 2022	Hawai'i, Maui, Honolulu, Kaua'i	Three earthquakes were 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. Locations: 8 km S of Pāhala, Hawai'i; 4 miles SSW of Pāhala, Hawai'i; 9 km SSW of Pāhala, Hawai'i, magnitudes: 4.6, 5.0, and 4.0
November 27, 2022	Hawai'i, Maui	About 50 people felt the earthquake on Hawai'i and Maui islands. Swarms of earthquakes continued sporadically when new fissures on Mauna Loa began to spill lava on the caldera floor. 17 miles E of Hōnaunau Nāpō'opo'o, Hawai'i, 4.2 magnitude

Source: (NOAA 2024) (FEMA 2024) (HI-EMA 2023)

Note: With earthquake 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, the table may not include all events that have occurred in the state (in that time period and magnitude level).

The following earthquakes are noted as having had a significant impact on Maui County:

- **1871 Lāna'i Earthquake**—The Lāna'i earthquake of 1871 was one of the most significant earthquakes to affect Maui County. From the geographic distribution of its effects, its magnitude is estimated to have been 7.0, with an epicenter near the south coast of the Island of Lāna'i.
- **1938 Maui Earthquake**—The January 22, 1938, Magnitude-6.9 earthquake had an epicenter about 12 miles northeast of Ke'anae Point in East Maui. The Island of Maui suffered more damage than any other Hawaiian Island, though there were few injuries and no mortalities. Damage on Moloka'i and Lāna'i was small and resulted from a few ground cracks. No tsunami accompanied the shock.
- **2006 Kiholo Bay and Mahukona Earthquakes**—The most recent earthquakes to strike Hawai'i were the Kiholo Bay and Mahukona earthquakes of October 15, 2006, centered in the Pacific Ocean west of the Island of Hawai'i. The Magnitude-6.7 Kiholo Bay earthquake occurred at 7:07 a.m., followed by the Magnitude-6.0 Mahukona earthquake at 7:14 a.m. Although the Mahukona earthquake was the smaller of the two in magnitude, its intensity was reportedly equal to or greater than that of the Kiholo Bay earthquake in some areas due to its shallower depth. On the Island of Maui, the earthquakes induced several landslides and rockfalls along Piilani Highway (Highway 31) on the southeastern coast. About 500 residents were cut off in the Manawainui area due to an incipient rockfall hazard and due to the closure of a bridge damaged by erosion at Pahihi. This event resulted in a disaster declaration for Maui County, with damage for the county estimated at $28.1 million.

9.1.5 Probability of Future Occurrences

Probability Based on Previous Occurrences

The probability of future major earthquake events impacting Maui County was determined using historic occurrence information. Twenty-five significant (above a 6.0 magnitude) events have been reported over a 170-year reporting period, equivalent to a significant earthquake every 6 to 7 years, on average.

Information on previous earthquake occurrences in the County was used to calculate the probability of future occurrence of such events. Table 9-6 lists the number of events from various sources from 1950 to 2024, which is the most complete period of record for all sources reviewed. Based on these records and input from the HMWG, the probability of occurrence of earthquakes occurring in the County is considered "occasional."

Table 9-6. Probability of Future Earthquake Events in Maui County

Hazard Type	Number of Occurrences Between 1950 and 2024	Percent Chance of Occurring in Any Given Year
Earthquakes	22	29%

Source: (USGS 2024)

Note: The number of hazard occurrences is calculated using the number of earthquakes of magnitude 4.0 or greater that occurred in Maui County or in the near-shore waters immediately surrounding the coastline.

Effect of Climate Change on Future Probability

The potential impacts of global climate change on earthquake probability are still under investigation. Some scientists suggest that melting glaciers could induce tectonic activity. As ice melts and water runs off, significant weight shifts occur on the earth's crust. The return of the newly freed crust to its original, pre-glacier shape could cause seismic plates to slip and stimulate volcanic activity. Additionally, changes in the earth's crust during periods of drought can be substantial. Similarly, groundwater extraction from underground aquifers for human use, which is exacerbated during droughts, has been shown to impact stress load patterns by "unweighting" the earth's crust (NASA 2019).

A study by University College London reported that El Niño cycles in the Pacific Ocean over the past 40 years have triggered a regular seismic response as water pressure changes with sea level fluctuations. The eastern Pacific experiences more earthquakes in the months following the cycle, which lowers sea levels in the area by a few centimeters, flexing the plates beneath. These climate change impacts could affect the entire State of Hawai'i (HI-EMA 2023).

9.1.6 Cascading Impacts on Other Hazards

Earthquakes can be contributors to the dam failure hazard. Earthen dams are highly susceptible to seismic events, with the most common type of dam failure being slumping or settlement of earth-fill dams where the fill has not been properly compacted. If slumping occurs when the dam is full, overtopping and rapid erosion can lead to dam failure (HI-EMA 2023).

Earthquakes are among the likeliest causes of tsunamis. This is a particular concern on Maui because a tsunami generated by an earthquake on the Big Island could arrive in Maui County in less than 30 minutes (HDOE n.d.).

9.2 VULNERABILITY AND IMPACT ASSESSMENT

To determine what assets are vulnerable to earthquakes, the asset inventories prepared for this HMP (population, buildings, critical facilities) were overlaid with the mapping of NEHRP Class D soils. Assets with their centroid located in the hazard areas were totaled to estimate the numbers and values at risk from the impacts of flood. To estimate potential losses associated with earthquakes, a Level 2 Hazus probabilistic earthquake analysis was performed for the 500- and 2,500-year MRP events using asset inventories prepared for this HMP.

9.2.1 Life, Health, and Safety

Overall Population

All residents and visitors in Maui County are at risk from the earthquake hazard. An earthquake could result in deaths, injuries, and disruption of normal activities. The effects could be aggravated by collateral emergencies such as fires, flooding, tsunamis, landslides, hazardous material spills, utility disruptions, and transportation emergencies. Earthquakes that are strong enough to damage infrastructure may have public health impacts, such as contaminated water supply, fires from natural gas leaks, or prolonged power outages, which can especially impact public health when combined with extreme temperatures.

The degree of exposure is dependent on the age and construction type of the structures that people live in and the soil types on which their homes are constructed. Table 9-7 summarizes the number of people living in areas with seismically sensitive NEHRP Class D soils.

Table 9-7. Population Living on NEHRP Class D Soils, Maui County

Community Plan Area	Total Population (2023 ACS)	Population on NEHRP Class D Soils	
		Number of Persons	% of Plan Area Total
Hāna	2,135	92	4.3%
Kīhei-Mākena	29,174	12,418	42.6%
Lānaʻi	3,333	902	27.1%
Makawao-Pukalani-Kula	24,505	138	0.6%
Molokaʻi	8,092	3,048	37.7%
Pāʻia-Haʻikū	17,037	701	4.1%
Wailuku-Kahului	58,606	57,177	97.6%
West Maui	21,749	6,308	29.0%
Maui County (Total)	164,632	80,784	49.1%

Source: U.S. Census Bureau 2023 ACS Vulnerable Population Totals, AECOM 2013, USGS 2013

As a result of an earthquake event, residents may be displaced or require temporary long-term shelter. 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. As shown in Table 9-8, Hazus estimates that there will be 1,091 displaced households and 556 persons seeking short-term shelter caused by the 500-year MRP event, and 5,708 displaced households and 2,994 persons seeking short-term shelter caused by the 2,500-year MRP event.

Table 9-8. Populations Affected by the 500-Year and 2,500- Year MRP Earthquake Events

Community Plan Area	Total Population (2023 ACS)	500-Year MRP Earthquake Event		2,500-Year MRP Earthquake Event	
		Displaced Households	Persons Seeking Short-Term Shelter	Displaced Households	Persons Seeking Short-Term Shelter
Hāna	2,135	2	1	17	10
Kīhei-Mākena	29,174	482	211	2,109	927
Lānaʻi	3,333	4	2	32	16
Makawao-Pukalani-Kula	24,505	62	30	450	219
Molokaʻi	8,092	12	9	92	67
Pāʻia-Haʻikū	17,037	36	17	260	128
Wailuku-Kahului	58,606	329	210	1,972	1,264
West Maui	21,749	164	76	776	363
Maui County (Total)	164,632	1,091	556	5,708	2,994

Source: U.S. Census Bureau 2023 ACS, Hazus v6.1

The casualty estimates are provided for three times of day that represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate represents the maximum residential occupancy load, the 2:00 PM estimate represents the maximum educational, commercial, and industrial sector loads, and the 5:00 PM estimate represents peak commute time. Table 9-9 shows that the severity of impacts increases significantly from the 500-year MRP event to the 2,500-year MRP event. Additionally, the number of injuries, hospitalizations, and casualties varies depending on the time of day, with 2:00 PM generally showing the highest numbers.

Table 9-9. Estimated Casualties for the 500-Year and 2,500-Year MRP Earthquake Events

Level of Severity	500-Year MRP			2,500-Year MRP		
	2:00 AM	2:00 PM	5:00 PM	2:00 AM	2:00 PM	5:00 PM
Injuries Without Hospitalization	163	314	199	809	1,459	944
Hospitalizations	26	70	42	190	427	268
Casualties	3	14	8	32	98	59

Source: Hazus v6.1

Socially Vulnerable Population

Populations considered most vulnerable are those located in/near the built environment, particularly those near unreinforced masonry construction. Of these most vulnerable populations, socially

vulnerable populations, including the elderly (persons over age 65) and individuals living below the poverty threshold, are most susceptible. Factors leading to this higher susceptibility include decreased mobility and financial ability to react or respond during a hazard, and the location and construction quality of their housing.

Table 9-10 presents the estimated socially vulnerable populations located within the NEHRP Soils Class D Hazard Areas. In these areas, there are 16,034 people over the age of 65, 4,129 people under the age of 5, 3,868 non-English speakers, 8,986 people with disabilities, and 6,758 people living in poverty.

Table 9-10. Number of Vulnerable Persons Living in NEHRP Class D Soils Hazard Area

Community Plan Area	Vulnerable Populations Living on NEHRP Class D Soils									
	Persons Over 65		Persons Under 5		Non-English Speaking Persons		Persons with a Disability		Persons in Poverty	
	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total
Hāna	24	4.3%	4	3.9%	1	2.5%	10	4.3%	14	4.2%
Kīhei-Mākena	2,602	42.5%	566	42.5%	362	42.5%	1,340	42.6%	1,234	42.6%
Lānaʻi	193	27.1%	60	27.0%	102	27.1%	156	27.0%	67	27.0%
Makawao-Pukalani-Kula	30	0.6%	7	0.5%	2	0.4%	13	0.5%	15	0.6%
Molokaʻi	649	37.6%	133	37.5%	21	36.0%	525	37.7%	561	37.6%
Pāʻia-Haʻikū	116	4.1%	46	4.1%	6	3.7%	58	4.1%	80	4.1%
Wailuku-Kahului	11,244	97.6%	2,885	97.5%	3,105	97.6%	6,298	97.6%	4,184	97.6%
West Maui	1,176	29.0%	428	28.9%	269	28.9%	586	29.0%	603	29.0%
Maui County (Total)	16,034	48.6%	4,129	46.1%	3,868	63.6%	8,986	50.8%	6,758	42.3%

Source: U.S. Census Bureau 2023 ACS Vulnerable Population Totals; AECOM 2013; USGS 2013

9.2.2 General Building Stock

Any structures not built to the Hawai'i State Building Code are at higher risk for damage or collapse. In addition, certain building types, such as unreinforced masonry and concrete, are at a higher risk of damage. Softer soils may collapse or slide during an earthquake, and soils subject to liquefaction may cause buildings to sink or foundations to fail. Nearly a third (29 percent) of the housing in Lānaʻi was built before 1950. Molokaʻi and Pāʻia-Haʻikū Community Plan Areas have the second and third highest proportion of housing built before 1950 (nearly 13 percent).

Buildings on Seismically Sensitive Soils

Buildings constructed on NEHRP Class D soils are particularly vulnerable to earthquakes because those soils can most easily experience liquefaction. Table 9-11 lists the number of buildings on NEHRP Class D soils and the replacement cost value (RCV) of those buildings. Table 9-12 categorizes these buildings by occupancy class.

Table 9-11. Building Stock and Replacement Costs on NEHRP Class D

Community Plan Area	Community Plan Area Total Buildings		Buildings on NEHRP Class D Soils			
			Number of Buildings		Replacement Cost Value	
	Count	Replacement Cost Value	Count	% of Plan Area Total	Value	% of Plan Area Total
Hāna	930	$741,266,476	41	4.4%	$23,981,565	3.2%
Kīhei-Mākena	7,613	$11,692,760,990	3,383	44.4%	$6,492,603,975	55.5%
Lānaʻi	1,258	$1,012,846,136	321	25.5%	$203,062,431	20.0%
Makawao-Pukalani-Kula	8,868	$6,037,317,698	49	0.6%	$48,894,370	0.8%
Molokaʻi	3,056	$2,384,451,998	1,164	38.1%	$824,711,609	34.6%
Pāʻia-Haʻikū	4,316	$2,686,054,376	246	5.7%	$225,746,691	8.4%
Wailuku-Kahului	15,444	$18,302,375,352	15,012	97.2%	$17,366,735,242	94.9%
West Maui	4,063	$8,896,487,618	1,332	32.8%	$5,046,870,668	56.7%
Maui County (Total)	45,548	$51,753,560,644	21,548	47.3%	$30,232,606,551	58.4%

Source: USACE NSI 2022; Hawai'i Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; RSMeans 2024; AECOM 2013; USGS 2013

Table 9-12. Buildings on NEHRP Class D Soils, by Occupancy Class

Community Plan Area	Buildings on NEHRP Class D Soils by General Occupancy Class			
	Residential	Commercial	Industrial	Other[a]
Hāna	36	3	1	1
Kīhei-Mākena	2,823	421	104	35
Lānaʻi	312	9	0	0
Makawao-Pukalani-Kula	47	2	0	0
Molokaʻi	1,065	79	11	9
Pāʻia-Haʻikū	162	77	6	1
Wailuku-Kahului	12,885	1,571	361	195
West Maui	1,025	255	30	22
Maui County (Total)	18,355	2,417	513	263

Source: USACE NSI 2022; Hawai'i Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; AECOM 2013; USGS 2013

a. Other = Government, Religion, Agricultural, and Education

Building Damage

The total replacement cost value (RCV) of the general building stock in Maui County is an estimated $51.8 billion. Table 9-13 summarizes the estimated damage from the 500-year MRP earthquake: $982 million in residential damage, $516 million in commercial damage, and $292 million in damage to all other occupancy types. The Community Plan Area of Wailuku-Kahului is estimated to lose over $768 million (4.2 percent) of its total building and contents from a 500-year MRP earthquake event, which is the most out of all the Community Plan Areas.

Table 9-14 summarizes the estimated damage from the 2,500-year MRP earthquake. Maui County is estimated to experience $3.5 billion in residential damage, $1.8 billion in commercial damage, and $1.1 billion in damage to all other occupancy types. The Community Plan Area of Wailuku-Kahului is estimated to lose over $2.7 billion (14.8 percent) of its total building and contents from a 2,500-year MRP earthquake event, which is the most out of all of the Community Plan Areas.

Table 9-15 shows that all building occupancy classes are likely to experience all levels of damage severity as a result of the 500-year and 2,500-year MRP events.

9.2.3 Community Lifelines and Other Critical Facilities

All infrastructure within Maui County is also considered at risk of earthquakes, including all pipes, roads, bridges, dams, water and wastewater treatment facilities, and utility poles. During earthquakes, underground infrastructure, such as water and sewer systems and natural gas pipelines, are especially vulnerable. Damaged or impassable roads may cut off certain populations from vital resources. In addition, in the event that a dam is damaged during an earthquake, there is potential for dam failure (See Chapter 7 for more on Dam Failure).

Table 9-13. Estimated Damage for 500-Year MRP Earthquake

Community Plan Area	Total Replacement Cost Value (RCV)	Estimated Building Damage from 500-Year MRP Earthquake Event				
		Estimated Total Building and Contents Damage		Estimated Damage by Occupancy Type		
		Value	% of Total Plan Area RCV	Residential	Commercial	Other[a]
Hāna	$741,266,476	$19,118,670	2.6%	$11,389,038	$6,093,064	$1,636,569
Kīhei-Mākena	$11,692,760,990	$491,186,942	4.2%	$364,640,016	$79,966,890	$46,580,037
Lānaʻi	$1,012,846,136	$20,055,907	2.0%	$10,181,554	$6,112,898	$3,761,455
Makawao-Pukalani-Kula	$6,037,317,698	$170,925,316	2.8%	$115,753,325	$25,969,810	$29,202,181
Molokaʻi	$2,384,451,998	$45,406,235	1.9%	$24,325,831	$10,852,098	$10,228,307
Pāʻia-Haʻikū	$2,686,054,376	$81,586,713	3.0%	$54,806,818	$16,905,901	$9,873,994
Wailuku-Kahului	$18,302,375,352	$767,827,915	4.2%	$253,761,749	$335,945,050	$178,121,117
West Maui	$8,896,487,618	$193,805,416	2.2%	$147,276,049	$34,213,533	$12,315,834
Maui County (Total)	$51,753,560,644	$1,789,913,115	3.5%	$982,134,380	$516,059,244	$291,719,492

Source: USACE NSI 2022; Hawaiʻi Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; Hazus v6.1; RSMeans 2024

a. Other = Industrial, Government, Religion, Agricultural, and Education

Table 9-14. Estimated Damage for the 2,500-Year MRP Earthquake

Community Plan Area	Total RCV	Estimated Building Damage from 2,500-Year MRP Earthquake Event				
		Estimated Total Building and Contents Damage		Estimated Damage by Occupancy Type		
		Value	% of Total Plan Area RCV	Residential	Commercial	Other[a]
Hāna	$741,266,476	$66,942,055	9.0%	$38,301,137	$21,649,080	$6,991,837
Kīhei-Mākena	$11,692,760,990	$1,753,217,223	15.0%	$1,308,491,880	$277,297,863	$167,427,480
Lānaʻi	$1,012,846,136	$77,402,618	7.6%	$37,451,269	$22,840,431	$17,110,917
Makawao-Pukalani-Kula	$6,037,317,698	$606,764,604	10.1%	$401,262,469	$90,475,347	$115,026,788
Molokaʻi	$2,384,451,998	$188,099,468	7.9%	$97,185,289	$43,777,957	$47,136,221
Pāʻia-Haʻikū	$2,686,054,376	$286,708,885	10.7%	$191,130,793	$59,164,596	$36,413,496
Wailuku-Kahului	$18,302,375,352	$2,708,803,562	14.8%	$894,723,138	$1,144,370,191	$669,710,233
West Maui	$8,896,487,618	$801,990,184	9.0%	$616,834,386	$135,893,368	$49,262,430
Maui County (Total)	$51,753,560,644	$6,422,986,543	12.4%	$3,547,079,224	$1,773,819,754	$1,102,087,565

Source: USACE NSI 2022; Hawaiʻi Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; Hazus v6.1; RSMeans 2024

a. Other = Industrial, Government, Religion, Agricultural, and Education

Table 9-15. Predicted Level of Damage from the 500- and 2,500-Year MRP Earthquake

Occupancy Class	Total Number of Buildings in Occupancy	Severity of Expected Damage	500-Year MRP Earthquake		2,500-Year MRP Earthquake	
			Building Count	% of All Buildings in Occupancy Class	Building Count	% of All Buildings in Occupancy Class
Residential Exposure (Single and Multi-Family Dwellings)	40,411	None	24,030	59.5%	10,098	25.0%
		Minor	10,808	26.7%	13,571	33.6%
		Moderate	4,641	11.5%	11,534	28.5%
		Severe	840	2.1%	4,054	10.0%
		Destruction	92	0.2%	1,154	2.9%
Commercial Buildings	3,807	None	1,867	49.1%	636	16.7%
		Minor	921	24.2%	864	22.7%
		Moderate	707	18.6%	1,181	31.0%
		Severe	258	6.8%	737	19.4%
		Destruction	52	1.4%	389	10.2%
Industrial Buildings	851	None	410	48.2%	141	16.6%
		Minor	189	22.2%	173	20.4%
		Moderate	164	19.2%	249	29.3%
		Severe	73	8.6%	175	20.5%
		Destruction	15	1.7%	112	13.2%
Other[a]	479	None	232	48.4%	77	16.1%
		Minor	114	23.7%	105	21.9%
		Moderate	92	19.2%	147	30.7%
		Severe	35	7.2%	96	20.1%
		Destruction	7	1.5%	53	11.1%

Source: USACE NSI 2022; Hawai'i Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; Hazus v6.1
Note: The number of damaged buildings may be over or under estimated.
a. Other = Government, Religion, Agricultural, and Education

Further, infrastructure in areas with liquefaction-prone soils may sink (e.g., drinking water pipes), or buried infrastructure may float to the surface (e.g., manholes or other infrastructure containing air). Secondary impacts from an earthquake, such as rock falls or fires, may also damage infrastructure. Much of Maui County's infrastructure was built in the 1970s and may not be seismically constructed or retrofitted to withstand strong earthquakes.

The Hazus earthquake model was used to assign the range or average probability of each damage state category to the critical facilities in Maui County for the 500-year event. In addition, Hazus estimates the time to restore critical facilities to fully functional. Results are presented as a probability of being functional at specified time increments (days after the event). For example, Hazus might estimate that a facility has a 5 percent chance of being fully functional on Day 3 and a 95 percent chance of being fully functional on Day 90. For the percent probability of sustaining damage, the minimum and maximum damage estimated value for that facility type is presented.

As a result of a 500-year MRP event, Hazus estimates that community lifelines will be impacted primarily between Day 1 and Day 7 with between 0.0 to 57.2 percent functionality and 0.0 to 82.1 percent functionality, respectively. For a 2,500-year MRP event, Hazus estimates that community lifelines will be impacted primarily on Day 1 with between 0.0 to 73 percent functionality. Refer to Table 9-16 and Table 9-17 for additional information.

Table 9-16. Community Lifeline Damage and Functionality, 500-Year MRP Earthquake

	Percent Probability of Sustaining Damage					Percent Functionality			
Lifeline	None	Slight	Moderate	Extensive	Complete	Day 1	Day 7	Day 30	Day 90
Communications	38.2%	24.0%	23.9%	10.5%	3.4%	38.1%	62.1%	86.0%	96.5%
Energy	32.7%	25.0%	26.5%	12.0%	3.9%	32.6%	57.6%	84.1%	96.1%
Food, Hydration, Shelter	37.0%	24.3%	24.4%	10.8%	3.5%	36.9%	61.2%	85.6%	96.4%
Hazardous Materials	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Health and Medical	57.2%	25.4%	13.6%	3.2%	0.6%	57.2%	82.1%	96.2%	98.6%
Safety and Security	55.6%	20.3%	16.8%	6.2%	1.0%	55.6%	75.6%	92.8%	96.9%
Transportation	29.4%	23.4%	27.4%	14.2%	5.6%	29.4%	52.7%	80.1%	94.3%
Water Systems	37.8%	24.1%	24.0%	10.6%	3.5%	37.8%	61.8%	85.8%	96.4%

Source: Hawai'i Emergency Management Agency 2017; Hazus v6.1

Table 9-17. Community Lifeline Damage and Functionality, 2,500-Year MRP Earthquake

	Percent Probability of Sustaining Damage					Percent Functionality			
Lifeline	None	Slight	Moderate	Extensive	Complete	Day 1	Day 7	Day 30	Day 90
Communications	25.6%	29.1%	32.1%	11.5%	1.7%	73.0%	92.8%	98.9%	99.8%
Energy	15.5%	23.8%	27.7%	17.5%	15.5%	32.2%	53.3%	69.0%	84.6%
Food, Hydration, Shelter	7.7%	14.9%	30.3%	26.3%	20.8%	7.6%	22.5%	52.8%	79.2%
Hazardous Materials	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Health and Medical	20.0%	30.1%	32.0%	12.7%	5.1%	20.0%	49.5%	82.1%	90.7%
Safety and Security	21.2%	20.9%	29.7%	19.3%	8.9%	21.1%	41.6%	71.7%	84.4%
Transportation	5.7%	12.8%	28.0%	26.1%	27.4%	9.7%	23.0%	47.2%	72.3%
Water Systems	11.9%	18.3%	28.5%	22.3%	19.1%	17.8%	34.8%	59.1%	80.8%

Source: Hawai'i Emergency Management Agency 2017; Hazus v6.1

Table 9-18 shows the number of critical facilities located in the NEHRP Class D soils hazard area for Maui County. A total of 155 facilities are located in this hazard area with the highest number among the Safety and Security lifeline (41). The Community Plan Area of Wailuku-Kahului has the highest number of critical facilities (96) located in the NEHRP Class D soil hazard area.

Table 9-18. Number of Facilities in the NEHRP Class D Soils Hazard Area, by Lifeline Category

Community Plan Area	Number of Facilities in the NEHRP Class D Soils Hazard Area, by Lifeline Category									Total Facilities in Hazard Area	
	Communications	Energy	Food, Hydration, Shelter	Hazardous Materials	Health & Medical	Safety & Security	Transportation	Water Systems	Other Critical Facilities	Count	% of Plan Area Total
Hāna	0	0	0	0	0	0	0	0	1	1	7.7%
Kīhei-Mākena	4	0	2	0	3	2	1	6	2	20	58.8%
Lānaʻi	0	0	0	0	0	0	0	0	0	0	0.0%
Makawao-Pukalani-Kula	1	0	0	0	0	0	0	0	0	1	4.2%
Molokaʻi	2	0	1	0	2	8	0	2	4	19	63.3%
Pāʻia-Haʻikū	0	1	0	0	0	2	0	0	0	3	21.4%
Wailuku-Kahului	4	2	1	0	25	28	8	14	14	96	94.1%
West Maui	0	0	3	0	2	1	0	9	0	15	37.5%
Maui County (Total)	11	3	7	0	32	41	9	31	21	155	56.4%

Source: Hawaiʻi Emergency Management Agency 2017;AECOM 2013; USGS 2013

9.2.4 Economy

Although the Hazus analysis does not compute damage estimates for individual roadway segments and railroad tracks, assumedly these features would undergo damage due to ground failure, resulting in interruptions of regional transportation and distribution of materials. Losses to the community that would result from damage to lifelines could exceed the costs of repair. Earthquake events can also significantly affect road bridges, many of which provide the only access to certain neighborhoods. Because softer soils generally follow floodplain boundaries, bridges that cross watercourses should be considered vulnerable. Another key factor in the degree of vulnerability is the age of facilities and infrastructure, which correlates with standards in place at times of construction.

Hazus estimates the volume of debris that may be generated as a result of an earthquake event to enable the study region to prepare and rapidly 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 it up before it can be transported, and (2) brick, wood, and other debris that can be loaded directly onto trucks with bulldozers (FEMA 2024).

For the 500-year MRP event, Hazus estimates a total of 106,391 tons of Brick/Wood debris and 184,316 Concrete/Steel debris will be generated County-wide; Wailuku-Kahului will generate the most brick/wood debris (52,712 tons), and concrete/steel debris (88,374 tons) out of all Community Plan Areas. For the 2,500-year MRP event, Hazus estimates a total of 362,876 tons of Brick/Wood debris and 751,083 Concrete/Steel debris will be generated County-wide; Wailuku-Kahului will generate the most brick/wood debris (164,640 tons), and concrete/steel debris (330,995 tons) out of all Community Plan Areas. See Table 9-19 for more information.

Table 9-19. Estimated Debris Generated by the 500-Year and 2,500-Year MRP Earthquake Events

Community Plan Area	Debris Generated by 500-Year MRP Event		Debris Generated by 2,500-Year MRP Event	
	Brick/Wood (tons)	Concrete/Steel (tons)	Brick/Wood (tons)	Concrete/Steel (tons)
Hāna	1,125	1,082	3,983	4,907
Kīhei-Mākena	24,533	50,859	87,165	205,928
Lānaʻi	936	1,424	3,815	6,690
Makawao-Pukalani-Kula	9,621	10,426	37,536	48,689
Molokaʻi	3,075	4,021	11,787	20,100
Pāʻia-Haʻikū	5,388	5,638	20,540	24,786
Wailuku-Kahului	52,712	88,374	164,640	330,995
West Maui	9,000	22,493	33,410	108,987
Maui County (Total)	106,391	184,316	362,876	751,083

Source: USACE NSI 2022; Hawaiʻi Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; Hazus v6.1

9.2.5 Natural, Historic and Cultural Resources

Natural Resources

Earthquakes can impact ecosystems and wildlife by triggering landslides, soil liquefaction, and changes in water flow, which can destroy habitats and degrade marine environments. Seismic activity can disrupt natural water sources, contaminating or destroying freshwater resources and affecting geothermal resources essential for local ecology.

Historic Resources

Earthquakes can cause significant structural damage or destruction to Maui County's historic buildings, temples, churches, and other historically significant sites, leading to the loss of irreplaceable heritage. Earthquake-induced landslides, ground shaking, and soil liquefaction can damage or destroy archaeological sites, burial grounds, and ancient petroglyphs, resulting in the loss of invaluable information about Maui's past, indigenous history, and heritage.

Cultural Resources

Earthquakes can disrupt access to natural resources essential for traditional practices, affecting the transmission of cultural knowledge to future generations. Additionally, museums and cultural institutions housing Hawaiian art, artifacts, and historical documents are at risk, and their loss would mean a significant loss of cultural heritage.

9.2.6 Identified Vulnerability Issues

The County has identified the following vulnerabilities related to this hazard:

- While stakeholders seem aware of facilities at risk from wildfire or coastal erosion, they did not report their facilities being at risk from earthquakes, despite the analysis demonstrating that all of Maui County is at risk from earthquakes. This demonstrates a need for more education for stakeholders about the threat of earthquakes in Maui County.
- Maui County has more than 18,000 residential buildings on NEHRP Class D soil. However, in the event of a major earthquake, the County does not have the engineering staff needed to complete damage assessments on these properties.
- The structural integrity of buildings can be damaged during an earthquake, including facilities identified as emergency shelters.
- The public rated earthquakes as the hazard they are third-least concerned about. This could indicate that residents are unaware of the hazard posed by earthquakes.

9.3 FUTURE CHANGES THAT MAY AFFECT RISK

9.3.1 Potential or Planned Development

As discussed, and illustrated in Chapter 3 (County Profile), areas targeted for future growth and development have been identified across the County. Development in areas with softer NEHRP soil classes, liquefaction, and landslide-susceptible areas may experience shifting or cracking in the foundation during earthquakes because of the loose soil characteristics of these soil classes. However, current building codes require seismic provisions that should render new construction less vulnerable to seismic impacts than older, existing construction that may have been built to lower construction standards.

In Maui County, 1,106 new developments are located within the NEHRP Class D soils hazard area, representing 34.1 percent of all new development. The Wailuku-Kahului planning area has the highest concentration with 707 developments (94.0 percent), followed by West Maui with 173 (30.2 percent), and Kihei-Makena with 168 (32.6 percent). Table 9-20 displays the number of new development by community planning area.

Table 9-20. Number of New Development in the NEHRP Soils (Class D) Hazard Area

Community Plan Area	Number of New Development in the NEHRP Soils (Class D) Hazard Area	
	[illegible]	[illegible]
Hana	0	0.0%
Kahoolawe	0	0.0%
Kihei - Makena	168	32.6%
Lanai	20	7.4%
Makawao - Pukalani - Kula	11	1.8%
Molokai	25	21.9%
Paia - Haiku	2	0.6%
Wailuku - Kahului	707	94.0%
West Maui	173	30.2%
Maui County (Total)	**1,106**	**34.1%**

Source: *County of Maui 2025; AECOM 2013; USGS 2013*

9.3.2 Projected Changes in Population

An increase in population density can impact the number of persons exposed to earthquakes. People who move into older buildings may increase their overall vulnerability to earthquakes. As noted earlier, if moving into new construction, current building codes require seismic provisions that should render new construction less vulnerable to seismic impacts.

The Department of Business, Economic Development and Tourism (DBEDT) produced population projections for the County from 2030 to 2050. According to these projections, Maui County's population is projected to grow to 173,520 by 2030, 181,000 by 2040, and 184,870 by 2050.

9.3.3 Climate Change

Scientists are studying the potential impacts of global climate change on earthquake probability. Melting glaciers and groundwater extraction during droughts can shift significant weight on the earth's crust, potentially causing seismic activity. El Niño cycles in the Pacific Ocean have also been linked to increased earthquake activity due to sea level fluctuations. These climate change impacts could affect seismic activity across the state.

The secondary impacts of earthquakes could be magnified by climate change. Earthquakes can trigger large and sometimes disastrous landslides, as any steep slope is vulnerable to failure. Rising air temperatures can facilitate soil breakdown, allowing more water to penetrate soils, which affects erosion rates, sediment control, and the likelihood of landslides. Climate change may also increase the frequency and intensity of rainstorms, resulting in greater erosion, higher sediment transport in rivers and streams, and a higher probability of landslides due to increased soil content (HI-EMA 2023).

9.3.4 Other Identified Conditions

In planning for future earthquake resilience, Maui County must prioritize infrastructure resilience, technological advancements, and economic factors. Ensuring that future infrastructure projects are designed with earthquake resilience in mind is crucial. This includes retrofitting existing structures to meet modern seismic standards and ensuring that new developments adhere to stringent building codes. By doing so, the county can significantly reduce the potential damage and enhance the safety of its residents.

Another vital aspect of earthquake preparedness is incorporating the latest technology in early warning systems, emergency response, and construction techniques. Advanced early warning systems can provide critical seconds to minutes of notice before an earthquake strikes, allowing people to take protective actions and emergency services to mobilize. Utilizing innovative construction techniques can also improve the durability and flexibility of buildings, making them more resistant to seismic forces. Maui County can use MEMA Alerts or the outdoor siren system to notify residents if an advanced warning is available.

Economic factors play a significant role in the effectiveness of earthquake mitigation efforts. Sustainable funding and investment in earthquake preparedness are essential for long-term resilience.

This includes allocating resources for regular infrastructure maintenance and upgrades and investing in community education and training programs. By ensuring a stable financial foundation, Maui County can support ongoing mitigation efforts and be better prepared for future seismic events.

10. FLOOD

10.1 HAZARD PROFILE

10.1.1 Hazard Description

A flood is an overflow of water onto normally dry land caused by rising water in an existing waterway, such as a river, stream, or drainage ditch, or ponding of water at or near the point where the rain fell (NWS 2015). Tropical air masses can hold more moisture than drier continental air masses, so intense rainfall rates are more frequent in tropical latitudes. Flooding is a frequent, dangerous, and costly hazard. Globally, it accounts for 40 percent of all natural disasters and results in an average of over 6,500 deaths annually (Statista 2024). In the U.S., the 30-year average for flood deaths is around 127 people per year (NWS n.d.) and approximately seventy-five percent of all federal disaster declarations are associated with flooding (NWS n.d.).

Flooding is the most common environmental hazard in the United States, primarily due to the widespread presence of valleys and coastal regions, along with high population densities in these areas. The severity of a flood is influenced by several key factors, including the topography and physiography of stream and river basins, precipitation and weather patterns, recent soil moisture levels, and the extent of vegetative clearing and impervious surfaces.

Weather Systems Causing Flooding

Flooding can be triggered by heavy rainfall. On Maui, heavy rains typically occur from October through April, while on Molokaʻi, the heaviest rainfall is usually from December through March. In Maui County, heavy rainfall and subsequent flooding are generally caused by the following types of storms:

Kona Storms

These storms occur during the wettest period of the year, from November to April. Trade winds from the northeast slack during this time, allowing storms from the south to approach the islands. Kona winds are generally warmer and carry moisture that is dropped evenly as rain over the entire county. The low elevation and southern location of these storms mean that drier sides of the islands get most of their rainfall (approximately 25 to 30 inches each season) during Kona storms. These events can cause coastal and inland flooding over large geographic areas.

Frontal Storms

Usually occurring from December through March, these storms originate over the Pacific Ocean as a result of the intersection of polar and tropical air masses and move eastward over the islands. Heavy continuous rainfall over several hours can create hazardous conditions in high-sloping areas of the islands. Low-lying areas with poor drainage are prone to landslides and flash floods during these storms.

Upper Level Lows

These can occur at any time of the year. While they often have little or no effect on the lower levels of the atmosphere, they can sometimes tap into the marine layer and induce heavy showers that result in flash flooding.

Tropical Cyclones

Tropical depressions, tropical storms, and hurricanes hitting or passing near the Hawaiian Islands cause heavy rains, storm surge, high winds, and surf. Impacts from these events include severe coastal and inland flooding and damage due to high surf.

El Niño–Southern Oscillation (ENSO) Cycle and Flooding

The El Niño-Southern Oscillation (ENSO) is a recurring climate pattern lasting three to seven years, during which conditions over the Pacific Ocean basin change dramatically. El Niño causes warmer-than-normal sea temperatures in the equatorial Pacific. The Southern Oscillation is defined as a "seesaw of atmospheric pressure between the eastern equatorial Pacific and Indo-Australian areas." During ENSO events, El Niño represents the sea temperature component, while the Southern Oscillation represents the atmospheric pressure component. These systems can impact weather patterns globally when in effect.

In Hawai‘i, ENSO events initially cause increased rainfall, followed by a rapid decrease, leading to severe rainfall events and subsequent flooding, followed by years of drought as trade winds decline. This first year of heavy rainfall is referred to as the El Niño year. During ENSO events, sea levels in Hawai‘i may be slightly higher, and the frequency of tropical cyclones increases due to warmer ocean temperatures. The increased tropical cyclones can heighten the frequency and severity of coastal flooding and storm surges during ENSO cycles (NOAA n.d.).

Types of Flooding

Inland Flooding

The following are the types of flooding that can occur inland, away from the coastline:

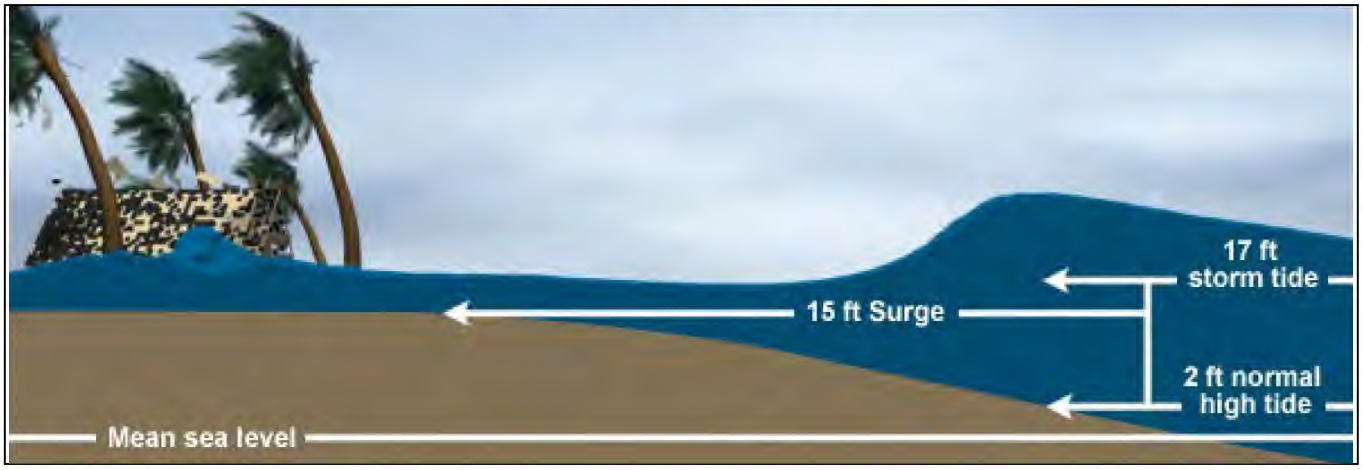
- **Riverine Flooding**—Periodic flooding of lands adjacent to non-tidal rivers and streams is a natural occurrence. When stream flow exceeds the capacity of the normal watercourse, some of the above-normal stream flows onto adjacent lands within the floodplain.
- **Flash Flooding**—Occurs within a few minutes or hours of heavy rainfall and can destroy buildings, uproot trees, and scour out new drainage channels. Flash floods are often caused by slow-moving thunderstorms, cyclones, Kona storms, or repeated thunderstorms in a local area. They are common in both mountainous areas and urban centers with impervious surfaces (NWS n.d.).
- **Sheet Flooding**—This condition occurs when stormwater runoff forms a sheet of water to a depth of six inches or more. It is common in flat areas with no clearly defined channels, making the path of flooding unpredictable.

- **Urban Flooding**—Caused by heavy rain over a short period of time. Urbanization increases runoff, turning parking lots into lakes, flooding basements and businesses, and causing lakes to form in roads where drainage is poor or overwhelmed (NWS n.d.).

Coastal Flooding

Coastal flooding in Hawai'i typically occurs along the shores of oceans, bays, and estuaries. It is caused by seawater rising above normal tide levels due to storm surges. Hurricanes and severe storms are the primary causes of coastal flooding (Hurricane Science 2020). During these events, high winds and surf can push water several feet and even hundreds of yards inland. Please refer to Figure 10-1 for a detailed diagram illustrating storm surge.

Figure 10-1. Storm Surge

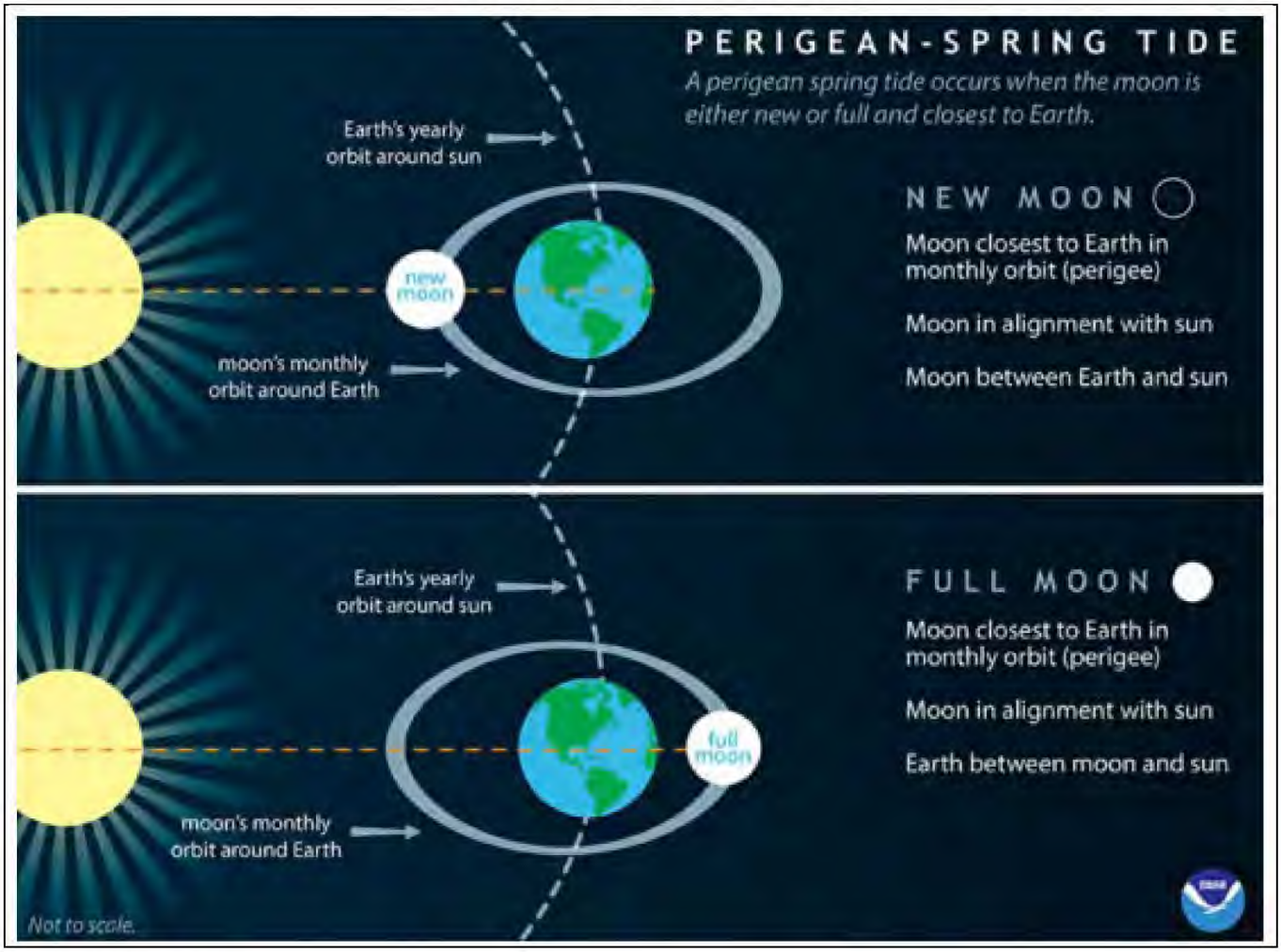


Source: (NHC n.d.)

Event-based coastal flooding is discussed in the context of a 1- percent annual chance storm. For more information on hurricanes and storm surges from less frequent and more severe events, refer to Chapter 12 (Hurricane).

- **High Wave Flooding**—Frequently occurring coastal hazard within the Hawaiian Islands. Large waves tend to travel in sets, and after breaking, they rush up onto the beach, temporarily elevating the sea surface near the shoreline.
- **King Tides**—The highest high tides of the year, occurring when the moon is at its closest point to earth during its monthly orbit and when the earth, moon, and sun are in alignment. In Hawai'i, King Tides tend to occur during the summer and winter months in conjunction with full moons and new moons. Figure 10-2 shows the formation of King Tide conditions.

Figure 10-2. King Tide Formation



Source: (NOAA 2024)

- **Sea Level Rise**—While sea level rise is a more gradual process compared to other types of flooding, it will eventually inundate buildings and infrastructure that are currently unaffected. More immediate threats arise when rising sea levels amplify other coastal hazards, such as high surf, high tides, coastal erosion, and storm surges. For example, high tide flooding along the U.S. coastline is now 300 percent to 900 percent more common than it was 50 years ago.

  Sea level rise is a consequence of climate change, primarily driven by the melting of glaciers and ice sheets, as well as the thermal expansion of seawater as it warms. Globally, the mean sea level has risen approximately eight to nine inches since 1880. Furthermore, the rate of global sea level rise is accelerating, having doubled from 0.06 inches per year throughout most of the twentieth century to 0.14 inches per year from 2006 to 2015 (NOAA 2023). For more on Sea Level Rise, see Chapter 6.

Floodplains

A floodplain is generally a land area susceptible to being inundated by water from any source (e.g., river, stream, lake, ocean, estuary). Floodplains are natural features of any river or stream. Streams that drain more than one square mile have their estimated floodplain areas mapped in most regions. These mapped areas are called the regulatory floodplain, resulting from hydrologic (rainfall) and hydraulic (runoff) analysis of the watershed and stream.

The floodway is a portion of the floodplain required to convey the flood event, while the flood fringe provides flood water storage. The floodway is the high-velocity area, and structures or obstructions in the floodway can increase flood heights.

National Flood Insurance Program

FEMA's National Flood Insurance Program (NFIP) provides flood insurance to property owners, renters, and businesses in participating communities. The NFIP aims to reduce the economic impact of flooding by providing affordable insurance and encouraging communities to adopt regulations to mitigate flood risks. The program makes flood insurance available to communities that adopt and enforce minimum floodplain management regulations established by the NFIP. Maui County has been an NFIP-participating community since June 1, 1981.

Flood Insurance Rate Maps

As part of the NFIP, FEMA identifies and maps several types of floodplains. Localized urban flooding and flash flooding often occur outside designated floodplain areas. Additionally, future flood risks associated with climate change, such as sea level rise or coastal erosion, may not be included in FEMA-mapped floodplains.

Floodplains are delineated on Flood Insurance Rate Maps (FIRMs), which are official maps of a community. FEMA uses these maps to delineate both the Special Flood Hazard Areas (SFHA) and the flood zones applicable to the community. These maps identify:

- SFHAs – areas having special flood, mudflow, or flood-related erosion hazards
- The location of a specific property in relation to SFHAs
- The base flood elevation (1-percent-annual-chance) at a specific site
- The magnitude of a flood hazard in a specific area
- The undeveloped coastal barriers where flood insurance is not available
- Locations of regulatory floodways and floodplain boundaries (1-percent and 0.2-percent-annual-chance floodplain boundaries)
- Areas with reduced flood risk due to levees

Special Flood Hazard Area (SFHA)

An SFHA shown on a FIRM is the regulatory floodplain. SFHAs are delineated on the FIRMs and may be designated as Zones A, AE, AO, AH, AR, V, VE, or A-99. Structures located in the SFHA are highly susceptible to flooding. Structures located in the SFHA Zones are required by lenders to purchase flood

insurance. Anyone in a community that participates in the NFIP may voluntarily purchase flood insurance.

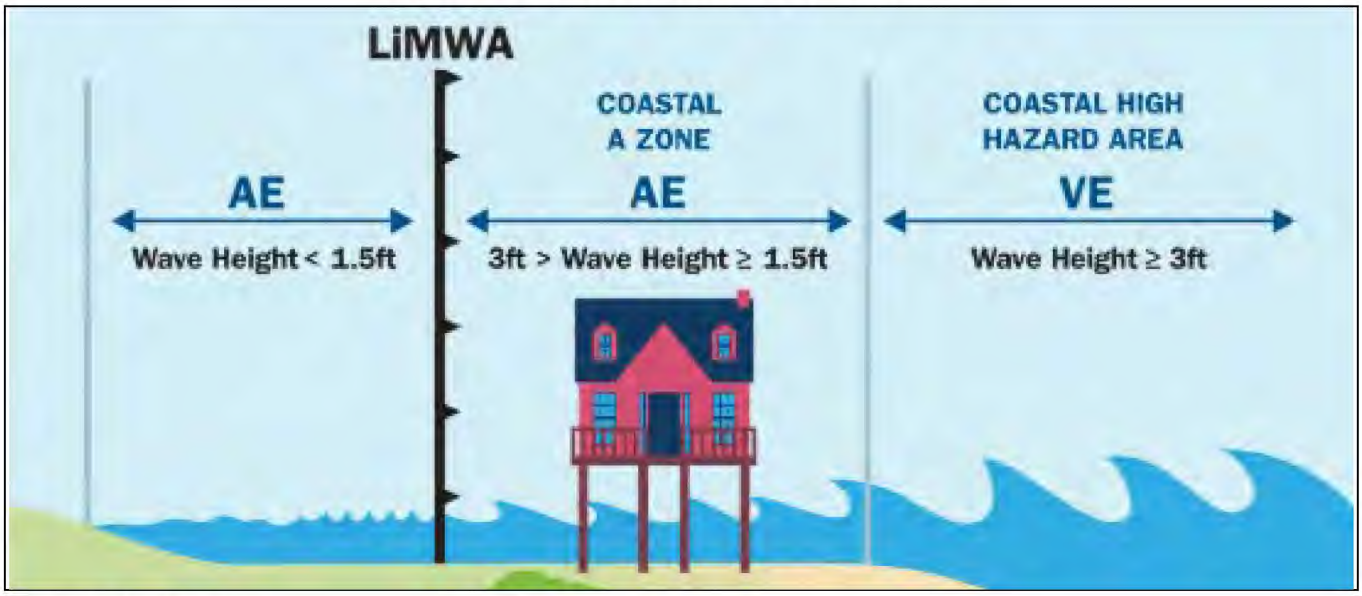
Coastal Flood Hazard Zones

The FIRM depicts the following coastal flood hazard zones:

- **Zones VE**—Flood elevation includes wave heights equal to or greater than three feet. These areas are referred to as Coastal High Hazard Areas.
- **Zone AE**—Flood elevation includes wave heights of less than three feet.

Post-storm field visits and laboratory tests throughout coastal areas of the United States have confirmed that wave heights as low as 1.5 feet can cause significant damage to structures not constructed to withstand such forces. In some cases, FIRMs include a line showing the Limit of Moderate Wave Action (LiMWA), which is the inland limit of the area expected to receive 1.5-foot or greater breaking waves during the 1- percent annual chance flood event (see Figure 10-3). LiMWA alerts property owners in Zone AE that their property may be affected by 1.5-foot or higher breaking waves (FEMA 2023). The area between Zone VE and the LiMWA is referred to as Coastal Zone A, although this is not an official flood zone. The current effective FIRM for Maui County does not delineate LiMWA areas. Future map updates will likely include such information and should be used to inform additional coastal flooding mitigation measures.

Figure 10-3. Limit of Moderate Wave Action



Source: (FEMA 2023)

Community Rating System

As a part of the NFIP, the Community Rating System (CRS) is a voluntary incentive program that recognizes and encourages community floodplain management activities exceeding the minimum program requirements. Over 1,500 communities in the U.S. currently participate in the CRS.

Participating communities benefit from discounted NFIP flood insurance premium rates, reflecting the reduced flood risk due to community actions that meet the three CRS goals:

- Reduce flood damage to insurable property.
- Strengthen and support the insurance aspects of the NFIP.
- Encourage a comprehensive approach to floodplain management.

The CRS employs a class rating system, with classes ranging from Class 10 to Class 1, to determine flood insurance premium reductions for residents. Maui County has been a participant in the CRS since 1995. As of 2024, Maui County holds a Class 7 rating, which provides a 15 percent discount on flood insurance premiums (FEMA 2024).

Regulation and Management

The regulatory floodplain is also known as the 100-year floodplain, base flood elevation, 1.0-percent-annual-chance floodplain, or SFHA. The 100-year floodplain is the land area subject to a 1.0 percent or greater chance of flooding in any given year. The term "100-year flood" is often misinterpreted; it does not mean that it will occur once every 100 years. A 100-year flood has a 1 in 100 (1 percent) chance of occurring in any given year and may occur multiple times in a single year. It is also possible not to have a 100-year flood event over the course of 100 years or more.

Floodplains in Maui County, including the floodway, are regulated by the Maui County Department of Public Works through Maui County Code Chapter 16.29. State of Hawai‘i DLNR is the NFIP State Coordinating Agency and works as a liaison between FEMA and local governments by providing technical assistance, evaluating community floodplain management programs, reviewing local floodplain ordinances, and participating in statewide flood hazard mitigation planning.

While the 100-year (or base flood) is the standard most commonly used for floodplain management and regulatory purposes in the United States, the 500-year flood, also known as the 0.2-percent-annual-chance flood area, is the national standard for protecting critical facilities, such as hospitals and power plants (when federally funded). A 500-year flood has a 1 in 500 (0.2 percent) chance of occurring in any given year. It is generally deeper than a 100-year flood and covers a greater area; however, it is statistically less likely to occur.

10.1.2 Location

All areas of Maui County are subject to flooding impacts. Most flooding sources include streams and gulches that flow from higher elevations in mountainous areas to the sea. Urban flooding also occurs in densely developed areas.

Principal Sources of Flooding

Flooding typically occurs in low-lying coastal areas and within floodplains associated with each island's principal flooding sources, as follows (FEMA 2015):

- Island of Maui
  - Hahakea Gulch
  - Honokahua Stream
  - Honokeana Bay Gulch
  - Honokōwai Stream
  - ʻĪao Stream
  - Kahana Stream
  - Kahoma Stream
  - Kahului Harbor
  - Kailua Gulch
  - Kalepa Gulch
  - Kalialinui Gulch
  - Kaluaihakoko Stream
  - Kamaole Gulch
  - Kaopala Gulch
  - Kauaula Stream
  - Keahaiwai Gulch
  - Kēōkea Gulch
  - Kīhei Gulch 1
  - Kīhei Gulch 2 (Wailuku Town Area)
  - Kīhei Gulch 3
  - Kīhei Gulch 4
  - Kope Gulch
  - Kulanihakoi Gulch
  - Liilioholo Gulch
  - Mahinahina Gulch
  - Nāpili Gulch 2 Overflow
  - Nāpili Gulch 3
  - Nāpili Gulch 4
  - Nāpili Gulch 5
  - Olowalu Gulch 2
  - Olowalu Stream
  - Spreckel's Ditch
  - Unnamed Stream at Kuau Point
  - Waiakoa Gulch
  - Waiakoa/Keahaiwai Split Flow
  - Waiehu Stream
  - Waiheʻe River
  - Waikapū Honoapaiilani Highway
  - Waikapū Stream
  - Waipuilani Gulch
- Island of Molokaʻi
  - Kahananui Gulch
  - Kamalo Gulch
  - Kamiloloa Gulch
  - Kaunakakai Stream
  - Kawela Gulch
  - Keawanui Gulch
  - Manawai Gulch
  - Mile 84 Stream
  - Ohia Gulch
  - Pukoo Gulch
  - Unnamed Gulch
  - Waialua Stream

More than 65 additional streams were assessed on the Islands of Maui and Molokaʻi using approximate methods due to the low development potential or impact from flooding in the surrounding areas. The flood hazard area information presented in this risk assessment reflects effective Flood Insurance Rate Maps (FIRMs) for Maui County, effective as of 2015.

It is important to note that at the time these unnumbered A zones were studied and mapped, they had low development potential or impact from flooding. However, since the original study (still reflected on the current effective FIRM), conditions may have changed. For example, zoning may have changed, the area may now be developed, or the risk of flooding may have increased due to changes in existing conditions.

Although the current effective Flood Insurance Study (FIS) is dated 2015, not all streams were restudied or studied in 2015. Most of the studies are much older, and the FIRM reflects the originally mapped flood hazards from the early 1980s when Maui County joined the National Flood Insurance

Program (NFIP). When Maui's Digital FIRM was made available on September 25, 2009, and all the FIRM panels reflected this date, it may have been interpreted that all the studies were updated. However, this is not the case; most of the flood hazards were simply digitized from the old paper maps and converted into a digital product.

In addition to the streams above, detailed studies were conducted on the entire coastlines of Maui and Molokaʻi to determine tsunami inundation limits. Approximately 80 percent of the coastline of Lānaʻi has undergone such assessment. Additionally, the following sections of the coast were studied in whole for the hurricane storm surge and wave height hazard using detailed methods:

- On the Island of Lānaʻi, the southwestern and southern coastline from Kaumalapau to Mānele.
- On the Island of Maui, the western, southern, and eastern-facing coasts from Honokahua to Kulepeamoa Point.
- On the Island of Molokaʻi, the coastline south and east of Ilio Point to Cape Hālawa.

To provide a comprehensive understanding of the coastal mapping efforts by FEMA, it is essential to highlight the scope and timeline of these studies. The Maui County Flood Insurance Study (FIS) Volume 1, Section 1.2 outlines the 2009 tsunami risk study, which led to the update of the Flood Insurance Rate Map (FIRM) in 2010. Additionally, the 2008 hurricane risk study resulted in the FIRM being updated in 2014.

FEMA Flood Zones

FIRMs across Maui County show various flood zones identified by FEMA as having some degree of flood risk. The following SFHA zones are present within Maui County:

- **Zone A**: Area of the 1-percent annual chance floodplain, also known as the 100-year floodplain, determined by approximate methods. No Base Flood Elevations (BFEs) or depths are shown within this zone. Mandatory flood insurance purchase requirements apply.
- **Zone AE**: Area of the 1-percent annual chance floodplain, also known as the 100-year floodplain,) determined in the Flood Insurance Study (FIS) by detailed methods. BFEs derived from detailed hydraulic analyses are shown at selected intervals within this zone. Mandatory flood insurance purchase requirements apply.
- **Zone AH**: Area subject to inundation by 1- percent annual chance of shallow flooding (usually areas of ponding) where average depths are between one and three feet. BFEs derived from detailed hydraulic analyses are shown in this zone. Mandatory flood insurance purchase requirements and floodplain management standards apply.
- **Zone AO**: Area subject to inundation by the 1- percent annual chance of shallow flooding (usually sheet flow on sloping terrain) where average depths are between one and three feet. Average flood depths derived from detailed hydraulic analyses are shown in this zone. Mandatory flood insurance purchase requirements apply.
- **Zone D**: Area where there are possible but undetermined flood hazards, as no analysis of flood hazards has been conducted. The designation of Zone D is also used when a community incorporates portions of another community's area where no map has been prepared. Flood insurance is available in Zone D and property owners are encouraged to

purchase it. Flood insurance is not mandatory, but lenders may require flood insurance as a condition of a loan.

- **Zone V**: Area along coasts subject to inundation by the 1- percent annual chance flood event with additional hazards associated with storm-induced waves (i.e., velocity). No BFEs or flood depths are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.
- **Zone VE**: Area subject to inundation by the 1- percent annual chance flood event with additional hazards due to storm-induced velocity wave action. BFEs derived from detailed hydraulic analyses are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.
- **Zone X (Shaded)**: Area of the 0.2-percent annual chance floodplain, also known as the 500-year floodplain. Federally mandated flood insurance not required.
- **Zone X (Unshaded)**: Area of minimal flood risk, typically outside of the 500-year floodplain. Federally mandated flood insurance not required.

Figure 10-4 shows the FEMA-designated flood hazard areas for the County, overall. Maps of flood hazard areas by Community Plan Area are provided in Appendix H. Table 10-1 summarizes the land area in the 1- percent annual chance flood hazard area by Community Plan Area. Overall, Maui County has 13,919 acres, or 1.9 percent of the total Community Plan Area, designated as flood hazard areas. The Community Plan Area of Molokaʻi has the largest number of acres in flood hazard areas, totaling 5,229 acres (3.3 percent) of its area.

Figure 10-4. FEMA Flood Hazard Area

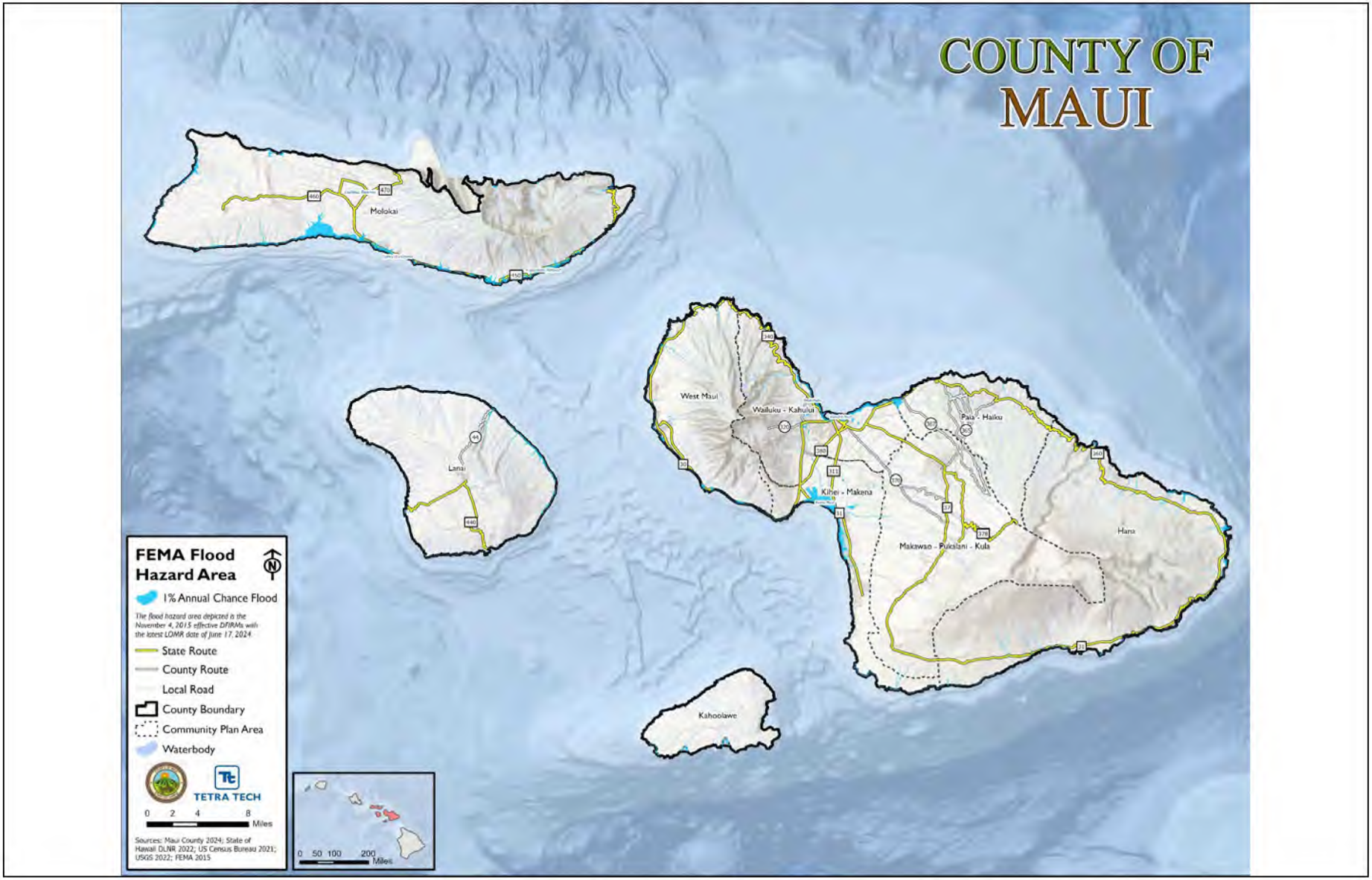


Table 10-1. Land Area in the 1 Percent Annual Chance Flood Hazard Area

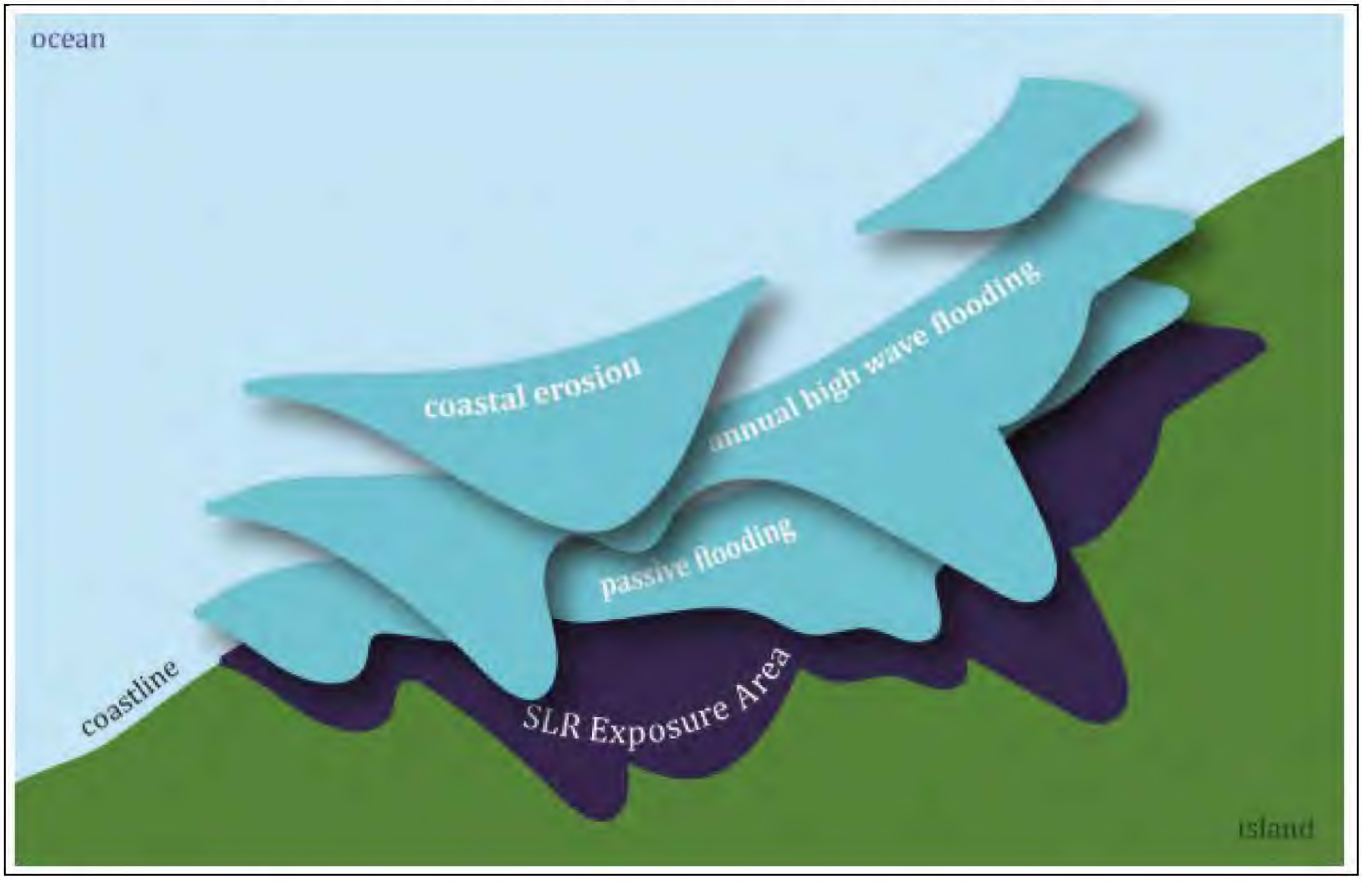
Community Plan Area	Total Land Area (Acres) Excludes Water Bodies	Land Area (Excluding Water Bodies) in the 1 Percent Annual Chance Flood Hazard Area	
		Total Area (acres)	% of Plan Area Total
Hāna	147,702	1,633	1.1%
Kahoʻolawe	28,309	333	1.2%
Kīhei-Mākena	39,848	2,545	6.4%
Lānaʻi	90,258	1,339	1.5%
Makawao-Pukalani-Kula	112,459	52	<0.1%
Molokaʻi	158,869	5,229	3.3%
Pāʻia-Haʻikū	45,978	381	0.8%
Wailuku-Kahului	57,289	1,422	2.5%
West Maui	61,271	984	1.6%
Maui County (Total)	741,983	13,919	1.9%

Source: County of Maui 2024; FEMA 2015

Sea Level Rise

In addition to FEMA FIRMs, the University of Hawaiʻi School of Ocean and Earth Science and Technology (UH SOEST) has modeled future areas of expected coastal flooding due to climate change. Chronic coastal flooding hazards, including coastal erosion, annual high wave flooding, and passive flooding due to sea level rise, were aggregated to map sea level rise hazard areas for 2030, 2050, 2075, and 2100. The footprint of these three hazards were combined to define the projected extent of chronic flooding due to sea level rise, called the sea level rise exposure area, shown in Figure 10-5. Further information can be found in the 2022 Hawai'i Sea Level Rise Vulnerability and Adaptation Report. For additional information on Sea Level Rise, please refer to Chapter 6 of this HMP.

Figure 10-5. Combined Exposure to Sea Level Rise Diagram



High Wave Flooding

The Pacific Disaster Center (PDC) has mapped shoreline susceptibility to high wave flooding, classifying high wave intensity as low, moderately low, moderately high, or high. Communities along shorelines ranked as high or very high are more susceptible to high wave flooding. Areas with high susceptibility include the northern shores of West Maui, Wailuku-Kahului, and Molokaʻi. Eastern Maui Island, Western Lānaʻi, and Western Molokaʻi are considered moderately high, while Southern Molokaʻi, Eastern Lānaʻi, and Western Maui are classified as lower intensity.

Inland Flooding

- **Hāna**—High-velocity sheet flow floods have caused road damage.
- **Kīhei-Mākena**—Flooding occurs near Wailea and Poolenalena, and near residential areas around Kalama Park, Kamaole Beach, and Lipoa Avenue. Principal streams include Kulanihakoi, Waipuilani, and Kēōkea. Flash flooding is common due to steep gradients and inadequate outlets to the sea.
- **Lānaʻi**—Floods occur on the arid west coast but pose a limited threat due to minimal coastal development.

- **Moloka‘i**—Perennial streams on the windward side of East Moloka‘i cause flooding. Major flood issues are associated with Wailaua stream and Wawaia, Kamalo, and Kawela gulches. Sheet flow flooding is common.
- **Wailuku-Kahului**—Flooding from ‘Īao Stream causes major problems. Flash flooding is a serious issue due to steep hillsides and inadequate storm drainage.
- **West Maui**—Lahaina is prone to flash floods due to steep slopes and lack of vegetation.

Coastal Flooding

- **Kīhei-Mākena**—Storm surge flooding threatens heavily developed coastal areas near Mā‘alaea, Kīhei, and Mākena. The North/South Kīhei Road is frequently flooded by coastal events.
- **All coastlines**—Coastal flooding, including surge, high wave flooding, king tides, and sea level rise, affects all coastal shorelines throughout the county.

Areas of Natural Floodplain Functions

Environmental assets are crucial when assessing flood risk and potential mitigation actions, as they can provide additional drainage or water storage capacity and offer co-benefits. For example, wetlands protect sensitive wildlife habitats while slowing and storing floodwater, and natural areas can serve both as recreation and water storage. Vegetation areas, such as forests, allow stormwater to infiltrate into the ground, reducing overall stormwater volume and the likelihood of flooding.

Maui County has many natural resources considered environmental assets, including natural beaches, forested areas with streams and waterfalls, forest reserves, wildlife sanctuaries, and parks. Wetlands, which are areas where soils are permanently or intermittently saturated, provide valuable ecological services such as water quality improvement, wildlife protection, recreation, and natural hazard mitigation. They store water during flood peaks and slowly release it downstream, reducing floodwater velocity and allowing sediments and pollutants to settle.

Protecting wetlands in their natural state through parks, open space, or nature preserves aids in flood mitigation. Wetlands are often found in floodplains and low-lying areas of a watershed. Maui County is home to various types of wetlands, including freshwater forested/shrub, emergent, riverine, lake, and pond wetlands, as well as estuarine and marine wetlands, including mangroves.

10.1.3 Extent

Floods are measured using discharge probability, which is the likelihood that a specific river discharge (flow) level will be equaled or exceeded within a given year. Flood studies rely on historical records to establish these probabilities. Although these measurements represent statistical averages, multiple low-probability floods can still occur within a short time frame. In riverine flooding, a single event can result in varying discharge probabilities at different river points.

The primary factors influencing flood damage are depth and velocity. Generally, deeper and faster-moving floodwaters cause greater damage, but shallow flooding with high velocities can be equally

destructive. Flood Insurance Rate Maps (FIRMs) illustrate the anticipated extent and depth of flooding for the base flood, with water-surface elevations corresponding to discharge levels.

The severity of a flood also depends on the land's ability to manage rainfall. Soil infiltration rates are significant; when the land is saturated, additional water flows as runoff, potentially causing flooding (Harris 2001).

Flood extent, or magnitude, can be defined by peak flow (cubic feet per second), the height of floodwaters, and damages. United States Geological Survey (USGS) stream gauge data can determine these factors. The largest peak flow recorded in Maui County was 107 cubic feet/second on Honopou Stream near Huelo along the northeast coast of Maui island.

Greater floods are possible with increasing precipitation, sea level rise due to climate change, and development pressure along coastal areas. Increasing impervious cover results in higher runoff volumes and increased flooding. Development within floodplains can raise base flood elevations and increase the number of people and properties at risk, leading to more damage, injuries, and loss of life.

Warning Time

Floods rarely occur without warning, with typical warning times ranging from 24 to 48 hours. The National Weather Service (NWS) issues flood warnings and watches, updating them as necessary and notifying the public when they are no longer in effect (HI-EMA 2023).

Coastal Flood Advisories, Warnings, and Watches

- **Coastal Flood Advisory**—Issued when minor or nuisance coastal flooding is occurring or imminent.
- **Coastal Flood Watch**—Issued when moderate to major coastal flooding is possible, posing a serious risk to life and property.
- **Coastal Flood Warning**—Issued when moderate to major coastal flooding is occurring or imminent, posing a serious risk to life and property.

Inland Flood Advisories, Watches, and Warnings

- **Flood Watch**—Indicates that heavy rain leading to flash flooding is possible. Issued up to 48 hours before expected flash flooding.
- **Flood Advisory**—Indicates that nuisance flooding is occurring or imminent. It may be upgraded to a Flash Flood Warning if conditions worsen.
- **Flash Flood Watch**—Indicates that flash flooding is possible due to causes other than heavy rain (e.g., dam or levee failure) or heavy rain on burn scars.
- **Flash Flood Warning**—Indicates that flooding is occurring or will develop quickly. Residents should take shelter or move to higher ground and avoid driving or walking across flooded roadways.

The duration of a flood event is the time between the start and end of the flood or the event that caused it. This can be difficult to define, especially for inland floods, as they recede slowly and do not vanish

completely. The duration depends on the type of flood: flash flooding occurs within six hours of a rain event, while other types of flooding may last a week or more.

High Wave and Tide Events

Warning times for high wave and tide events are available through high surf advisories and high tide advisories. The NWS Honolulu Forecast Office issues these advisories and warnings in coordination with civil defense agencies and water safety organizations in Hawai‘i (see Table 10-2). Satellite observations, numerical forecasts, and offshore wave buoys provide adequate warning for approaching high waves with damaging potential.

Table 10-2 High Surf Advisory and Warning Criteria

Location	Advisory (in feet)	Warning (in feet)
North-Facing Shores	15	25
West-Facing Shores – Island of Hawai‘i	8	12
West-Facing Shores – Remaining Islands	12	20
South-Facing Shores	10	15
East-Facing Shores	10	15

Source: (NWS n.d.)
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 Hawai‘i are based on the astronomical tide calendar, accounting for the gravitational pull of the moon and sun on the earth’s oceans. These predictions help forecast when high tide flooding and king tides may impact low-lying and coastal areas. However, impacts from king tides may be compounded by additional high-water levels, high waves, storms, and rainfall flooding, which may only be predicted days to a week prior to arrival.

10.1.4 Previous Occurrences

FEMA Disaster Declarations

Between 1954 and 2024, Maui County was included in 12 major disaster (DR) or emergency (EM) declarations for flood-related events (FEMA 2024). Table 10-3 lists these declarations.

Table 10-3. FEMA Disaster Declarations for Flood Events in Maui County

Event Date	Declaration Date	Declaration Number	Description
May 25, 1960	May 25, 1960	DR-101	Tidal Waves
April 24, 1963	April 24, 1963	DR-152	Heavy Rains & Flooding
September 13, 1968	September 13, 1968	DR-251	Heavy Rains & Flooding
February 6, 1980	February 6, 1980	DR-613	Severe Storms, High Surf & Flooding

Event Date	Declaration Date	Declaration Number	Description
April 22, 1982	April 22, 1982	DR-656	Heavy Rains & Flooding
October 28, 2000 to November 2, 2000	November 9, 2000	DR-1348	Severe Storms and Flooding
December 4, 2007 to December 7, 2007	February 6, 2008	DR-1743	Severe Storms, High Surf, Flooding, and Mudslides
March 11, 2011	April 8, 2011	DR-1967	Tsunami Waves
March 3, 2012 to March 11, 2012	April 18, 2012	DR-4062	Severe Storms, Flooding, and Landslides
September 11, 2016 to September 14, 4016	October 6, 2016	DR-4282	Severe Storms, Flooding, Landslides, and Mudslides
March 8, 2021 to March 18, 2021	May 13, 2021	DR-4604	Severe Storms, Flooding, and Landslides
December 5, 2021 to December 10, 2021	February 15, 2022	DR-4639	Severe Storms, Flooding, and Landslides

Source: (FEMA 2024)

State Emergency Proclamations

The Governor of Hawai'i may declare a state of emergency by proclamation if an emergency or disaster has occurred or there is imminent danger or threat of an emergency or disaster in any portion of the state (Hawai'i State Legislature 2020). Between 2020 and 2024, Maui County was included in three flood-related state emergency proclamations as shown in Table 10-4.

Table 10-4. State Emergency Proclamations For Flood Events in Maui County, 2020 to 2024

Declaration Date	State Proclamation Number	Description
July 26, 2020	N/A	Proclamation for Hurricane Douglas
March 9, 2021	N/A	Emergency Proclamation Related to Heavy Rains and Flooding
May 15, 2024	2024-034	Proclamation Relating to Kona Low Weather Event
August 24, 2024	2024-062	Proclamation Relating to Tropical Storm Hone

Source: (HI-EMA 2024)

USDA Declarations

Between 2020 and 2024, Maui County was not included in any USDA flood-related agricultural disaster declarations (USDA 2024).

All Recent Events

Flood events between 2020 and 2024 that impacted Maui County are like in Table 10-5. For earlier events, refer to the previous HMP.

Table 10-5. Flood Events in Maui County, 2020 to 2024

Event Date	FEMA Declaration or State Proclamation Number	Event Description
January 10, 2020	-	With plenty of moisture near the surface and unstable conditions aloft, heavy rainfall and isolated thunderstorms developed across much of the state. On January 13, the Department of Public Works reported erosion in the Kaupo at Nuanualoa Gulch due to the recent rain. On January 14, a caller reported damages to property and surrounding homes, extreme surf and rain, coastal erosion, and a flooded stream. Request to assist Hāna district posting road closed sign at Kanio junction. Request to assist Hāna district by posting road closed signage at Kanio junction. Lahaina: Sinkholes on Liloa Street, failing drainage pipes. Low impact on nearby homes. Hāna town experienced strong winds and heavy rain. Road closure with local traffic. Low impact for residents on Kana Place. On-street parking was closed due to the condition of the roadway. Low impacts to residents and travelers. Introduction of dirt and debris into storm drain system, that will make its way to the ocean. Dirt and debris on road and in storm drains.
March 2, 2020	-	An upper low north of the area and a weak surface trough passing south of the state caused downpours over portions of the island chain, and flash flooding on Maui. No serious injuries were reported. The costs of any damages were unavailable. Hāna Highway was closed between Waikoloa Road and the town of Hāna due to deep ponding on the roadway. Flooding at 156 E Aipuni Pl. due to collected surface water from Lahaina Fire Temp housing. Surface water channelized affecting 156 Aipuni and possibly other homes in the vicinity. Piilani highway Nu'u and Paihi completely washed out due to high flowing river. Introduction of dirt and debris into storm drain system, that will make its way to the ocean.
April 6, 2020	-	A weak front heading toward the islands from the northwest produced heavy showers and isolated thunderstorms. Most of the precipitation caused ponding on roadways, and small stream and drainage ditch flooding over parts of the Big Island, Maui, Oahu, and Kaua‘i. A flash flood was also reported in Kīhei in the southern section of Maui's Central Valley. However, there were no reports of significant injuries. The costs of any damages were not available. South Kīhei Road was closed near Kulanihakoi Gulch, between Wailana Place and Kulanihakoi Street, in the southern part of Maui's Central Valley because of rising water. The flood rendered a few cars inoperable. More flooding was reported along South Kīhei Road between Lipoa and Halekuai streets. 1 day of storm clean up on Kaonoulu, Kenolio, and Kamalii Piilani Hwy Mp.#29 to Mp.#16 heavy rain lead to mud crossing highway. Impacted resident in Kanaio driveways got washed out. Kaonoulu had moderate flooding and road needed to be closed impacting traffic. Affecting residents and travelers to pass. Mud and debris made it hard to pass. Dirt and debris on road and in storm drains.
April 14, 2020	-	A decaying front over the eastern part of the Aloha State, along with nearby surface and upper troughs, triggered heavy downpours and isolated thunderstorms over portions of the Big Island, Oahu, and Maui. The heavy rain caused ponding on roadways, and small stream and drainage ditch flooding. No serious injuries or property damage were reported. One landslide reported beyond Keanae at MM15. 1 lane is open. Hāna highway rock slide Mp.#46. 1 to 2 hour wait to clear slide. Dirt and Debris on road and in storm drains.

Event Date	FEMA Declaration or State Proclamation Number	Event Description
July 26, 2020	FEMA: EM-3529 State: Proclamation for Hurricane Douglas	As Hurricane Douglas was passing just north of the islands, heavy showers developed over portions of Maui and Kaua'i. The rain caused ponding on roadways, and small stream and drainage ditch flooding. No significant property damage or injuries were reported. The rain caused ponding on roadways, and small stream and drainage ditch flooding. No significant property damage or injuries were reported.
January 18, 2021	-	A cold front moving through the islands and an associated upper air trough combined to trigger heavy showers and isolated thunderstorms, including flash flooding in parts of Moloka'i, Maui, and Kaua'i. There were no reports of serious injuries. The costs of any property damage were not available. Debris (large boulders) on Honoapi`ilani Highway in West Maui near mile marker 35 caused a road closure after heavy downpours. 4 large boulders the size of washing machines blocking both lanes of traffic on Honoapi`ilani Highway between mile marker 5 and 6 and road was impassable. Power outage on Moloka'i in Kualapuu Town, Kaluakoi Area, and Kalae Area. Heavy rain caused flooding, and road closures, over portions of Kamehameha Highway V near Kamalo and Pukoo on the Island of Moloka'i.
February 18, 2021	-	A surface front stalled near Kaua'i, along with an upper trough, brought heavy rain and thunderstorms to parts of the Aloha State, and flash flooding to Kaua'i. Downpours over windward East Maui during this episode 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 Haleakalā summit. The costs of any damages were not available. A 26-year-old woman died when she was swept out to sea after the place where she was swimming near Hāna became swollen by rainwater that had fallen over the upper slopes of Haleakalā.
February 27, 2021	-	Gusty trade winds helped keep showers moving as an upper trough induced downpours from the Big Island to Oahu. The precipitation caused ponding on roadways, and small stream and drainage ditch flooding. Also, two hikers were killed in East Maui on the 27th, apparently after being swept over a falls along Waikamoi Trail into the sea. The body of one hiker had been found as of this writing, but the other was still unaccounted for. There were no significant damages reported. Two hikers went missing along the Waikamoi Trail in East Maui. As of this writing, the body of one hiker had been found, apparently swept out to sea over a waterfall in the area. The other hiker remained unaccounted for, but he likely perished as well.
March 8, 2021	FEMA: DR-4604	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. Hāna Highway was closed from Peahi Road near Ha'ikū to Keanae in windward East Maui due to flooding. A dam failure in the same area was a possibility as water topped the Kaupakulua Dam upstream from the Ha'ikū and Pauwela communities. The dam survived the downpours, however.

Event Date	FEMA Declaration or State Proclamation Number	Event Description
March 12-13, 2021	FEMA: DR-4604	Conditions remained unstable across most of the Aloha State with features aloft and at the surface west of the islands. Low level moisture continued to pool over the area, and the result was more heavy precipitation and periods of flash flooding. The costs of damages were hard to separate during the extended heavy rain event and were included in the previous episode. No significant injuries were reported. Hāna Highway in windward East Maui became impassable because of high water. Later, near Kahului, water from heavy rain was flowing into a few homes due to storm drains being overwhelmed by the downpours. Peak of flood wave occurred at Kawela Gulch on the Island of Molokaʻi.
December 5, 2021	FEMA: DR-4639	A surface front and a deep upper low, known locally as a Kona low, produced heavy and sustained showers and thunderstorms as tropical moisture was pulled north over the Aloha State. The downpours also led to instances of flash flooding. Also, 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. Flooding was reported at the Krispy Kreme in Kahului. More flooding occurred in the Wakea Business Center in Kahului, and around the Puunene Bridge. A little later, multiple homes were flooded in Maui Meadows, and a few vehicles were washed away. With deep water covering the roadway, Kamehameha V Highway became impassable near mile marker 8 on the Island of Molokaʻi. Week long clean up in Maui Meadows with multiple crews. Cleaning of flood debris and storm damage Homes and vehicles flooded. Roads and shoulders with moderate damage people not being able to stay in their homes, Roads not passable so some people were stuck in homes none
May 1, 2022	-	An upper air disturbance caused heavy showers and isolated thunderstorms. Early on in the episode, a flash flood occurred over a portion of Maui along Piilani Highway. Otherwise, the precipitation produced small stream and drainage ditch flooding, and ponding on roadways, over other parts of Maui and on the Big Island. No serious injuries were reported. Piilani Highway between mile markers 31 and 39 became impassable after heavy rain, and a culvert was washed out at the Lelekea Culvert crossing.
September 9, 2022	-	Downpours occurred over a portion of leeward Haleakalā in East Maui with afternoon heating, leading to flash flooding on the 9th. More showers developed later over parts of Oahu, Maui, and the Big Island. No serious injuries or property damage were reported. Flooding forced the closure of South Kīhei Road at Kalani Road in Kīhei on Maui. More inundation was reported near Kalama Park in the area of Waimahaihai Street and Keala Place.
November 17, 2022	-	Locally heavy rainfall nearing 2 to 4 inches per hour generated a flood threat across portions of Molokaʻi and Maui islands during the evening.

Event Date	FEMA Declaration or State Proclamation Number	Event Description
December 18, 2022	-	A strong early season cold front dropped across the state from the northwest, which generated strong and nearly stationary thunderstorms. These storms produced high rainfall rates that resulted in some flash flooding impacts. Pillani Highway was closed from the town of Kipahulu to Ulupalakua due to heavy rainfall. Additionally, in the Kaupo/Kipahulu area, the road was washed out about a mile east of Kaupo Gulch. South Kīhei Road was closed between Kulanihakoi Street and Kanoulu Street, as well as south to Kulanihakoi Street. Both Maui island hospitals lost power. – The Maui County Department of Water Supply issued a Water Conservation Request for Kaunakakai, Molokaʻi, due to the loss of the well pump that services the area caused by storm-related power outages. The estimated time to assess the situation, restore the pump, and replenish water storage levels is 72 hours. The NWS reported record daily maximum rainfall in Kahului on 12/18 and 12/19. The rain total on 12/18 in Kahului was 1.73 inches, breaking the old record set for the same day in 1964 of 0.68 inches. The rain total on 12/19 was 1.85 inches, breaking the old record for the same say of 0.91 inches set in 1982. The Maui County Department of Water Supply issued an island-wide request for water conservation, due to debris blocking intakes to multiple water treatment facilities. The estimated time to safely assess and repair damages, restore the water treatment facilities back online and replenish the diminished water storage levels to meet demand is 48 hours. Total customers without power peaked on 12/19 at around 12,000. Nuu Bridge near Kaupo washed away because of heavy rain. National Park Service officials also reported a measured wind gust of 61 knots. Barricades deployed Overtime required. Month long clean up. Multiple roads closed have significant impact on traffic. Stores and condos flooded cause water and debris damage. Sidewalk closed leading to interrupted pedestrian routes. Bus routes were unavailable for certain areas. Some businesses were not able to open due to flood damage resulting in loss of income. Some condo parking lots were full of mud impacting guest from leaving or arriving. Storm debris running from ditches into ocean
January 27, 2023	-	An extended period of deep layered moisture and moderate instability generated periods of heavy rainfall and localized flooding impacts across portions of Maui County. Flash flooding closed Pulehu Road was above the landfill, South Kīhei Road near Kulanihakoi Gulch, and Piilani Highway near Nuu. A firefighter helping to clear flood waters was swept into a storm drain and carried about 800 yards to the ocean. He succumbed to injuries on February 4, 2023. Kamehameha V Highway near Kaunakakai was closed due to flash flooding. There were rapid rises on the Kawela Gulch and the Kaunakakai Gulch stream gauges and homes were flooded in the Kawela Gulch area. Barricades deployed Overtime required. Weeks long clean up. Multiple roads closed have significant impact on traffic. Stores and condos flooded cause water and debris damage. Sidewalk closed leading to interrupted pedestrian routes. Bus routes were unavailable for certain areas. Some businesses were not able to open due to flood damage resulting in loss of income. Some condo parking lots were full of mud impacting guest from leaving or arriving. Storm debris running from ditches into ocean

Event Date	FEMA Declaration or State Proclamation Number	Event Description
January 29, 2023	-	Radar indicated heavy rain across portions of Maui County through the early morning hours. The most intense rain fell over the Wailuku and Waikapu areas with rainfall rates of one to two inches per hour over saturated ground. The Maalaea area of south Maui and the Honoapi`ilani Highway from Maalaea to Lahaina were the most vulnerable to flooding impacts, as well poor drainage areas in Wailuku and Kahului. The Honopou Stream gage on the windward Haleakalā slopes also showed rapid increase in water levels. Makawao Avenue was closed at Maliko Gulch between Kee Road and Kokomo Road. South Kīhei Road was closed due to flooding.
November 30, 2023	-	A Kona low developed west-northwest of the Hawaiian Islands and brought periods of heavy rainfall and isolated thunderstorms. Heavy rainfall led to localized flash flooding and landslides across portions of the state. Periods of heavy rainfall led to an accumulation of water on the roadways which led to the closure of Piilani highway from mile marker 29-31, as well as mile marker 16. Hāna Highway was also closed near mile marker 40.
December 1, 2023	-	A Kona low brought heavy rain to portions of the state leading to periods of flooding. This is a continuation of episode 186329 that began November 30, 2023. Hāna Highway was closed near mile marker 40. And Piilani Highway was closed near mile marker 16, and 29-31.
January 9, 2024	-	A strong cold front impacted the Hawaiian Islands and brought periods of heavy rain and gusty winds. This resulted in flooding over portions of the islands as well as wind damage. Keawe St between Honoapi`ilani Highway and Komo Mai St had standing water 6 to 8 inches deep. S Kīhei Road near Kaonoulu St was closed due to flooding on roadways. There was a road closure in both directions near the old Sudas Road near Uwapo Rd. This was due to water on the road. New repetitive loss property on Waiapo Place (prior flood claim in October 2022)
January 16, 2024	-	A cold front caused flooding and wind damage over portions of the islands. South Kīhei Road was closed between Kaonoulu and Ohukai. The west bound lanes were closed due to heavy flooding. Emergency managers reported a swift water rescue. Barricades deployed Overtime required. Month long clean up. Multiple roads closed have significant impact on traffic. Stores and condos flooded cause water and debris damage. Sidewalk closed leading to interrupted pedestrian routes. Bus routes were unavailable for certain areas. Some businesses were not able to open due to flood damage resulting in loss of income. Some condo parking lots were full of mud impacting guest from leaving or arriving. Storm debris running from ditches into ocean

Source: (NOAA 2024)

10.1.5 Probability of Future Occurrences

Probability Based on Previous Occurrences

It is anticipated that flood events will become more frequent in the future due to climate change, as extreme weather patterns, such as those associated with the El Niño-Southern Oscillation (ENSO), become more common. This increase in extreme weather events, including heavy rainfall, hurricanes, and other severe storms, will likely lead to more frequent flooding.

Table 10-6 lists the number of flood events from various sources over the period from 1996 to 2024, representing the most complete record available. Based on these records and input from the HMWG, the probability of flooding in the County is considered "frequent."

Table 10-6. Probability of Future Flood Events in Maui County

Hazard Type	Number of Occurrences Between 1996 and 2024	Percent Chance of Occurring in Any Given Year
Flash Flood	122	100%
Flood	56	100%
Total	**176**	**100%**

Source: (NOAA 2024)

Note: The time period presented in this table is the most complete period of record for the various data sources reviewed; 100% probability indicates that it is statistically likely for an event to occur every year. It does not indicate that the occurrence of an event is a certainty in any given year.

Effect of Climate Change on Future Probability

Climate projections for Maui County indicate an overall decline in rainfall; however, the county will experience an increase in heavy rain events, leading to more frequent or intense flash flooding, infrastructure damage, runoff, and sedimentation. Sea level rise is also projected, increasing the risk of coastal flooding from hurricanes and tropical storms. Event-based coastal flooding with sea level rise would expand the areas subject to flooding, particularly where streams and rivers empty into the ocean. Beach and wetland systems may not be able to adapt and could be lost, reducing the coast's ability to buffer impacts from storms and flooding (HI-EMA 2023).

10.1.6 Cascading Impacts on Other Hazards

Cascading risks due to flooding refer to a chain of interrelated effects between flooding and other hazards. Heavy rainfall from flooding can saturate steep slopes and soils, leading to landslides and mudslides that block roads, damage homes, and disrupt access to critical services. Flooding can also trigger debris flows, which are fast-moving mixtures of water, mud, and debris, causing severe damage to structures, roads, and agricultural land, particularly in mountainous areas.

Additionally, flooding can cause significant erosion of riverbanks and coastal areas, leading to loss of land and damage to properties, undermining foundations, threatening coastal roads, and degrading natural habitats such as beaches and coral reefs. In some cases, areas that experience severe flooding can subsequently face increased fire risk due to dead vegetation left behind as floodwaters recede, creating a cycle of alternating flooding and fire hazards. Flooding can also compound other natural hazards, such as earthquakes, or tsunamis.

Hazardous material spills are also a secondary effect of flooding if storage tanks rupture and spill into streams, rivers, or storm drains. The release of hazardous materials into flood waters can expose people, wildlife, and ecosystems to substances that are harmful to health, safety, and water quality. Finally, lithium-ion batteries and electric vehicles can catch fire when exposed to flood conditions, creating dangerous conditions for survivors and first responders.

10.1.7 National Flood Insurance Program Compliance

This section provides specific information on the management and regulation of the regulatory floodplain, including current and future compliance with the National Flood Insurance Program (NFIP). The floodplain administrator is responsible for maintaining this information. For additional information regarding the NFIP, see Chapter 18, Section 18.8 (NFIP and CRS Capabilities).

NFIP Statistics and Repetitive Loss and Severe Repetitive Loss Properties

In the realm of flood insurance, certain properties stand out due to their unfortunate history of repeated flood damage. These properties are categorized as Repetitive Loss (RL) and Severe Repetitive Loss (SRL) properties under the NFIP.

The NFIP defines RL properties as structures that meet one of the following qualifiers (FEMA 2022):

- Two or more claims of more than $1,000 paid by NFIP within any rolling 10-year period, since 1978.
- Two or more claims (building payments only) that, on average, equal or exceed 25 percent of the market value of the property.

On the other hand, SRL properties are defined as structures that meet one of the following qualifiers (FEMA 2022):

- Incurred four or more separate flood-related claims payments, each exceeding $5,000, or
- Experienced two or more separate claims where the total payments exceed the current value of the property, with at least two of these claims occurring within a 10-year period

The county's floodplain manager provided repetitive loss data as of 2024 (most up-to-date list available). The data showed 35 unmitigated repetitive loss properties in Maui County (three former repetitive loss properties have been mitigated). Table 10-7 summarizes the NFIP policy and claim statistics for Maui County.

Table 10-7. Maui County NFIP Summary of Policy and Claim Statistics

# New Policies since 2021	2,110
# Claims (Losses)	346
Total Loss Payments	$10,721,891
# Repetitive Loss Properties (NFIP definition)	35
# Repetitive Loss Properties (FMA definition)	0
# Severe Repetitive Loss Properties (NFIP definition)	4

Source: (FEMA 2025)

NFIP Definition of Repetitive Loss: The NFIP defines a repetitive loss property as any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period since 1978.

FMA Definition of Repetitive Loss: FEMA's Flood Mitigation Assistance (FMA) program defines a repetitive loss property as any insurable building that has incurred flood-related damage on two occasions, in which the cost of the repair, on average, equaled or exceeded 25 percent of the market value of the structure at the time of each such flood event.

Definition of Severe Repetitive Loss: A residential property covered under an NFIP flood insurance policy and: (a) That has at least four NFIP claim payments over $5,000 each, and the cumulative amount of such claims payments exceeds $20,000; or (b) For which at least two separate claims payments have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building. At least two of the claims must have occurred within any 10-year period, more than 10 days apart.

Pre-FIRM and Post-FIRM

When discussing flood insurance through FEMA's National Flood Insurance Program (NFIP), it's essential to understand the distinction between pre-FIRM and post-FIRM buildings. This classification significantly impacts insurance rates and requirements.

Pre-FIRM buildings are those constructed before the community's first Flood Insurance Rate Map (FIRM) was issued. These structures often do not meet current floodplain management regulations, making them eligible for subsidized flood insurance rates. On the other hand, post-FIRM buildings are those built after the issuance of the first FIRM. These buildings must comply with contemporary floodplain management regulations, which typically means they are designed to be more resistant to flood damage. Consequently, their flood insurance rates are based on the building's adherence to these regulations.

Table 10-8 and Table 10-9 provide a detailed pre-FIRM and post-FIRM insurance summary for Maui County.

Table 10-8. Pre-FIRM Insurance, Maui County

	Policies in Force	Premium	Insurance in Force	Number of Closed Paid Losses	$ of Closed Paid Losses	Adjustment Expense
A01-30 & AE Zones	3,352	$2,441,038	$794,498,000	122	$1,660,302.22	$129,475.92
A Zones	63	$62,922	$13,968,000	66	$737,646.79	$94,207.95
AO Zones	57	$74,397	$14,807,000	22	$408,010.96	$17,063.39
AH Zones	102	$176,080	$27,692,000	25	$555,899.07	$47,522.72
AR Zones	0	$0	$0	0	$0.00	$0.00
A99 Zones	0	$0	$0	0	$0.00	$0.00
V01-30 & VE Zones	616	$1,008,668	$123,486,000	99	$3,181,895.57	$367,994.34
V Zones	0	$0	$0	0	$0.00	$0.00
D Zones	0	$0	$0	0	$0.00	$0.00
B, C & X Zones	3,348	$1,633,217	$788,909,000	116	$2,435,738.85	$298,549.29
Standard	3,348	$1,633,217	$788,909,000	92	$1,593,869.91	$236,675.51
Preferred	0	$0	$0	26	$844,767.76	$62,273.78
Grand Total	7,538	$5,396,322	$1,763,360,000	450	$8,979,493.46	$954,813.61

Source: FEMA CIS 2024

Table 10-9. Post-FIRM Insurance, Maui County

	Policies in Force	Premium	Insurance in Force	Number of Closed Paid Losses	$ of Closed Paid Losses	Adjustment Expense
A01-30 & AE Zones	757	$463,472	$195,861,000	34	$236,138.27	$47,963.92
A Zones	4	$11,716	$1,313,000	7	$13,505.00	$3,000.00
AO Zones	26	$38,720	$6,914,000	5	$179,318.96	$7,095.18
AH Zones	27	$45,299	$7,138,000	9	$54,521.13	$5,765.00
AR Zones	0	$0	$0	0	$0.00	$0.00
A99 Zones	0	$0	$0	0	$0.00	$0.00
V01-30 & VE Zones	16	$33,747	$4,627,000	6	$2,185.85	$2,305.00
V Zones	0	$0	$0	0	$0.00	$0.00
D Zones	0	$0	$0	0	$0.00	$0.00
B, C & X Zones	1,965	$984,159	$518,887,000	63	$923,307.84	$74,191.27
Standard	1,965	$984,159	$518,887,000	34	$327,507.54	$34,939.98
Preferred	0	$0	$0	30	$595,800.30	$39,476.29
Grand Total	2,795	$1,577,113	$734,740,000	124	$1,408,977.05	$140,320.37

Source: FEMA CIS 2024

Flood Vulnerability Summary

Table 10-10 provides a comprehensive overview of flood vulnerability in Maui County, highlighting areas prone to flooding, the status of RL properties, and the county's efforts in floodplain management and mitigation.

Table 10-10. NFIP Summary

NFIP Topic	Comments
Flood Vulnerability Summary	
Describe areas prone to flooding.	Kīhei – Each year Kīhei experiences extensive flooding resulting in road closures and damage to County infrastructure. Inundation of muddy waters in the low-lying areas results in ponding along sand dunes. There are 17 RL areas: 2 in Zone VE; 5 in Zone AE; 6 in Zone AH; and 4 in Zone X. Kahului – There is one RL area in Zone X. This area is at a dead-end road with no natural drainage out. The County has installed pumps that are used following storms. Lahaina – There are 10 RL areas; 5 areas are within Zone X. The most frequently flooded area is within Zone X, but those structures were destroyed in the 2023 Lahaina wildfire. Wailuku – Two RL areas, one in floodway and one in Zone X.
Does the County maintain a list of properties that have been damaged by flooding?	The repetitive loss list (last received June 2024) has 35 RL properties and 7 mitigated properties.
Does the County maintain a list of property owners interested in flood mitigation?	No
Are any RiskMAP projects currently underway?	FEMA Advisory BFE mapping efforts in Lahaina affected by wildfires.

NFIP Topic	Comments
How does the County make Substantial Damage determinations?	Substantial improvements or substantial damage is determined based on a cumulative cost worksheet for all improvements over a ten-year period.
How many Substantial Damage determinations were declared for recent flood events in the community?	Approximately 220 structures within the SFHA were destroyed in the 2023 Lahaina Wildfire.
How many properties have been mitigated (elevation or acquisition) in the community?	Four properties on the repetitive loss list have been mitigated and removed from the list because the four structures were destroyed in the 2023 Lahaina Wildfire.
Do current flood hazard maps adequately address the flood risk within the community?	No, the FIRM does not show all high flood risk areas, particularly for low-lying flood-prone areas from smaller drainage areas.
NFIP Compliance	
What local department is responsible for floodplain management?	Department of Public Works, Engineering Division.
Are any certified floodplain managers (CFMs) on staff?	No CFMs are working on the Flood Program.
Does the County have access to resources to determine possible future flooding conditions from climate change?	State of Hawai'i Sea Level Rise Viewer
Does the floodplain management staff need any assistance or training to support its floodplain management program? If so, what type of assistance/training is needed?	Yes, assistance or training of floodplain management staff is needed. Training is needed for flood development permit compliance, particularly for items with minimal FEMA guidelines such as non-residential structures. The lack of specific requirements or conflicts with other County requirements (building code or utilities) makes it difficult to regulate.
Provide an explanation of NFIP administration services the County provides (e.g., permit review, GIS, education/outreach, inspections, engineering capability)	Permit reviews are conducted for flood development, building, grading, construction, and roadway permits, as well as for subdivision plat reviews and agricultural building exemptions. Public requests for FIRM information, elevation certificates, or flood mitigation information. Hydraulic modeling technical reviews are provided for Letter of Map Revision (LOMR) and new flood mapping or base flood data provided by a federal or state agency or other sources.

NFIP Topic	Comments
How does the County determine if proposed development on an existing structure would qualify as a substantial improvement?	A substantial improvement refers to any repair, replacement, reconstruction, rehabilitation, addition, or series of such actions, or new development of a structure, or repetitive loss of a structure within the ten-year period preceding the proposed improvement, but no earlier than September 25, 2009. The cumulative cost must equal or exceed fifty percent of the market value of the structure, excluding land. For each improvement, the director must calculate the percentage of the cost of improvement divided by the market value of the structure, excluding land, on the flood development permit application. The cumulative total of these percentages must exceed fifty percent for the improvements to be considered substantial. This term includes structures that have incurred substantial damage, regardless of the actual repair work performed. An improvement is considered substantial if: 1. The structure was constructed on or before June 1, 1981. 2. The structure was constructed after June 1, 1981, and was not within a special flood hazard area at the time the building permit was issued. 3. The structure was constructed after June 1, 1981, and was subject to a map change resulting in higher base flood elevations. 4. The structure was constructed after June 1, 1981, and was subject to a map change resulting in a FIRM zone change. Exceptions to substantial improvement include: 1. Projects to correct existing violations of State or County health, sanitary, or safety specifications. 2. Alterations of historic structures that do not preclude their continued designation as historic structures.
What are the barriers to running an effective NFIP program in the community, if any?	The Flood Program continues to be understaffed. Overall, the Flood Program needs to be modified so that it can be effectively managed with a minimal number of staff. A comprehensive, centralized document and mapping system is needed for NFIP and CRS compliance. This would enable records to be stored by structure (rather than parcel or address) and provide NFIP administration services efficiently.
Does the County have any outstanding NFIP compliance violations that need to be addressed? If so, state the violations.	There are 8 remaining properties on the Community Assistance Visit (CAV) list initiated in 2011. The County waited for responses by FEMA since 2018. In November 2024, FEMA and the County began working to resolve the remaining properties and have three outstanding issues to address. There are 35 properties on the National Violations Tracker list and updated elevation certificates are being provided to show NFIP compliance.

NFIP Topic	Comments
When was the most recent Community Assistance Visit (CAV) or Community Assistance Contact (CAC)?	The last CAV was initiated in 2011. Updated CAV list and status provided 11/14/2024. CAV Audit: 616 permits in SFHA provided to DLNR. 103 were randomly selected for review. Turned over to FEMA on 2/26/2014. 8 items remain outstanding.
What is the local law number of the flood damage prevention ordinance and date last amended?	Title 16, Chapter 16.29 (Ord. 5603 passed 1/26/2024, effective September 1, 2024)
Does the floodplain management program meet or exceed minimum requirements? If exceeds, in what ways?	Yes, the floodplain management program exceeds NFIP minimum requirements. Requires one-foot freeboard for the lowest floor and machinery and equipment in the SFHA. SI/SD based on cumulative costs over 10-year period. Enclosure limits for V zones. Requires compensatory storage for A zones without floodway. The County enforces stormwater management regulations. Areas of a structure below the base flood elevation may be used for parking vehicles, storage, or access to the building, but not for human habitation. For these areas that are five feet or more in height as measured from any point within these areas, the property owner must enter into a "non-conversion agreement for construction within flood hazard areas" with the County. The agreement must be in a form acceptable to the director and will be recorded with the bureau of conveyances or land court as a deed restriction.
Are there other local ordinances, plans or programs (e.g., site plan review) that support floodplain management and meeting the NFIP requirements? For instance, does the planning board or zoning board consider efforts to reduce flood risk when reviewing variances such as height restrictions?	The flood ordinance allows exceptions to height restrictions up to 5 feet for elevation required by flood ordinance requirements. Ordinance 429.2 Site Criteria for Safe Rooms: Residential safe rooms must not be constructed in areas subject to stream flooding, coastal flooding, or dam failure inundation, including: 1. FEMA Special Flood Hazard Areas (SFHA) subject to rainfall runoff or stream/flash flooding. 2. Coastal zones "V" or "A" identified in FEMA FIRMs, subject to tides, storm surge, waves, tsunamis, or a combination of these hazards. 3. Areas subject to dam failure inundation as determined by the Department of Land and Natural Resources.
Does the community plan to join the CRS program or is the community interested in improving its CRS classification?	Maui County joined the CRS program in 1995 and has maintained a Class 7 rating since 2018. There are no plans to improve classification because the County currently does not meet the minimum prerequisites for Class 6.

10.2 VULNERABILITY AND IMPACT ASSESSMENT

To assess Maui County's risk to the flood hazard, a spatial analysis was conducted using FEMA flood data (effective November 4, 2015). To determine what assets are exposed to flooding, the asset inventories prepared for this HMP (population, buildings, critical facilities) were overlaid with the 1 percent annual chance flood hazard area. Assets with their centroid located in the hazard areas were

totaled to estimate the numbers and values at risk from the impacts of flood. These results are summarized below. To estimate potential losses associated with flood, a Level 2 Hazus riverine flood analysis was performed using asset inventories prepared for this HMP and the 1 percent annual chance flood hazard area flood depth grid.

10.2.1 Life, Health, and Safety

The public often underestimates the dangers presented by floodwaters. Flooding can localize to specific parts of a community, such as certain roads, intersections, or neighborhoods, making buildings and facilities inaccessible. Entire communities can become isolated due to floodwaters, posing significant dangers when motorists and pedestrians attempt to traverse them. Vehicles and individuals can be swept away by flood currents, increasing the risk of drowning. Even shallow, fast-moving waters can carry people or vehicles into deeper areas, where the pressure from flowing water can trap drivers in submerged vehicles. Floodwaters often conceal hazards like electrical wires, debris, nails, and open manholes, and can weaken roads and bridges, making them unsafe for travel.

Overall Population

Flooding in Maui County has led to small-scale evacuations and swift water rescues. Larger-scale evacuations may be necessary during severe storms, such as hurricanes, tropical storms, or Kona storms. Visitors to Maui, unfamiliar with evacuation routes, may face additional risks. Communities can mitigate these risks through exercises and road markers to familiarize residents and visitors with evacuation procedures. Floodwaters often contain contaminants like bacteria and chemicals, leading to combined sewer overflows and sewage in floodwaters. Individuals traversing or playing in floodwaters risk contracting diseases, injuries, and infections. Contaminated floodwaters can also affect drinking water sources and increase the likelihood of waterborne diseases. Stagnant water and saturated grounds can lead to mosquito-borne diseases, while rats and other animals can carry viruses and diseases. Structures exposed to floodwaters may present public health hazards, including damaged electrical systems, natural gas tanks, and mold growth. Floodwaters can also make food unsafe for consumption, carrying disease-causing bacteria, dirt, oil, waste, and chemicals. Power failures during floods can damage stored food, making it unsafe to eat.

To estimate population exposure to the 1-percent annual chance flood events, the DFIRM flood boundaries were used. Based on the spatial analysis, there are an estimated 7,657 residents living in the Special Flood Hazard Area (SFHA, or 1-percent annual chance floodplain), or 4.7-percent of the County's total population. The Community Plan Area of Kīhei-Mākena has the greatest number of residents living in the 1-percent annual chance flood hazard area with approximately 1,731 residents, or 9.4-percent of the Community Plan Area total. Table 10-11 summarizes the population exposed to the flood hazard by Community Plan Area.

Table 10-11. Estimated Population Exposed to the 1-Percent Annual Chance Flood Hazard Area

Community Plan Area	Total Population (2023 ACS)	Population in the 1-Percent Annual Chance Flood Hazard Area	
		Number of Persons	% of Plan Area Total
Hāna	2,135	104	4.9%
Kīhei-Mākena	29,174	2,731	9.4%
Lānaʻi	3,333	5	0.2%
Makawao-Pukalani-Kula	24,505	0	0.0%
Molokaʻi	8,092	1,351	16.7%
Pāʻia-Haʻikū	17,037	121	0.7%
Wailuku-Kahului	58,606	2,010	3.4%
West Maui	21,749	1,335	6.1%
Maui County (Total)	164,632	7,657	4.7%

Source: U.S. Census Bureau 2023 ACS; FEMA 2015

Socially Vulnerable Population

Research indicates that certain populations, while not necessarily facing greater hazard exposure, may suffer more severe impacts and experience longer recovery times when affected by flooding. This heightened vulnerability is often due to factors such as physical and financial limitations that hinder their ability to respond effectively during a disaster.

Among those at risk, the economically disadvantaged and individuals over the age of 65 are particularly vulnerable. Economically disadvantaged populations may base their evacuation decisions on the potential economic impact on their families, making them less likely to evacuate promptly. Meanwhile, older adults are more likely to require medical attention, which may be inaccessible during a flood due to isolation, and they may face greater challenges in evacuating safely.

Table 10-12 presents the estimated socially vulnerable populations living in the 1-percent annual chance flood hazard areas by Community Plan Area. In Maui County, there are 1,551 persons over the age of 65 years, 387 persons under the age of 5 years, 256 non-English speakers, 893 persons with a disability, and 822 living in poverty located in the 1-percent annual chance flood hazard area.

Table 10-12. Estimated Vulnerable Populations in the 1-Percent Annual Chance Flood Hazard Area

Community Plan Area	Estimated Number of Vulnerable Persons Located in the 1-Percent Annual Chance Flood Hazard Area									
	Persons Over 65	% of Total	Persons Under 5	% of Total	Non-English Speaking Persons	% of Total	Persons with a Disability	% of Total	Persons in Poverty	% of Total
Hāna	27	4.8%	5	4.9%	1	2.5%	11	4.7%	16	4.8%
Kīhei-Mākena	572	9.4%	124	9.3%	79	9.3%	294	9.3%	271	9.3%
Lānaʻi	1	0.1%	0	0.0%	0	0.0%	1	0.2%	0	0.0%

Community Plan Area	Estimated Number of Vulnerable Persons Located in the 1-Percent Annual Chance Flood Hazard Area									
	Persons Over 65	% of Total	Persons Under 5	% of Total	Non-English Speaking Persons	% of Total	Persons with a Disability	% of Total	Persons in Poverty	% of Total
Makawao-Pukalani-Kula	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Molokaʻi	287	16.6%	59	16.6%	9	15.4%	232	16.6%	248	16.6%
Pāʻia-Haʻikū	20	0.7%	8	0.7%	1	0.6%	10	0.7%	13	0.7%
Wailuku-Kahului	395	3.4%	101	3.4%	109	3.4%	221	3.4%	147	3.4%
West Maui	249	6.1%	90	6.1%	57	6.1%	124	6.1%	127	6.1%
Maui County (Total)	1,551	4.7%	387	4.3%	256	4.2%	893	5.1%	822	5.1%

Source: U.S. Census Bureau 2023 ACS Vulnerable Population Totals; FEMA 2015

Flood events can have devastating impacts on communities, often leading to the displacement of residents and the need for emergency shelter. Table 10-13 provides an overview of the number of individuals displaced or seeking shelter as a result of flood events by Community Plan Area. In Maui County, it is projected that flooding will displace approximately 5,044 individuals, with 1,408 of them requiring short-term shelter. The Kīhei-Mākena Community Plan Area is expected to have the highest number of displaced persons, totaling 2,134. Meanwhile, the Wailuku-Kahului area will have the highest number of individuals seeking short-term shelter, with an estimated 466 persons.

Table 10-13. Persons Displaced or Seeking Short-Term Sheltering Due to 1-Percent Annual Chance Flood

Community Plan Area	Total Population (2023 ACS)	1-Percent Annual Chance Flood Impacts on People	
		Displaced Population	Persons Seeking Short-Term Sheltering
Hāna	2,135	62	41
Kīhei-Mākena	29,174	2,134	431
Lānaʻi	3,333	5	0
Makawao-Pukalani-Kula	24,505	0	0
Molokaʻi	8,092	1,094	217
Pāʻia-Haʻikū	17,037	37	18
Wailuku-Kahului	58,606	1,062	466
West Maui	21,749	650	235
Maui County (Total)	164,632	5,044	1,408

Source: U.S. Census Bureau 2023 ACS; FEMA 2015; Hazus v6.1

10.2.2 General Building Stock

All current and future buildings and infrastructure, including critical facilities, are at risk of flooding in Maui County. Floods can impact both coastal and inland areas, with riverine, sheet flow, urban flooding, and flash flooding affecting inland regions, while coastal flooding can result from high waves, King Tides, sea level rise, and storm surge.

Structures exposed to flooding can suffer severe damage, including loss or destruction of building contents and compromised foundations due to water pressure. Coastal floods can batter structures and erode soils, undermining foundations. Post-flood, wooden structures may rot, and mold can develop within 24 to 48 hours, posing significant health risks and requiring costly treatment. Buildings constructed before the County's FIRM implementation in 1981 may be more vulnerable due to their location in flood-prone areas and outdated building codes.

The potential damage is the modeled loss that could occur to the exposed inventory, including structural and content replacement cost values. Table 10-14 summarizes these results for Maui County. There are 2,336 buildings located in the 1-percent annual chance flood hazard area with an estimated $4.3 billion of replacement cost value (i.e., building and content replacement costs). In total, this represents approximately 5.1 percent of the County’s total general building stock inventory.

The Hazus flood model estimated potential damages to the buildings in Maui County at the structure level using the custom structure inventory developed for this HMP and the depth grid generated using the effective DFIRM data. The potential damage estimated by Hazus to the general building stock inventory associated with the 1-percent annual chance flood is approximately $2.2 billion or 4.3 percent of the total building replacement cost value. The Community Plan Area of West Maui has the greatest estimated building loss—approximately $763.2 million (8.6 percent of the total replacement cost value). Refer to Table 10-15 for the estimated losses by Community Plan Area, which also shows the estimated losses for residential, commercial, and other occupancy structures, respectively.

Table 10-16 displays the buildings by general occupancy located within the 1-percent annual chance flood hazard areas. The Community Plan Area of Kīhei-Mākena has the highest number of residential buildings (621), commercial buildings (157), and government, religious, agricultural, and educational buildings (14). Meanwhile, Wailuku-Kahului has the highest number of industrial buildings (48).

Table 10-14. Buildings in the 1-Percent Annual Chance Flood Hazard Area

Community Plan Area	Community Plan Area Total Buildings		Buildings in the 1-Percent Annual Chance Flood Hazard Area			
			Number of Buildings		Replacement Cost Value	
	Count	Replacement Cost Value	Count	% of Plan Area Total	Value	% of Plan Area Total
Hāna	930	$741,266,476	45	4.8%	$20,235,408	2.7%
Kīhei-Mākena	7,613	$11,692,760,990	811	10.7%	$1,638,245,134	14.0%
Lānaʻi	1,258	$1,012,846,136	4	0.3%	$7,823,940	0.8%
Makawao-Pukalani-Kula	8,868	$6,037,317,698	0	0.0%	$0	0.0%
Molokaʻi	3,056	$2,384,451,998	525	17.2%	$433,977,352	18.2%
Pāʻia-Haʻikū	4,316	$2,686,054,376	50	1.2%	$62,136,430	2.3%
Wailuku-Kahului	15,444	$18,302,375,352	627	4.1%	$1,154,454,911	6.3%
West Maui	4,063	$8,896,487,618	274	6.7%	$1,076,677,618	12.1%
Maui County (Total)	45,548	$51,753,560,644	2,336	5.1%	$4,393,550,793	8.5%

Source: USACE NSI 2022; Hawaiʻi Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; RSMeans 2024; FEMA 2015

Table 10-15. 1-Percent Annual Chance Flood Impacts on Buildings

Community Plan Area	Total Replacement Cost Value (RCV)	1-Percent Annual Chance Flood Impacts on Buildings				
		Estimated Loss for All Occupancies	Percent of Total	Estimated Loss for Residential Properties	Estimated Loss for Commercial Properties	Estimated Loss for All Other Occupancies
Hāna	$741,266,476	$5,788,307	0.8%	$3,817,773	$0	$1,970,534
Kīhei-Mākena	$11,692,760,990	$573,188,036	4.9%	$404,445,211	$136,817,447	$31,925,377
Lānaʻi	$1,012,846,136	$7,823,940	0.8%	$386,089	$7,437,851	$0
Makawao-Pukalani-Kula	$6,037,317,698	$0	0.0%	$0	$0	$0
Molokaʻi	$2,384,451,998	$428,001,875	17.9%	$197,445,491	$175,707,295	$54,849,089
Pāʻia-Haʻikū	$2,686,054,376	$43,941,652	1.6%	$17,035,866	$19,562,501	$7,343,284
Wailuku-Kahului	$18,302,375,352	$411,182,279	2.2%	$129,969,921	$186,561,598	$94,650,759
West Maui	$8,896,487,618	$763,198,838	8.6%	$688,643,497	$73,714,155	$841,186
Maui County (Total)	$51,753,560,644	$2,233,124,926	4.3%	$1,441,743,849	$599,800,847	$191,580,230

Source: USACE NSI 2022; Hawai'i Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; FEMA 2015; Hazus v6.1; RSMeans 2024

Table 10-16. Buildings in the 1-Percent Annual Chance Flood Hazard Area by General Occupancy Class

Community Plan Area	Buildings in the 1-Percent Annual Chance Flood Hazard Area by Occupancy Class			
	Residential	Commercial	Industrial	Other[a]
Hāna	41	2	0	2
Kīhei-Mākena	621	158	18	14
Lānaʻi	2	2	0	0
Makawao-Pukalani-Kula	0	0	0	0
Molokaʻi	472	40	9	4
Pāʻia-Haʻikū	28	20	1	1
Wailuku-Kahului	453	115	48	11
West Maui	217	51	1	5
Maui County (Total)	1,834	388	77	37

Source: USACE NSI 2022; Hawaiʻi Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; FEMA 2015

a. Other = Government, Religion, Agricultural, and Education

Insurance Occupancy Table

Table 10-17 and Table 10-18 provide a detailed breakdown of flood insurance data for different types of properties in Maui County.

Table 10-17. Insurance Occupancy - Residential, Maui County

	Policies in Force	Premium	Insurance in Force	Number of Closed Paid Losses	$ of Closed Paid Losses	Adjustment Expense
Single Family	1,180	$1,130,195	$349,153,000	338	$4,205,718.61	$309,846.94
2-4 Family	354	$340,528	$88,128,000	32	$300,908.85	$19,061.94
All Other Residential	9,095	$4,772,346	$2,067,233,000	189	$5,080,064.02	$720,039.69
Non-Residential	239	$899,612	$124,972,000	72	$1,138,797.91	$63,775.59
Total	**10,868**	**$7,142,681**	**$2,629,486,000**	**631**	**$10,725,489.39**	**$1,112,724.15**

Source: FEMA CIS 2024

Table 10-18. Insurance Occupancy – Condos, Maui County

	Policies in Force	Premium	Insurance in Force	Number of Closed Paid Losses	$ of Closed Paid Losses	Adjustment Expense
Condo	9,436	$5,079,750	$2,145,371,000	156	$4,967,665.95	$719,215.76
Non Condo	1,432	$2,062,931	$484,115,000	475	$5,757,823.44	$393,508.39
Total	**10,868**	**$7,142,681**	**$2,629,486,000**	**631**	**$10,725,489.39**	**$1,112,724.15**

Source: FEMA CIS 2024

10.2.3 Community Lifelines and Other Critical Facilities

Critical services during and after a flood event may not be available if critical facilities are directly damaged or transportation routes to access these critical facilities are impacted. Roads that are blocked or damaged can isolate residents and can prevent access throughout the planning area to many service providers needing to get to vulnerable populations or to make repairs. Utilities such as overhead power, cable, and phone lines could also be vulnerable due to utility poles damaged by standing water or the surge of water from a storm event.

Table 10-19 summarizes the number of community lifelines exposed to the 1-percent annual chance flood hazard area by Community Plan Area. Of the 40 community lifelines located in the 1-percent annual chance flood hazard area, the majority of these are Water Systems facilities (14). The Community Plan Area of Wailuku-Kahului has the highest number of facilities (18) in this hazard area.

10.2.4 Economy

Flood events can have extensive impacts in Maui County. Flood losses occur directly due to damaged structures and infrastructure. Estimating flood damage to businesses is challenging, as floods often force businesses to close, resulting in lost inventories, inaccessible locations for customers, and employees focusing on protecting or cleaning up their flooded homes. Business disruptions can occur even if the business is not located in the floodplain, as customers and clients may be unable to reach them. This interruption leads to forgone sales and tourism taxes for the county. According to the Hawai‘i Climate Change Mitigation and Adaptation Commission 2017 report, potential economic losses (including all structures and land) across the island could increase from an estimated $4.1 billion with 1.1 feet of sea level rise to $12.9 billion with 3.2 feet of sea level rise (HCCMAC 2017).

Table 10-19. Number of Facilities in 1-Percent Annual Chance Flood Hazard Area, by Lifeline Category

Community Plan Area	Number of Facilities in 1-Percent Annual Chance Flood Hazard Area, by Lifeline Category									Total Facilities in Hazard Area	
	Communications	Energy	Food, Hydration, Shelter	Hazardous Materials	Health & Medical	Safety & Security	Transportation	Water Systems	Other Critical Facilities	Count	% of Plan Area Total
Hāna	0	0	0	0	0	0	0	0	1	1	7.7%
Kīhei-Mākena	1	0	1	0	2	1	0	5	1	11	32.4%
Lānaʻi	0	0	0	0	0	0	0	0	0	0	0.0%
Makawao-Pukalani-Kula	0	0	0	0	0	0	0	0	0	0	0.0%
Molokaʻi	1	0	1	0	2	1	0	0	0	5	16.7%
Pāʻia-Haʻikū	0	1	0	0	0	1	0	0	0	2	14.3%
Wailuku-Kahului	0	0	0	0	0	2	7	7	2	18	17.6%
West Maui	0	0	0	0	0	1	0	2	0	3	7.5%
Maui County (Total)	2	1	2	0	4	6	7	14	4	40	14.5%

Source: Hawai'i Emergency Management Agency 2017; FEMA 2015

Additionally, public expenditures on flood fighting, sandbags, fire department calls, clean-up, and repairs to damaged public property affect all residents, not just those in the floodplain.

Debris management may also be a large expense after a flood event. Hazus-MH estimates the amount of debris generated from the 1-percent annual chance event. The model breaks down debris into three categories: (1) finishes (drywall, insulation, etc.); (2) structural (wood, brick, etc.) and (3) foundations (concrete slab and block, rebar, etc.). The distinction is made because of the different types of equipment needed to handle the debris. Table 10-20 summarizes the debris estimates for these events. During a 1-percent annual chance event, an estimated 1,629 tons of debris will be generated in total.

Table 10-20. Estimated Debris Created During the 1-Percent Annual Chance Flood Event

Community Plan Area	Estimated Debris Created During the 1-Percent Annual Chance Flood Event			
	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Hāna	32	29	2	1
Kīhei-Mākena	365	362	1	1
Lānaʻi	7	7	0	0
Makawao-Pukalani-Kula	0	0	0	0
Molokaʻi	499	499	0	0
Pāʻia-Haʻikū	17	17	0	0
Wailuku-Kahului	189	180	5	4
West Maui	521	476	34	12
Maui County (Total)	1,629	1,569	42	18

Source: USACE NSI 2022; Hawai'i Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; FEMA 2015; Hazus v6.1

10.2.5 Natural, Historic and Cultural Resources

Natural Resources

Environmental resources are invaluable to both the environment and the economy. Coral reefs and wetlands, for instance, provide essential coastal buffers that protect against wave and flood impacts. However, flooding can have several adverse effects on the natural environment, including:

- Beach erosion
- Loss or submergence of wetlands and other coastal ecosystems
- Saltwater intrusion
- Elevated water tables
- Loss of coastal recreation areas, beaches, protective sand dunes, parks, and open spaces
- Damage to coastal structures such as sea walls, piers, bulkheads, bridges, and buildings

Flash floods often lead to increased sediment deposition in nearshore environments, which negatively impacts coral reefs through sedimentation and stormwater runoff. Critical habitats, wetlands, parks, and reserves are particularly vulnerable to event-based flooding, which can disrupt ecosystems and threaten endangered or threatened species (HI-EMA 2023).

Historic Resources

Flooding can cause significant damage to historic buildings, monuments, and archaeological sites. Water intrusion, erosion, and mold growth can deteriorate structures made from traditional materials, such as wooden buildings or stone walls. Floods can wash away or bury archaeological sites containing important artifacts and historical evidence, making it difficult or impossible to recover or study them.

Cultural Resources

Flooding in Maui County can significantly impact cultural resources and sites. Floodwaters can cause erosion, leading to the loss of soil and destabilization of structures, which damages archaeological sites, historic buildings, and other cultural landmarks. Burial sites, particularly those of Native Hawaiians, can be disturbed, exposing or displacing human remains that hold significant cultural and spiritual importance.

Additionally, artifacts and historical records stored in museums or archives may be damaged or destroyed if not adequately protected against flooding. Environmental changes caused by flooding, such as alterations in vegetation or water flow, can affect traditional agricultural practices and the availability of natural resources used in cultural rituals.

Furthermore, flooding can make cultural sites inaccessible, hindering cultural practices and the ability to maintain and preserve these sites. Efforts to mitigate these impacts include improving flood management infrastructure, conducting regular assessments of vulnerable sites, and involving local communities in preservation efforts.

10.2.6 Identified Vulnerability Issues

The County has identified the following vulnerabilities related to this hazard:

- Repetitive loss properties are not limited to the SFHA and flooding losses can occur in areas not identified on the FIRM.
- Rainfall intensity is expected to increase, straining existing drainage and stormwater infrastructure, potentially leading to flooding damage if these systems fail.
- Planned communities in former wetlands are not designed to redirect extreme rainfall leading to flash flooding conditions.
- Wildfire burn scars are at risk of post-fire debris flows and flash floods.
- There is a gap in knowledge about flood risk and the County floodplain management program among county staff, elected officials, and the public.
- County infrastructure and critical facilities are located within the SFHA and at risk from flooding.

10.3 FUTURE CHANGES THAT MAY AFFECT RISK

10.3.1 Potential or Planned Development

The ability of new development to withstand flooding impacts can be enhanced through land use practices and consistent enforcement of codes and regulations for new construction. New development changes the landscape, where buildings, roads, and other infrastructure potentially replace open land and vegetation. This transformation of pervious surfaces (including vegetation) to impervious surfaces increases runoff and the potential for flooding. Proper planning and implementation of green infrastructure can help mitigate these effects by promoting natural water absorption and reducing the risk of flood events.

An evaluation of new development for which County permits have been issued since 2020 found that 67 of the 3,248 permits are for development in the 1 percent annual chance flood hazard area, as shown in Table 10-21.

Table 10-21. Recent Development Permits in SFHA

Community Plan Area	Permits since 2020 in 1-Percent Annual Chance Flood Hazard Area	
	Count	% of Plan Area Total
Hāna	0	0.0%
Kīhei-Mākena	32	6.2%
Lānaʻi	0	0.0%
Makawao-Pukalani-Kula	0	0.0%
Molokaʻi	7	6.1%
Pāʻia-Haʻikū	0	0.0%
Wailuku-Kahului	26	3.5%
West Maui	2	0.3%
Maui County (Total)	67	2.1%

Source: County of Maui 2025; FEMA 2015

10.3.2 Projected Changes in Population

As areas continue to be cleared for new development and run-off persists, the population in the County will remain exposed to this hazard. If population growth occurs outside the SFHA, the risk exposure remains the same. However, if it grows within the SFHA, the risk exposure increases.

The Department of Business, Economic Development and Tourism (DBEDT) produced population projections for the County from 2030 to 2050. According to these projections, Maui County's population is projected to grow to 173,520 by 2030, 181,000 by 2040, and 184,870 by 2050.

10.3.3 Climate Change

Climate projections for Maui County suggest a decline in overall rainfall but an increase in heavy rain events, leading to more frequent flash flooding and infrastructure damage. Sea level rise will heighten the risk of coastal flooding from hurricanes and storms, expanding flood-prone areas, especially where streams and rivers meet the ocean. Beach and wetland systems may struggle to adapt, reducing their ability to buffer storm impacts.

10.3.4 Other Identified Conditions

M Most studies project that Maui County will see an increase in average annual temperatures and a decline in precipitation. Despite the decrease in overall rainfall, severe storm events and heavy rainfall are still likely to occur, potentially increasing the occurrence and severity of flooding. The County is expected to continue experiencing direct and indirect impacts from these flooding events annually, which may lead to secondary hazards such as infrastructure deterioration or failure, utility outages, power outages, water quality and supply concerns, and transportation delays, accidents, and inconveniences.

11. HIGH WINDSTORM

11.1 HAZARD PROFILE

11.1.1 Hazard Description

Wind is defined as the perceptible natural movement of air, especially in the form of a current of air blowing from a particular direction. Windstorm hazards in Maui County involve strong, damaging winds that can result from various weather events, including trade winds, thunderstorms and their associated winds, and straight-line winds, which are discussed below.

Wind Types

Trade Winds

In Maui County, northeast and east-northeast trade winds occur about 70 percent of the time, playing a major role in defining the region's climatology. North Pacific high-pressure systems are responsible for most gusty trade wind episodes, which can persist for several days before tapering off. The northeast trade winds prevail over the Hawaiian Islands throughout the year, with an average speed of 15.7 mph and speeds ranging between 10 and 25 mph. Extreme events can occasionally reach 40 to 50 mph when the subtropical high-pressure cell intensifies (HI-EMA 2023). As a result, the east-facing coastlines, or windward coasts, are most impacted by trade wind energy.

Average wind speeds across Maui are highest during the summer trade wind period (May through September), when trade winds are present 85 to 95 percent of the time, and wind speeds over the ocean exceed 12 mph about 50 percent of the time. During the winter (October through April), when trade winds are less prevalent (50 to 80 percent of the time), wind speeds exceed 12 mph about 40 percent of the time (WRCC 2024).

Trade winds appear to be stronger when passing through the isthmus between the West Maui Mountains and Haleakalā. Wind speeds may be higher at locations such as Māʻalaea and north Kīhei than along the island's north shore. This increase in wind speed is the result of wind funneling, which occurs when wind passes between two mountains or into a valley.

Thunderstorms and Associated Winds

Thunderstorms are associated with high winds because wind is typically one component of thunderstorms. Thunderstorms are very dangerous due to their ability to generate tornadoes, hailstorms, strong winds, flash flooding, and damaging lightning. While thunderstorms can occur in all regions of the United States, they are most common in the central and southern states due to ideal atmospheric conditions.

Three conditions need to occur for a thunderstorm to form:

- Moisture to form clouds and rain.

- Unstable air, such as warm air that can rise rapidly.
- Lift, which comes in the form of cold or warm fronts, sea breezes, mountains, or the sun's heat.

These storm events can occur singularly, in lines, or in clusters, and can move through an area quickly or linger for several hours.

Straight-Line Winds

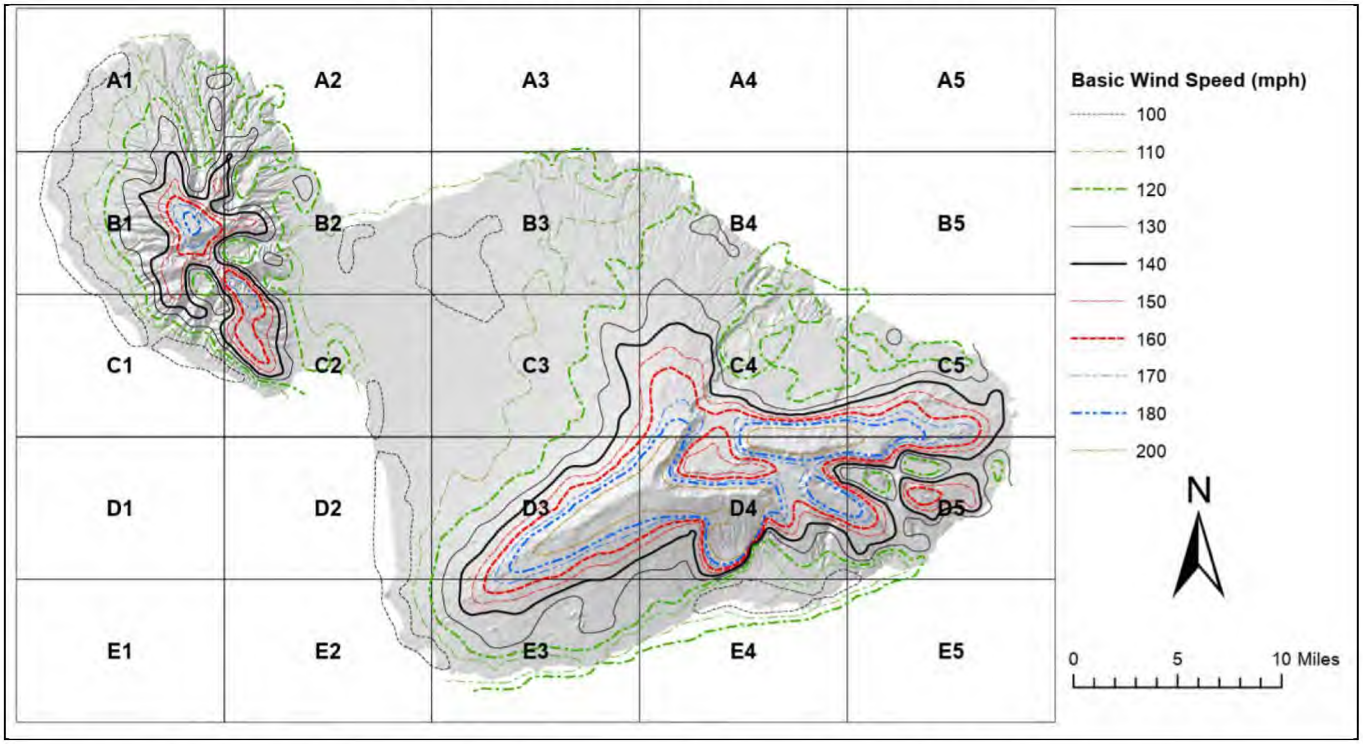
Straight-line winds, which in extreme cases can cause wind gusts exceeding 100 mph, are responsible for most thunderstorm wind damage. One type of straight-line wind, the downburst, can cause damage equivalent to a strong tornado and can be extremely dangerous to aviation.

11.1.2 Location

High windstorms, including thunderstorms, can occur anywhere in Maui County. However, topography can play 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 (HI-EMA 2023). 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 Hawai'i generally experience the highest wind speeds (WRCC 2024).

In 2024, the Hawai'i Department of Accounting and General Services completed wind speed analyses on the main Hawaiian Islands to determine the potential impact of wind speeds on proposed building code changes. Figure 11-1 to Figure 11-3 display the results of the analyses. The wind direction analyses for Maui County reveal that the prevailing winds on Maui, Moloka'i, and Lāna'i are predominantly from the northeast, known as the trade winds. On Maui, these winds are consistent year-round, especially along the windward coasts and slopes. Moloka'i experiences strong northeast trade winds, particularly along its northern and eastern shores, where they are funneled through valleys. Lāna'i also sees northeast trade winds, but its topography causes some variations in wind direction and speed across the island.

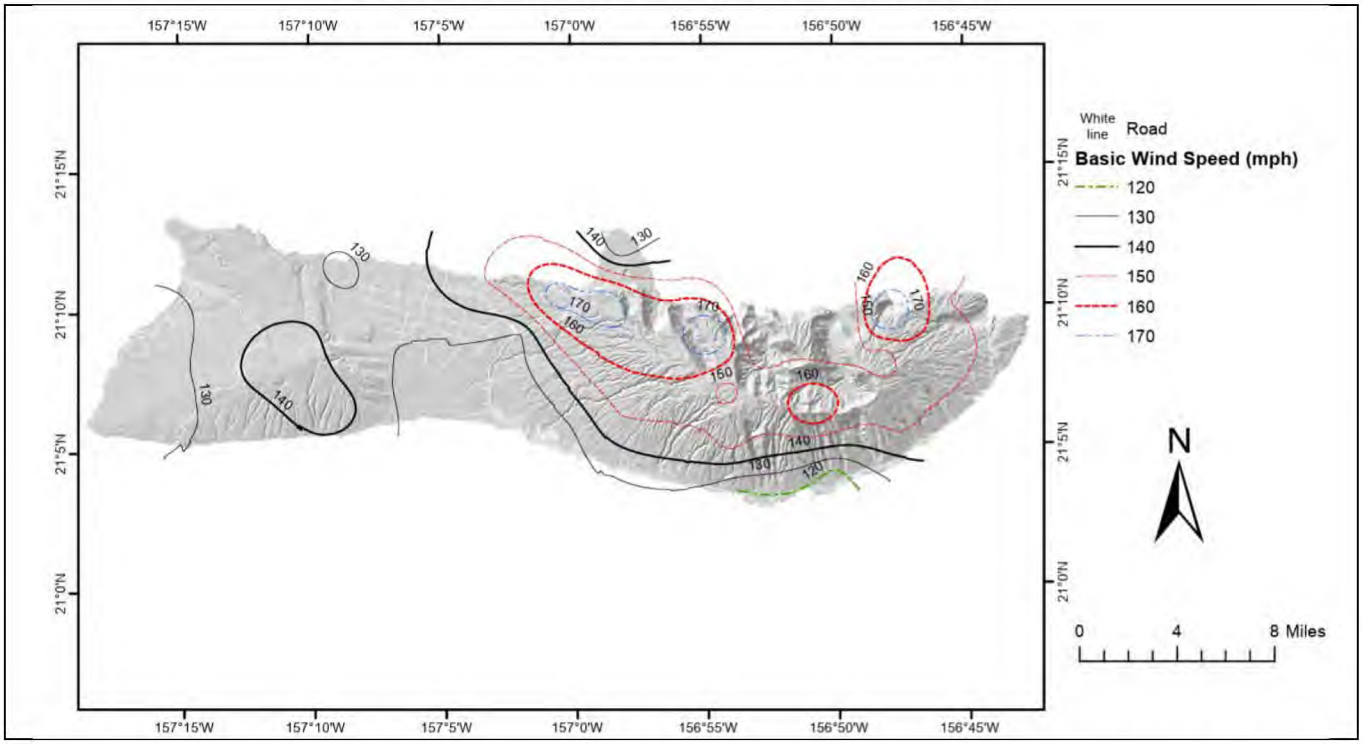
Figure 11-1. Maui Island Basic Wind Speeds



Note: Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10m) above ground for Exposure C category. Linear interpolation between contours is permitted. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area. Ocean promontories and local escarpments shall be examined for unusual wind conditions. Wind speeds correspond to approximately a 15% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00333, MRI = 300 Years).

Source: (DAGS 2024)

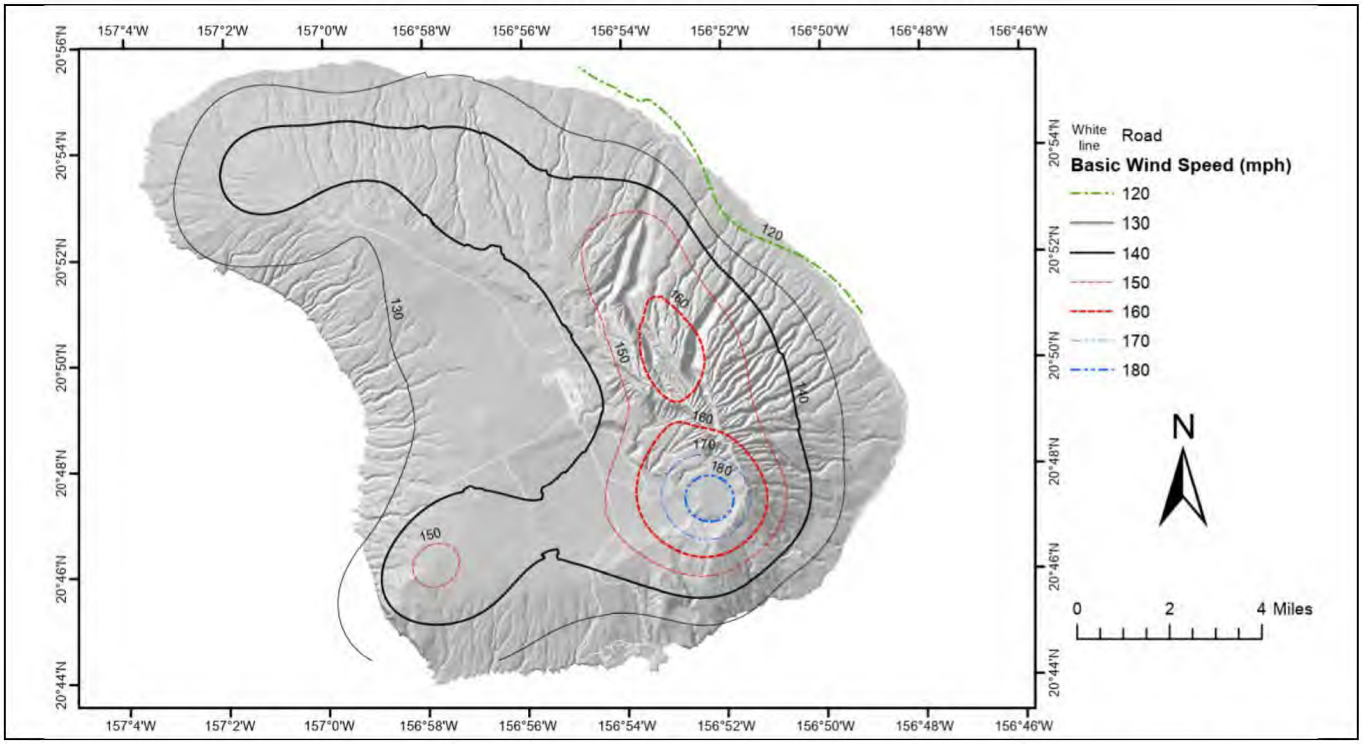
Figure 11-2. Moloka‘i Island Basic Wind Speeds



Note: Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10m) above ground for Exposure C category. Linear interpolation between contours is permitted. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area. Ocean promontories and local escarpments shall be examined for unusual wind conditions. Wind speeds correspond to approximately a 15% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00333, MRI = 300 Years).

Source: (DAGS 2024)

Figure 11-3. Lānaʻi Island Basic Wind Speeds



Note: Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10m) above ground for Exposure C category. Linear interpolation between contours is permitted. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area. Ocean promontories and local escarpments shall be examined for unusual wind conditions. Wind speeds correspond to approximately a 15% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00333, MRI = 300 Years).

Source: (DAGS 2024)

11.1.3 Extent

The range of magnitudes for windstorm hazards in Maui County varies widely depending on the type of windstorm event, local geographic factors, and specific conditions associated with each storm. The magnitude of windstorms is typically measured in terms of wind speed, which can be influenced by the event's origin, duration, and intensity. Wind extent can be measured in terms of speed, reported in knots or miles per hour.

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 (HI-EMA 2023):

- **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).

- **Sustained Wind** – Sustained Wind is the wind speed averaged over 2 minutes. This is the measurement standard used by the National Weather Service (AMS 2022).
- **Peak Gusts** – Peak Gusts are the maximum wind gust speeds averaged over a period of two to five seconds.

It is important to understand that wind load, and not wind speed, causes wind damage. Wind load is the force or pressure that wind exerts on the outside of a structure. Wind can exert three types of load/forces on a structure:

- **Uplift** – This occurs when wind flows over and under a roof, creating a lifting effect similar to an airplane wing. The wind pressure underneath the roof pushes it upward, while the wind flowing over the roof pulls it upward. This can cause the roof to lift off if not properly secured.
- **Shear** – Horizontal wind pressure can cause shear forces, which push against the sides of a structure. This can lead to racking, where the building tilts or shifts horizontally. Proper bracing and structural design are essential to resist these forces.
- **Lateral** – Wind can exert lateral forces that push against the vertical surfaces of a structure, such as walls. These forces can cause the building to sway or even collapse if not adequately designed to withstand them.

The Beaufort Wind Scale

The Beaufort Scale is an empirical measure that relates wind speed to observed conditions at sea or on land. It was devised by Admiral Sir Francis Beaufort of the Royal Navy in 1805. The scale ranges from 0 to 12, with each level describing the effects of different wind speeds on the environment, as listed in Table 11-1 (NWS 2016).

Table 11-1. Beaufort Wind Scale

Force	Speed (mph)	Description
0	0 – 1	**CALM** – Smoke rises vertically
1	1 – 3	**LIGHT AIR** – Direction of wind shown by smoke drift, but not by wind vanes
2	4 – 7	**LIGHT BREEZE** – Wind felt on face; leaves rustle; ordinary vanes moved by wind
3	8 – 12	**GENTLE BREEZE** – Leaves and small twigs in constant motion; wind extends light flag
4	13 – 18	**MODERATE BREEZE** – Raises dust and loose paper; small branches are moved
5	19 – 24	**FRESH BREEZE** – Small trees in leaf begin to sway; crested wavelets on inland waters
6	25 – 31	**STRONG BREEZE** – Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty
7	32 – 38	**NEAR GALE** – Whole trees in motion; inconvenience felt when walking against the wind
8	39 – 46	**GALE** – Breaks twigs off trees; generally impedes progress
9	47 – 54	**SEVERE GALE** – Slight structural damage occurs (chimney-pots and slates removed)

Force	Speed (mph)	Description
10	55 – 63	**STORM** – Seldom experienced inland; trees uprooted; considerable structural damage occurs
11	64 – 72	**VIOLENT STORM** – Very rarely experienced; accompanied by widespread damage
12	72 – 83	**HURRICANE**

Source: (NWS 2016)

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 quickly resulting in 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 percent to 30 percent higher (HI-EMA 2023).

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 2024):

- **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 frequent gusts over 66 mph. People in an area for which a High Wind Watch has been issued should prepare by securing loose objects outdoors that may blow about and avoiding outdoor activity that exposes them 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 frequent gusts over 66 mph. Wind warnings may be issued up to 24 hours ahead of the onset of high winds. People in an area where a high wind warning is in effect should avoid activities that expose them 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. People in an area where a wind advisory is in effect should secure loose objects that may be blown about outdoors and limit activity that may expose them 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.

- **Special Marine Warning** means that thunderstorms capable of producing wind gusts of 34 knots or greater and/or hail of 3/4 inch in diameter or larger are occurring or could form at any time over the coastal waters within 40 nautical miles of shore. If a gale warning is in effect, Special Marine Warnings are issued for wind gusts of 50 knots or greater.

11.1.4 Previous Occurrences

FEMA Disaster Declarations

Between 1954 and 2025, Maui County was included in 14 major disaster (DR) or emergency (EM) declarations for high windstorm-related events, as listed in Table 11-2 (FEMA 2024). For disaster declarations related to tropical storms and hurricanes, refer to Section 12 (Hurricane).

Table 11-2. FEMA Disaster Declarations for High Windstorm Events in Maui County

Event Date	Declaration Date	Declaration Number	Description
October 28, 2000 to November 2, 2000	November 9, 2000	DR-1348	Severe Storms and Flooding
December 4, 2007 to December 7, 2007	February 6, 2008	DR-1743	Severe Storms, High Surf, Flooding, and Mudslides
March 3, 2012 to March 7, 2012	April 18, 2012	DR-4062	Severe Storms, Flooding, and Landslides
September 11, 2016 to September 14, 2016	October 6, 2016	DR-4282	Severe Storms, Flooding, Landslides, and Mudslides
March 8, 2021 to March 18, 2021	May 13, 2021	DR-4604	Severe Storms, Flooding, and Landslides
December 5, 2021 to December 10, 2021	February 15, 2022	DR-4639	Severe Storms, Flooding, and Landslides
August 8, 2023 to September 30, 2023	August 10, 2023	DR-4724	Wildfires and High Winds

Source: (FEMA 2024)

State Emergency Proclamations

The Governor of Hawai'i may declare a state of emergency by proclamation if an emergency or disaster has occurred or there is imminent danger or threat of an emergency or disaster in any portion of the state (Hawai'i State Legislature 2020). Between 2020 and 2024, Maui County was included in three windstorm-related state emergency proclamations (HI-EMA 2024), as summarized in Table 11-3. For information on state emergency proclamations related to tropical storms and hurricanes, refer to Section 12 (Hurricane).

Table 11-3. State Emergency Proclamations for High Windstorm Events in Maui County, 2020 to 2024

Declaration Date	State Proclamation Number	Description
March 9, 2021	N/A	Emergency Proclamation Related to Heavy Rains and Flooding
December 6, 2021	N/A	Emergency Proclamation Related to Heavy Rains and Flooding
May 15, 2024	2024-034	Proclamation Relating to Kona Low Weather Event

Source: (HI-EMA 2024)

USDA Declarations

The U.S. Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and counties contiguous to them. Between 2020 and 2025, Maui County was not included in any USDA windstorm-related agricultural disaster declarations (USDA 2024).

All Recent Events

Between 2020 and 2024, Maui County had six high windstorm related events. Table 11-4 lists these events that impacted Maui County since the previous HMP was developed. For tropical storm and hurricane events, refer to Section 12 (Hurricane). For earlier events, refer to the previous HMP.

Table 11-4. High windstorm Events in Maui County, 2020 to 2024

Event Date	FEMA Declaration or State Proclamation Number	Event Description
November 24, 2022	N/A	A period of high winds were noted across portions of the islands. Frequent gusts between 34 and 49 knots were reported. Lānaʻi Airport reported 46 knot wind gusts.
December 18, 2022	N/A	At the summits on Big Island, sustained west winds were recorded over 43 knots with gusts over 104 knots, with a max wind gust recorded at 144 knots on Dec 19th. Otherwise, at lower elevations, southwest winds over 35 knots, with localized gusts over 60 knots, were recorded at various locations across the islands. The winds were the result of a strong early season cold front which dropped across the state from the northwest. National Park Service officials also reported a measured wind gust of 61 knots. Barricades deployed. Overtime required. Month long clean up. Multiple roads closed have significant impact on traffic. Stores and condos flooded cause water and debris damage. Sidewalk closed leading to interrupted pedestrian routes. Bus routes were unavailable for certain areas. Some businesses were not able to open due to flood damage resulting in loss of income. Some condo parking lots were full of mud impacting guest from leaving or arriving. Storm debris running from ditches into ocean.

Event Date	FEMA Declaration or State Proclamation Number	Event Description
February 9, 2023	N/A	A period of gusty east winds sustained up to 35 knots with localized gusts near 50 knots generated some damage for portions of the Hawaiian Island chain. Park staff reported that an approximately 16-inch diameter eucalyptus tree fell across Haleakalā Hwy, State Route 377, at mile 3 of State Highway 377.
March 2, 2023	N/A	A period of gusty winds caused damage to some trees and power lines across portions of Maui County and the Big Island of Hawai'i.
August 7-8, 2023	DR-4724	A strong high-pressure system to the north along with Hurricane Dora to the south helped to fuel powerful northeast winds which caused widespread damage to trees in upcountry Maui. A few of the trees were completely uprooted, but most of them had branches ripped off. Kamehameha V Hwy was closed in between MP 8.5 and MP 10 due to two utility poles knocked down and thousands of customers were out of power as a result of high winds. Water tankers deployed to assist the fire department for a week. Overtime accrued in that time.
May 15, 2024	2024-034	Proclamation Relating to Kona Low Weather Event

Source: (NOAA 2024)
Note: The NOAA NCEI database currently contains data from January 1950 to December 2024.

11.1.5 Probability of Future Occurrences

Probability Based on Previous Occurrences

Information on previous high windstorm occurrences in Maui County was used to calculate the probability of future occurrence of such events. Table 11-5 lists the number of events recorded in the NOAA National Centers for Environmental Information (NCEI) Storm Events Database from 1950 to 2024, categorized by wind type. Based on these records and input from the HMWG, the probability of occurrence for high windstorm in the County is considered "occasional."

Table 11-5. Probability of Future High Windstorm Events in Maui County

Hazard Type	Number of Occurrences Between 1950 and 2024	Percent Chance of Occurring in Any Given Year
High Wind	32	42.7%
Strong Wind	15	20%
Thunderstorm Wind	5	6.67%
Marine High Wind	0	0%
Marine Strong Wind	0	0%
Marine Thunderstorm Wind	0	0%
Dust Devil	4	5.3%
Total	**56**	**74.7%**

Source: (NOAA 2024)

Note: This may not be a complete list of wind events for Maui County, as some events go unreported. However, the NOAA NCEI Storm Events Database provides an accurate and comprehensive record of reported wind events. The wind types searched within this database are listed above in Table 11-5. The database currently contains data from January 1950 to December 2024.

Effect of Climate Change on Future Probability

Although the average atmospheric and land surface temperatures are increasing in the State of Hawai'i and are projected to continue rising, the rates will vary depending on land use, 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, remains uncertain in local predictions. Changes in the prevailing northeast trade winds may shift large-scale pressure and wind patterns, impacting the State of Hawai'i in the future.

Predicting the intensity, frequency, and duration of specific windstorm events resulting from climate change impacts is challenging for any particular location in the state. The reduction of trade winds may increase drought conditions on the windward sides of the islands, subsequently raising the likelihood of extreme heat events, wildfire risk, and air quality impacts from volcanic haze. Additionally, an increase in Kona winds on the leeward sides of the islands could further spread wildfires exacerbated by drought conditions. (HI-EMA 2023).

11.1.6 Cascading Impacts on Other Hazards

High winds pose a serious threat to structures, especially older or substandard ones, by tearing off roofs, shattering windows, and destroying weaker or poorly constructed homes and outbuildings. Structural damage from high wind events can cause debris to fall and make buildings more vulnerable to future storms. Strong winds also uproot trees and scatter debris, which can damage power lines and cause prolonged outages, affecting essential services like telecommunications, water supply, and healthcare. Coastal areas are particularly vulnerable, as high winds can generate large waves, leading to coastal flooding and erosion. Additionally, high winds combined with heavy rainfall can increase the risk of landslides, blocking roads and posing threats to human life.

11.2 VULNERABILITY AND IMPACT ASSESSMENT

High windstorms are a significant natural hazard that can impact the entirety of Maui County. These events pose various risks, including structural damage, power outages, and life safety threats.

11.2.1 Life, Health, and Safety

Understanding the vulnerability of the overall population, as well as socially vulnerable communities, is crucial for effective preparedness and response. The following section discusses the County's exposure to windstorms and highlights specific vulnerabilities faced by the population and socially vulnerable groups.

Overall Population

The entire population of Maui County, totaling 164,632 residents, is exposed and vulnerable to windstorms. This includes socially vulnerable communities, which are equally at risk (HI-EMA 2023). Certain areas are particularly susceptible due to their geographic location and local weather patterns. For instance, residents living at higher elevations with large stands of trees or near powerlines may face increased risks of wind damage and power outages (HI-EMA 2023).

Severe winds pose significant life safety risks. Individuals outdoors during such events may be struck by falling trees and limbs, or by objects dislodged from buildings and hurled through the air. While high windstorms rarely necessitate evacuations, wind advisories, watches, and warnings are issued for sustained winds and gusts at specific speeds. These alerts can be issued from several days to just hours before an event. To ensure safety, certain areas, such as Haleakalā National Park, may close to visitors during high wind events.

Socially Vulnerable Population

Socially vulnerable populations are particularly susceptible to high windstorms. These populations include individuals over the age of 65, children under the age of 5, non-English speaking individuals, people with disabilities, and residents living below the poverty line. Those living in remote areas with limited road networks are also considered socially vulnerable.

Power outages from windstorms can be life-threatening to those dependent on electricity for life support and are a significant concern. These populations face isolation and exposure during windstorm events and could suffer more secondary effects of the hazard. After high wind events, residents may be displaced or require temporary to long-term sheltering. Vulnerability is influenced by several factors, including the physical and financial ability to prepare, react, or respond during a hazard, as well as the location and construction quality of their housing. Because these populations face various forms of isolation, they are more at risk for secondary effects from high wind hazards.

11.2.2 General Building Stock

The Hawai‘i State Building Code requires that new structures be built to withstand Category 3 hurricane wind speeds (HI-EMA 2023). Structures built before the code incorporated provisions for wind load and topographic factors are particularly vulnerable. Locations at higher elevations, on leeward sides of islands during Kona winds, on ridgelines, under or near power lines, or near large trees are more susceptible to wind damage. High windstorms can cause windows and doors to be blown out, roofs to be ripped off, and walls to collapse, depending on the storm's severity and duration.

When estimating the potential impact on individual structures, factors such as structural integrity, mitigation measures, building construction, and date of construction should be considered. Residential structures are generally more susceptible to wind damage than commercial and industrial structures due to differences in construction. Wood and masonry buildings, regardless of occupancy class, tend to experience more damage than concrete or steel buildings. All current and future buildings in Maui County, including critical facilities, are at risk from high wind events.

11.2.3 Community Lifelines and Other Critical Facilities

All community lifelines and critical facilities in the county are vulnerable to high windstorms. Loss of utilities is the most common issue with high windstorms. High winds can severely impact power transmission and telecommunication lines as high winds are funneled through changes in terrain, causing widespread power outages.

11.2.4 Economy

High windstorms can have a profound impact on Maui's economy. Communication lines, antennas, and towers are particularly vulnerable to damage from strong winds and falling branches or trees, leading to disruptions in telecommunications and broadcasting services. This can affect both businesses and residents who rely on these services for daily operations and communication.

Damages to buildings, roads, and vehicles can be extensive and costly. High winds can tear off roofs, shatter windows, and cause structural damage to buildings. Roads may be blocked by debris, making transportation difficult and delaying emergency response efforts (CBO 2019). The cost of repairs and cleanup can strain local resources and budgets.

Business interruptions are a significant concern during high windstorms. Power outages, which are common during such events, can halt business operations, leading to financial losses. Extended outages can affect essential services, such as water supply, communication networks, and healthcare facilities, further compounding the economic impact.

The tourism industry, a vital part of Maui's economy, can also be severely affected. Flights may be delayed or canceled due to severe wind events, disrupting travel plans for visitors and causing a ripple effect on local businesses that depend on tourism. For instance, during a recent windstorm in January 2025, Maui's Kahului Airport experienced numerous flight delays and cancellations, impacting travelers and local businesses alike (Beat of Hawai‘i 2025).

11.2.5 Natural, Historic and Cultural Resources

Natural

Natural habitats such as forests and waterways are particularly vulnerable to damage from high windstorms. Major damage can occur from downed or uprooted trees and other debris, which can block rivers and streams. Agricultural losses have been reported due to historic Kona wind events. Generally, forest trees on the leeward side of the 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 (HI-EMA 2023).

Historic

Windstorms can have significant impacts on historic resources in the County. High winds can cause physical damage to historic buildings and monuments, including roofs, walls, windows, and other

structural elements, compromising their integrity. Debris from fallen trees and branches can strike and damage these structures, and obstruct access, making repairs and preservation efforts challenging. Heavy rains accompanying windstorms can lead to water infiltration in historic buildings, causing wood rot, mold growth, and damage to interior finishes and artifacts.

In coastal areas, rainfall associated with windstorms can cause erosion and flooding, undermining the foundations of historic buildings and leading to potential collapse. Shoreline changes can threaten archaeological sites and other cultural landscapes. The surrounding environment of historic resources can also be altered by windstorms, affecting the context and setting that contribute to their historical significance, such as the loss of historic trees, gardens, and other landscape features.

Damage from windstorms can make historic sites unsafe for visitors and staff, leading to temporary or prolonged closures. This impacts tourism and the local economy, as well as hinders ongoing preservation efforts.

Cultural

Cultural resources, including historical sites and culturally significant landscapes, are also at risk during high windstorms. The impact of strong winds and heavy rains can cause structural damage to historical buildings and monuments. Debris from downed trees and other materials can obstruct access to these sites, complicating preservation efforts.

Kona storms, with their potential for large wave heights and shoreline changes, can significantly affect cultural assets located along the coast. Erosion and flooding can damage or destroy sites of cultural importance, leading to a loss of heritage and history. Protecting these resources requires careful planning and the implementation of measures to mitigate the effects of windstorms and other natural hazards (HI-EMA 2023).

11.2.6 Identified Vulnerability Issues

After review of the hazard event history, hazard exposure, and current capabilities, the County identified the following vulnerabilities related to this hazard:

- Much of the electrical power infrastructure of Maui County is above ground, which makes it vulnerable to high winds.
- Telecommunication services often run parallel to power lines and are vulnerable to high wind events.
- Downed trees and power lines pose a risk to human life and safety and can prevent emergency vehicles from reaching people in need of their services.
- Strong winds can exacerbate wildfires, as exemplified by the 2023 Wildfires on Maui.
- Emergency shelters in the county may not withstand high winds.

11.3 FUTURE CHANGES THAT MAY AFFECT RISK

11.3.1 Potential or Planned Development

All future developments within the County are vulnerable to high wind hazards. However, the ability to withstand impacts from high winds is based on 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.

11.3.2 Projected Changes in Population

Projected changes in population can significantly affect the risks associated with windstorms. As population density increases, particularly in urban and coastal areas, the potential for damage and disruption from windstorms also rises. More people living in these areas means that more infrastructure, homes, and businesses are at risk. This can lead to higher economic losses and greater challenges in emergency response and recovery efforts.

Furthermore, as more people move to areas prone to windstorms, the overall exposure to these hazards increases. This can result in more frequent and severe disruptions to daily life, including power outages, transportation issues, and damage to critical infrastructure.

The Department of Business, Economic Development and Tourism (DBEDT) produced population projections for the County from 2030 to 2050. According to these projections, Maui County's population is projected to grow to 173,520 by 2030, 181,000 by 2040, and 184,870 by 2050.

11.3.3 Climate Change

Climate change projections for high windstorms in Maui County indicate that rising temperatures and changes in trade wind patterns could impact the region. The reduction in northeast trade winds, which has been observed over the past 40 years, may lead to more muggy weather and volcanic haze. This change can also increase drought conditions on the windward sides of the island, raising the risk of extreme heat events, wildfires, and air quality issues. Additionally, an increase in Kona winds on the leeward sides could further spread wildfires exacerbated by drought conditions. Predicting the exact intensity, frequency, and duration of windstorm events remains challenging. (HI-EMA 2023).

11.3.4 Other Identified Conditions

Urbanization, infrastructure vulnerability, and vegetation management are key factors that can significantly influence the risk of windstorms. As urban areas expand, the density of buildings increases, creating wind tunnels that can amplify wind speeds and cause more severe damage to structures and infrastructure. This urbanization effect can lead to higher economic losses and greater challenges in emergency response and recovery efforts.

The condition and resilience of infrastructure, such as power lines, roads, and bridges, also play a crucial role in determining the impact of windstorms. Aging or poorly maintained infrastructure is more likely to fail during high wind events, leading to widespread disruptions. Ensuring that infrastructure is regularly inspected, maintained, and upgraded can help mitigate these risks and enhance community resilience.

Vegetation management is another critical factor in reducing windstorm risks. Properly maintained vegetation around buildings and infrastructure can act as a natural windbreak, reducing wind speeds and protecting structures. Conversely, poorly managed vegetation can increase the risk of damage from falling trees and branches. Implementing effective vegetation management practices, such as regular pruning and removal of hazardous trees, can significantly reduce the potential for windstorm-related damage.

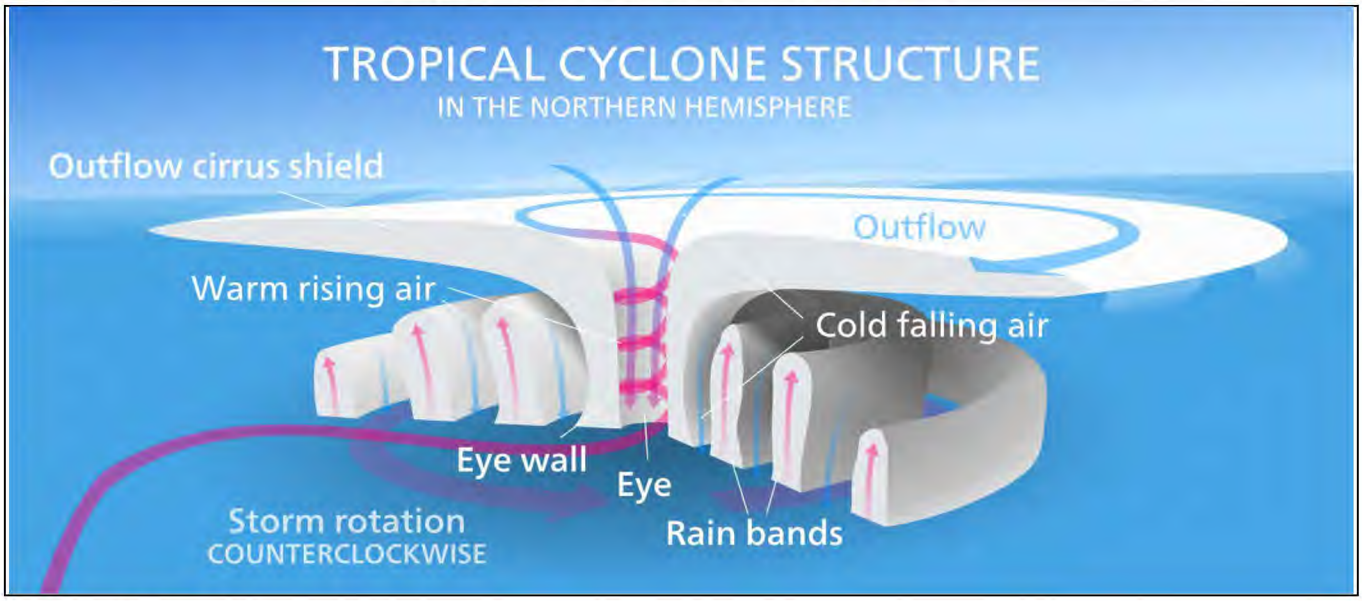
12. HURRICANE

12.1 HAZARD PROFILE

12.1.1 Hazard Description

A hurricane is a large, rotating storm with high-speed winds. Hurricanes form over warm, tropical waters when warm, moist air rises, creating an area of low pressure, as illustrated in Figure 12-1. Surrounding areas of high pressure push toward the low pressure, then also warm and rise. As warmed air continues to rise, surrounding air swirls around the low-pressure area to take its place. As the warm air rises it cools and forms clouds. The storm system spins and grows as it continues to be fed by warm ocean water. As the storm spins faster, a low-pressure eye forms in the center of the storm. The eye is clear and calm, but is surrounded by the eyewall, which contains the storm's strongest winds and heaviest rains. As a hurricane makes landfall, it weakens as its supply of warm ocean water is cut off. Hurricanes and tropical storms (also referred to as tropical cyclones), can be damaging and potentially deadly in the Hawaiian Islands. These storms can bring excessive amounts of rain, strong and damaging winds, storm surge, high waves, erosion along shorelines, and tidal and coastal flooding.

Figure 12-1. Tropical Cyclone Structure



Source: (Wikimedia 2012)

Tropical Cyclones

In the Northern Hemisphere, hurricanes typically form in three regions of the world: the tropical Atlantic, the eastern tropical Pacific, and the western tropical Pacific. In the Southern Hemisphere, hurricanes form in the western tropical Pacific and Indian Ocean. Hawai'i lies in the Central Pacific, which, on average, experiences four to five hurricanes every year.

In the United States, forecast centers classify hurricanes and similar, but weaker storms, in the following categories according to their maximum sustained winds:

- **Tropical Depression**—A weak tropical cyclone with a surface circulation including one or more closed isobars (lines or curves of constant pressure) and highest sustained winds (measured over one minute or more) of less than 38 mph. Tropical depressions are assigned a number denoting their chronological order of formation in a given year.
- **Tropical Storm**—A tropical cyclone with highest sustained winds between 39 and 73 mph.
- **Hurricane** (or Typhoon west of 180º longitude) —A tropical cyclone with highest sustained winds greater than 74 mph.

Tropical cyclones can occur in the Central Pacific any time of year, but most form between June 1 and November 30. This period is known as hurricane season. August to October are peak months for hurricane development.

The three major threats caused by hurricanes include storm surge, high winds, and flooding associated with heavy rainfall. These threats are described below:

- Storm Surge – Storm surge is an abnormal rise is water due to a storm, above predicted astronomical tides. Storm surge occurs when water is pushed toward the shore by the force of the winds swirling around the storm. This rise in water level can cause extreme flooding in coastal areas, especially when storm surge coincides with normal high tide, resulting in storm tides reaching up to 20 feet or more. The water level rise due to the combination of storm surge and the astronomical tide is referred to as a storm tide. Storm surge pushes breaking waves further inland, which can batter buildings, roads, and other infrastructure. Storm surge is often the greatest threat to life and property from hurricanes and is responsible for nearly 90 percent of all hurricane-related deaths and injuries (NOAA 2019).
- High Winds— Hurricane winds can reach speeds upwards of 155 miles per hour in the eye-wall of the hurricane, with gusts exceeding 224 miles per hour. The force of wind during a hurricane can uproot large trees, down power lines and utility poles, knock over signs, and damage/destroy homes and buildings. Flying debris can also cause damage to both structures and the general population. When hurricanes first make landfall, it is common for tornadoes to form, which can cause severe localized wind damage.
- Rainfall and Flooding—The torrential rains that normally accompany a hurricane can cause serious flooding over a wide area. The speed of a hurricane impacts rain – slow-moving storms with lots of moisture may saturate an area for a longer period, whereas fast-moving systems may not cause substantial flooding. Whereas the storm surge and high winds are concentrated around the eye of a hurricane, the rain may extend for hundreds of miles and may last for several days, affecting areas well after the hurricane has diminished. Intense rainfall can cause different types of destruction. Seepage of water into buildings can cause structural damage and if the rain is steady and persistent, the structures may simply collapse from the weight of the absorbed water. Inland flooding means that building structures and critical transportation facilities, such as roads and bridges in valleys and low-lying areas, are at risk. In addition, heavy rain often triggers landslides, typical in areas with medium to steep slopes that have become over-saturated.

Tropical cyclones impact coastal areas in stages, with waves and storm surges typically arriving before high winds due to their faster propagation speed. As the hurricane makes landfall, localized intense rainfall often occurs. Historical evidence shows that direct landfall is not necessary for islands to sustain significant damage from these storms.

Several factors determine a tropical cyclone's impact:

- Wind strength
- Radius of maximum winds
- Timing
- Proximity to land

Hurricanes can affect all parts of an island, with mountain ranges potentially intensifying wind effects through orographic or topographic amplification. This phenomenon means that even a minimal hurricane or tropical storm can produce significant wind impacts on land, as hurricane winds blowing from various directions interact with the terrain.

Kona Storms

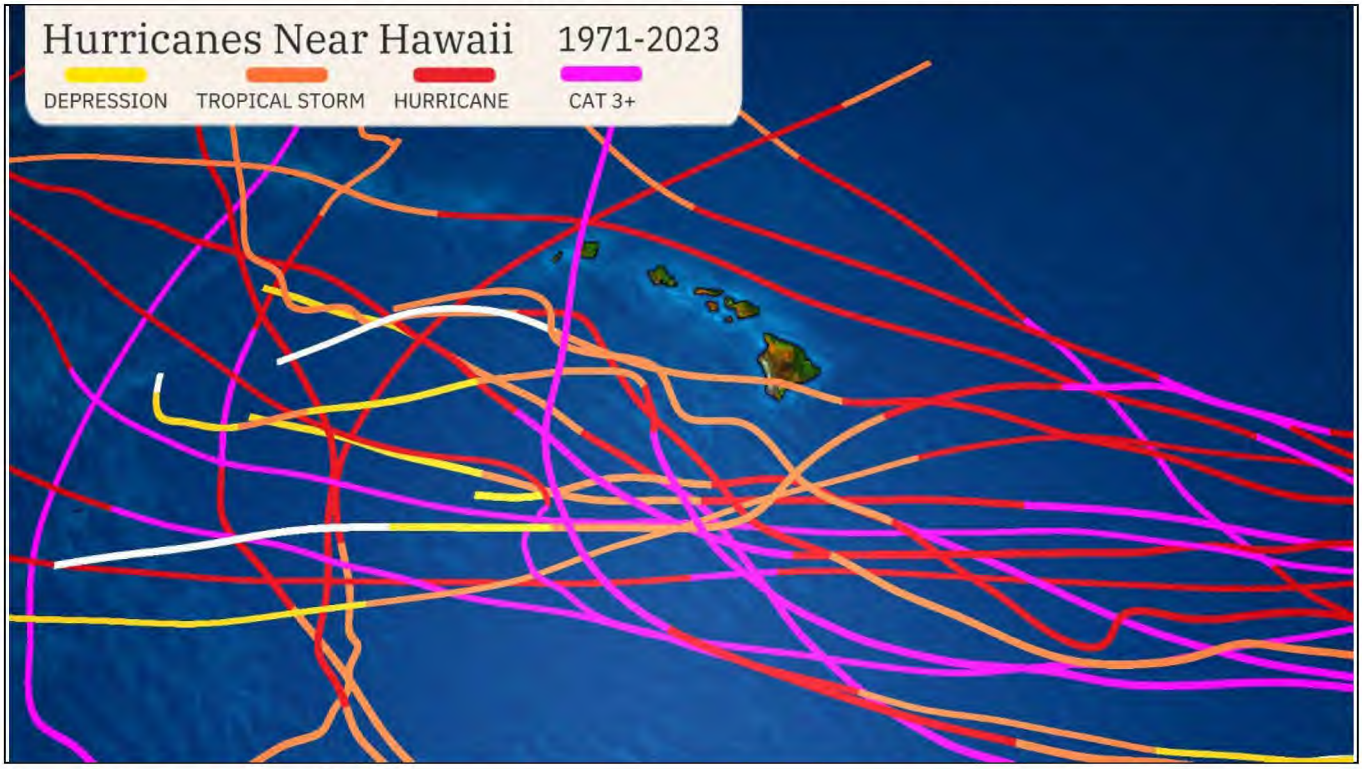
Kona storms, also referred to as Kona lows, are subtropical cyclones that occur in the north central Pacific during the cool season. The Hawaiian word “Kona” means leeward and refers to the southwesterly winds associated with the storm that replace the usually dominant trade winds in Hawai‘i that blow from the northeast. Unlike hurricanes, Kona storms form over cool waters and typically occur from October through April in Hawai‘i. Kona storms originate from a southward dip in the jet stream (a band of strong winds high in the atmosphere that drive weather systems) that sinks and breaks off, leaving behind a low-pressure circulation that is cut off from the main core of the jet. These lows can linger for several days. Swirling winds and clouds form around this low-pressure system in a manner similar to that of a hurricane.

The impacts of Kona storms are similar to those of a hurricane or tropical storm, including heavy rains, hailstorms, high winds, large surf, waterspouts, and severe thunderstorms. Heavy rains associated with Kona storms can cause flooding and landslides. Kona storms can also bring blizzard conditions to high elevations.

12.1.2 Location

Hurricanes and tropical storms have the potential to impact all islands in Maui County. Therefore, it is assumed that all of Maui County is susceptible to hurricanes and tropical storms. However, areas impacted by specific storms will depend on the storm’s track and location. Maui County can be impacted by hurricanes that do not make a direct hit (e.g., the eye does not make landfall in the county), as damaging winds and bands of rain can impact locations one hundred miles or more from the eye of the storm, depending on storm size. As illustrated in Figure 12-2, only one hurricane has made direct landfall on the main Hawaiian Islands since 1971, Hurricane Iniki on Kaua‘i in 1992.

Figure 12-2. Hurricanes Near Hawai'i, 1971-2023



Source: (Weather Channel 2024)

Coastal areas are often the hardest hit during a hurricane. They are the recipient of a hurricane's strongest winds and rainfall before it weakens upon tracking inland. In addition, coastal areas have the potential to be impacted by storm surge, one of the most deadly and damaging impacts associated with hurricanes. On the Island of Maui, Kahului (one of the county's most urbanized cities), coastal areas of Wailuku (the county seat), and the tourist destination of Kīhei are some of the most populated areas within potential storm surge locations. On the Island of Moloka'i, Kaunakakai, the island's most populous town, is largely within estimated storm surge areas.

Peak Wind Gusts

Hazus is a tool used to assess wind hazard losses through probabilistic analysis. For Maui County, Hazus evaluated potential losses from wind hazards for the 100- and 500-year mean return period (MRP) events. The Hazus hurricane model uses a database of thousands of storms, reflecting hurricanes observed since 1886, and identifies those with tracks associated with Maui County. It includes data on historical hurricane events, wind speeds, surface roughness, and vegetation maps. This analysis helps model wind force across different land surfaces. Figure 12-3 and Figure 12-4 show peak potential wind gusts for the worst-case hurricane paths for the 100- and 500-year wind events.

Figure 12-3. 100-Year Peak Wind Gusts

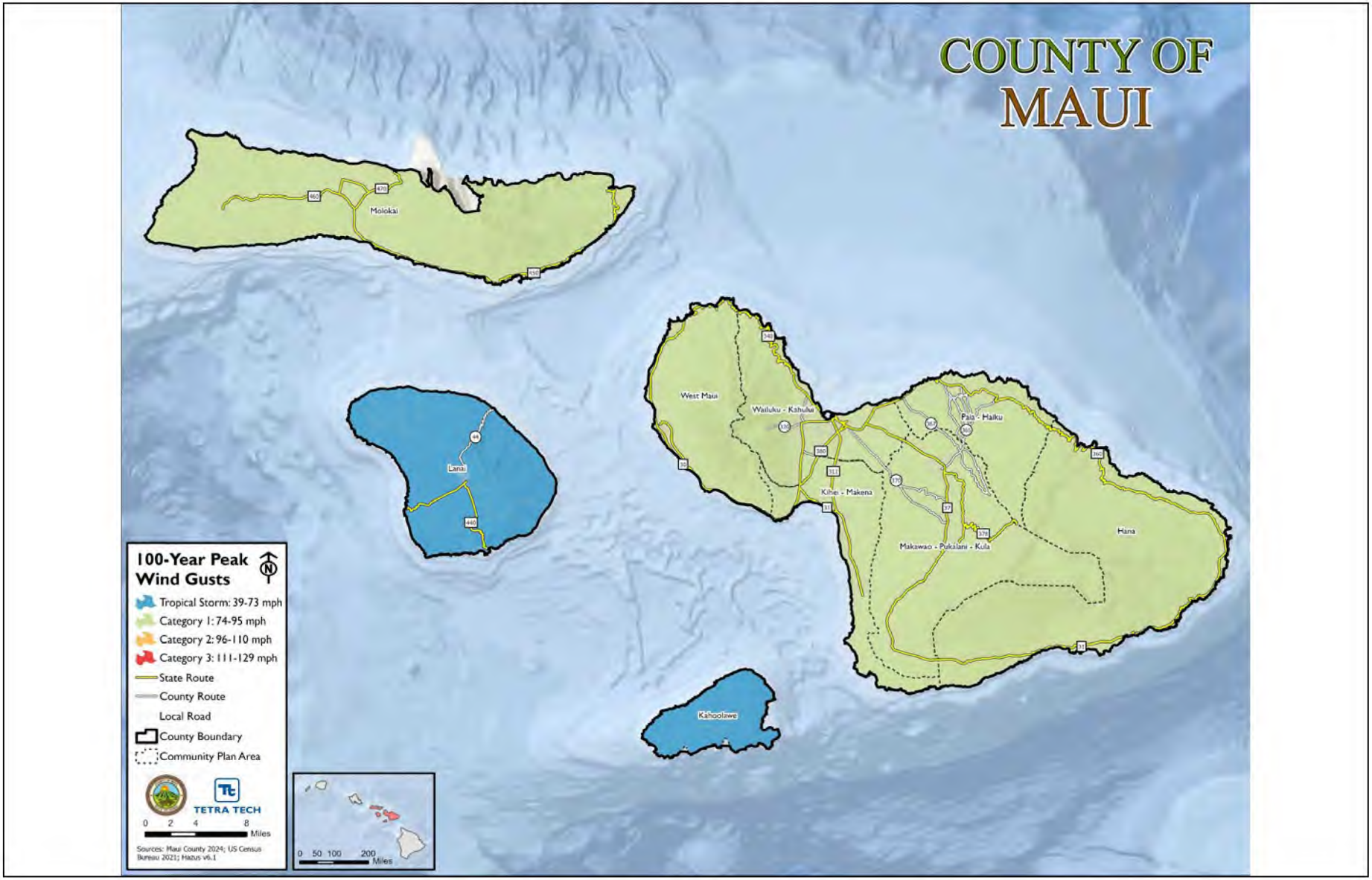
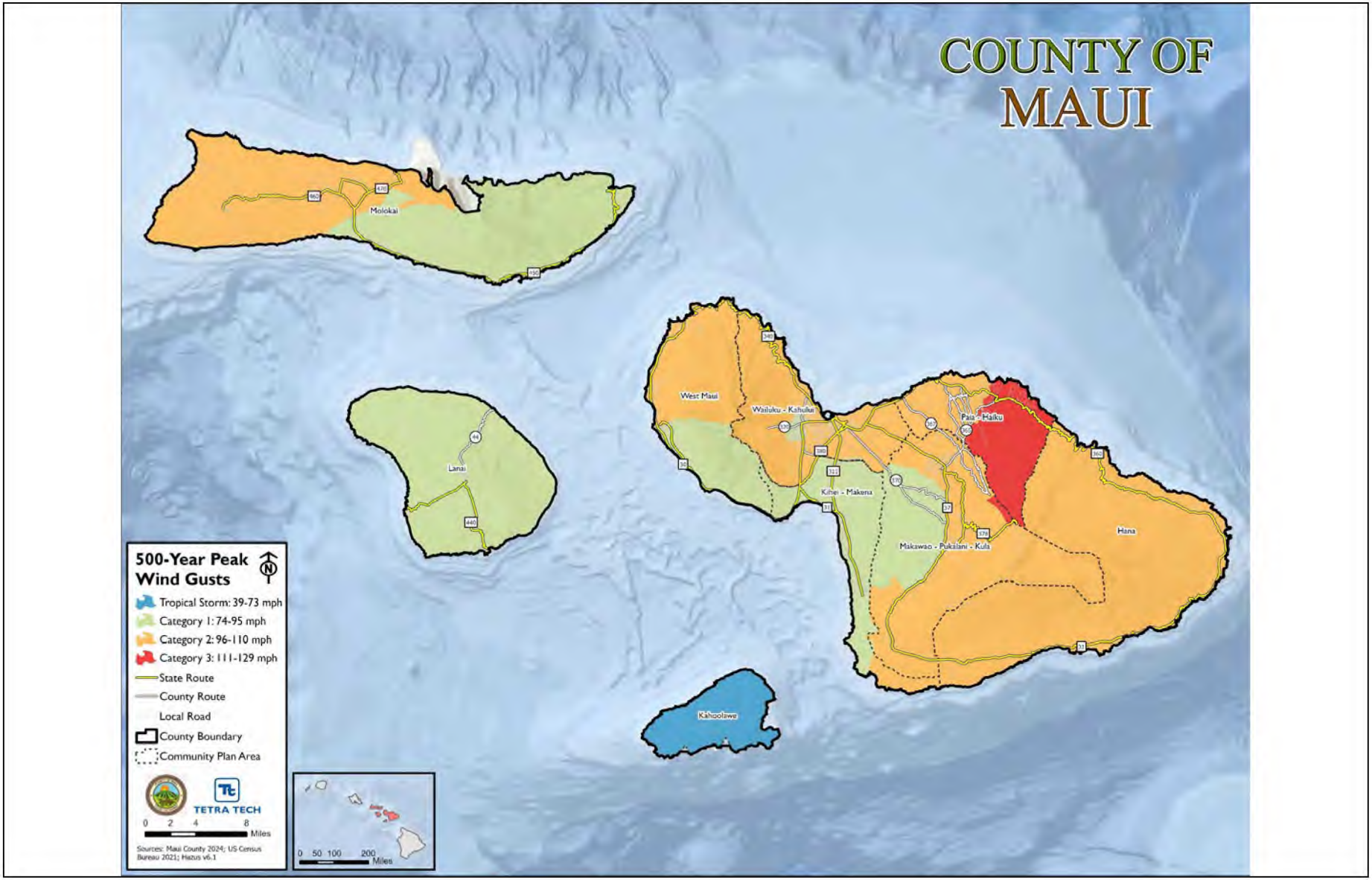


Figure 12-4. 500-Year Peak Wind Gusts



12.1.3 Extent

As demonstrated by previous occurrences, powerful hurricanes, tropical storms, and Kona storms occur in Maui County. Category 5 hurricanes, as assigned via the Saffir-Simpson scale (see Table 12-1), are the most severe hurricanes. However, the severity of hurricanes and tropical storms can also be described by the damage they cause. In Maui County, the most damaging hurricane to impact the county was Hurricane Lane in 2018, which caused approximately $6.5 million in damages and resulted in a federal disaster declaration. Hurricane Lane was initially forecasted to strike Maui with Category 5 hurricane-force winds. While the storm stayed south of the islands and gradually weakened, it still brought tremendous damage and is an example that stronger events are possible.

However, more intense hurricane events have also been experienced on neighboring islands. For instance, Kaua'i County received the brunt of Hurricane Iwa in 1982, which produced an estimated $234 million in damage. Similarly, Hurricane Iniki was a Category 4 hurricane that hit the County of Kaua'i in September 1992, causing almost $2 billion in damages. Events such as these are possible in Maui County. In addition, hurricane and tropical storm frequency and intensity are projected to increase in the central Pacific region under climate warming scenarios. Similarly, projected sea level rise combined with storm surges could have impacts from which coastal communities are unable to fully recover.

Tropical storms and hurricanes are named by the World Meteorological Organization (WMO) using pre-determined, rotating lists of names, which are maintained by the National Hurricane Center (NHC). If a disturbance or tropical depression develops into a named storm between 140°W and the dateline, then it receives a Hawaiian name.

Table 12-1. Saffir-Simpson Hurricane Scale

Category	Wind Speed	Expected Damage
1	74-95 mph	Very dangerous winds will produce some damage: Well-constructed frame homes could have damage to roofs, shingles, vinyl siding, and gutters. Large branches of trees will snap, and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110 mph	Extremely dangerous winds will cause extensive damage: Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted 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.
3 (Major)	111-129 mph	Devastating damage will occur: Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4 (Major)	130-156 mph	Catastrophic damage will occur: Well-built framed homes can sustain severe damage with the loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted, and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Category	Wind Speed	Expected Damage
5 (Major)	>157 mph	Catastrophic damage will occur: A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Source: NWS, 2013

Warning Time

Tropical cyclones can now be closely monitored and tracked, allowing for accurate warnings up to several days in advance of an event. Advanced modeling can even provide possible storm movement predictions up to a week prior. The National Hurricane Center issues public advisories for all tropical or subtropical cyclones in the Atlantic, Eastern Pacific, and Central Pacific regions. The Central Pacific Hurricane Center (CPHC) is the official body responsible for tracking and issuing tropical cyclone warnings, watches, advisories, discussions, and statements for the Central Pacific region from the equator northward, including Hawai'i. It is the Regional Specialized Meteorological Center (RSMC) for tropical cyclones in this region, and in this capacity is known as RSMC Honolulu. Based in Honolulu, the CPHC is co-located with the NWS Honolulu forecast office on the campus of the University of Hawai'i at Mānoa. The Honolulu forecast office activates the CPHC when tropical cyclones form in, or move into, the Central Pacific region. CPHC issues tropical cyclone public advisories, which provide crucial information including:

- Current watches and warnings
- Cyclone position (latitude and longitude)
- Distance from selected land points
- Current motion
- Maximum sustained wind speed
- Estimated or measured minimum central pressure

For eastern and central Pacific tropical cyclones, advisories are typically released every 6 hours. However, the frequency increases under certain conditions. Advisories are released every 3 hours when coastal watches or warnings are in effect, every 2 hours when coastal watches or warnings are in effect and land-based radars have identified a reliable storm center, and special public advisories may be issued at any time if significant changes in conditions occur (NWS n.d.).

These advisories may also include information on potential storm tides, rainfall, or tornadoes associated with the tropical cyclone, as well as any other pertinent weather observations (NWS n.d.). This detailed and timely information helps communities and individuals better prepare for and respond to approaching tropical cyclones. The different advisories for hurricanes and tropical storms are defined in Table 12-2.

Table 12-2. National Weather Service Hurricane and Tropical Storm Advisory

Advisory	Definition
Tropical Cyclone Warning	Tropical storm conditions are expected in the area within 36 hours and consist of sustained winds between 39 to 73 mph.
Hurricane Warning	Hurricane conditions are expected in the area with sustained winds of 74 mph or greater. Generally, a hurricane warning is issued within 36 hours before a tropical storm-force wind is expected to give time for preparations.
Tropical Storm Watch	Tropical storm conditions are possible within the area, consisting of sustained winds of 39 to 73 mph.
Hurricane Watch	Hurricane conditions of sustained winds 74 mph or greater are possible in the area. Generally, a hurricane watch is issued 48 hours before a tropical storm-force wind is expected.

Source: NWS n.d.

12.1.4 Previous Occurrences

FEMA Disaster Declarations

Table 12-3 lists all presidentially declared disasters for tropical cyclone events that have included Maui County. Between 1954 and 2024, Maui County was included in seven major disaster (DR) or emergency (EM) declarations (FEMA 2024).

Table 12-3. FEMA Disaster Declarations for Hurricane Events in Maui County

Event Date	Declaration Date	Declaration Number	Description
August 16, 1959	August 16, 1959	DR-94	Hurricane Dot
September 11, 1992	September 12, 1992	DR-961	Hurricane Iniki
August 7, 2014 to August 9, 2014	September 12, 2014	DR-4194	Tropical Storm Iselle
August 22, 2018 to August 29, 2018	August 22, 2018	EM-3399	Hurricane Lane
September 9, 2018 to September 13, 2018	September 12, 2018	EM-3404	Tropical Storm Olivia
August 22, 2018 to August 29, 2018	September 27, 2018	DR-4395	Hurricane Lane
July 23, 2020 to July 27, 2020	July 25, 2020	EM-3529	Hurricane Douglas

Source: (FEMA 2024)

State Emergency Proclamations

The Governor of Hawai'i may declare a state of emergency by proclamation if an emergency or disaster has occurred or there is imminent danger or threat of an emergency or disaster in any portion of the state (Hawai'i State Legislature 2020). Between 2020 and 2024, Maui County was included in three hurricane-related state emergency proclamations (HI-EMA 2024), as summarized in Table 12-4.

Table 12-4. State Emergency Proclamations for Hurricane Events in Maui County, 2020 to 2024

Declaration Date	State Proclamation Number	Description
July 26, 2020	N/A	Proclamation for Hurricane Douglas
May 15, 2024	2024-034	Proclamation Relating to Kona Low Weather Event
August 24, 2024	2024-062	Proclamation Relating to Tropical Storm Hone

Source: (HI-EMA 2024)

USDA Declarations

The U.S. Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and counties contiguous to them. Between 2020 and 2024, Maui County was not included in any USDA hurricane-related agricultural disaster declarations (USDA 2024).

All Recent Events

Between 2020 and 2024, Maui County had four hurricane-related events. Table 12-5 lists major recorded hurricane-related events that have impacted Maui County since the previous HMP was developed. For earlier events, refer to the previous HMP.

Table 12-5. Hurricane Events in Maui County, 2020 to 2024

Event Date	FEMA Declaration or State Proclamation Number	Event Description
July 26, 2020	FEMA: EM-3529 State: Proclamation for Hurricane Douglas	As Hurricane Douglas was passing just north of the islands, heavy showers developed over portions of Maui and Kaua‘i. The rain caused ponding on roadways, and small stream and drainage ditch flooding. No significant property damage or injuries were reported. The rain caused ponding on roadways, and small stream and drainage ditch flooding. No significant property damage or injuries were reported.
December 5, 2021	FEMA: DR-4639	A surface front and a deep upper low, known locally as a Kona low, produced heavy and sustained showers and thunderstorms as tropical moisture was pulled north over the Aloha State. The downpours also led to instances of flash flooding. Also, 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. Flooding was reported at the Krispy Kreme in Kahului. More flooding occurred in the Wakea Business Center in Kahului, and around the Puunene Bridge. A little later, multiple homes were flooded in Maui Meadows, and a few vehicles were washed away. With deep water covering the roadway, Kamehameha V Highway became impassable near mile marker 8 on the Island of Moloka‘i. Week long clean up in Maui Meadows with multiple crews. Cleaning of flood debris and storm damage Homes and vehicles flooded. Roads and shoulders with moderate damage people not being able to stay in their homes, some roads were not passable so some people were stuck in homes.

Event Date	FEMA Declaration or State Proclamation Number	Event Description
August 7, 2023	-	Between August 7-9, strong winds impacted the Hawaiian islands. A strong high-pressure system to the north of the state along with Hurricane Dora to the south helped to fuel powerful northeast winds which caused widespread damage to trees in upcountry Maui. A few of the trees were completely uprooted, but most of them had branches ripped off. Honoapiʻilani Hwy was closed between Front St. and Hokiokio Rd due to downed utility poles on the road caused by the high winds.
August 25, 2024	State: 2024-062	Hurricane Hone, which formed in the Central Pacific, tracked towards the Hawaiian islands and passed by just south of the Big Island. Hurricane Hone's outer rain bands brought flooding to portions of the Big Island and the close proximity of the center of the storm brought widespread tropical storm force winds with pockets of power outages over the Big Island and Maui. Thousands of customers reportedly lost power and utility poles were damaged. There was a road closure on Olinda Road fronting Seabury Hall on both south and north sides due to a large tree down along with power lines.

Source: FEMA 2024; HI-EMA 2024; County of Maui

Historic Tropical Cyclone Events

While Maui County has only received one direct hit from a hurricane or tropical storm in recent history (Tropical Storm Olivia), many historic hurricanes have tracked close enough to the county to impact one or more of its islands. Official hurricane tracking began in 1950. However, one notable hurricane before this reporting period began has been described as impacting Maui County; in 1874, storm Die Deutsche Seewarte III destroyed 23 homes on Molokaʻi and several others on Lānaʻi. Since 1950, 20 hurricanes and tropical storms have had a significant impact on one or more islands in Maui County, as detailed below:

- Hurricane Nina (November 1957) – Brought gusts greater than 90 mph to the Island of Maui.
- Hurricane Dot (1959) – Resulted in a disaster declaration for Maui County. Estimated damages were approximately $150,000 (non-inflated).
- Tropical Storm Sarah (1971) – Five houses were damaged on Molokaʻi and the Lānaʻi airport closed.
- Hurricane Estelle (1986) – Produced high surf in Maui County.
- Hurricane Iniki (September 1992) – One of the costliest hurricanes to impact the State of Hawaiʻi. Kauaʻi was the hardest hit, with $1.8 billion in damages and 13,000 homes destroyed. This event was much less devasting for Maui County, but did result in a disaster declaration.
- Tropical Storm Dora (July 1993) – Flooding closed Honoapi`ilani Highway, clogged drainage channels, deposited silt in water supplies, and caused one family to be evacuated.
- Tropical Storm Flossie (July 2013) – Brought high surf, thunderstorms, heavy rain, flash flooding and strong wind to Maui and Hawaiʻi Counties. Strong winds downed trees and power lines, which closed roads and caused power outages on the islands of Maui and Molokaʻi in Maui

County. The state emergency operations center (EOC) was activated for this hurricane, and several injuries were reported due to lightning strikes.

- Tropical Storm Iselle – (August 2014) – Made landfall on the Big Island, and caused power outages, washed out roads, and widespread flooding throughout Maui County. This event resulted in a disaster declaration for Maui County and caused approximately $4.9 million in damages.
- Tropical Storm Ana (October 2014) – Maui County experienced gusty winds, high surf, and heavy rain. No significant damages were reported in the county.
- Tropical Storm Guillermo (August 2015) – In Maui County, Tropical Storm Guillermo brought surf of 10 to 20 feet along the eastern shores of Maui and Molokaʻi. Beaches were closed in Maui County, and high water brought debris onto coastal roads. No significant property damages were reported.
- Hurricane Kilo (August 2015) – Produced flash flooding and road closures in Maui County.
- Hurricane Ignacio (August – September 2015) – Swell from Hurricane Ignacio generated 10 to 20-foot surf along east-facing shores, and six to eight-foot surf along south-facing shores on all islands, except for Lānaʻi. No significant damages to property in Maui County were reported, but the high surf deposited sand and debris on coastal roads.
- Hurricane Jimena (September 2015) – Remnants of Hurricane Jimena brought heavy rains and flooding to parts of the state, including Maui County.
- Tropical Storm Niala (September 2015) – All state and county EOCs monitored the event.
- Tropical Storm Oho (October 2015) – All state and county EOCs monitored the event.
- Hurricane Olaf (October 2015) – Swell produced eight to 12-foot surf on east-facing shores on Maui Island, and 6 to 9-foot surf along southern-facing shores. Several roadways were inundated by several inches of water. There were no significant injuries or property damage reported. All EOCs in the state were monitoring the event.
- Tropical Storm Darby (July 2016) - Tropical Storm Darby brought significant challenges to Maui County, including heavy rainfall that led to flooding in low-lying areas and locations with poor drainage. The storm generated a historic south swell, with waves reaching heights of 12 to 16 feet and occasional sets up to 20 feet, causing dangerous conditions along south-facing shores and leading to beach closures. Southeast winds of 35 to 45 mph, with localized gusts around 55 mph, were reported, particularly at higher elevations like Haleakalā summit. The storm resulted in road closures, sewage spills, flight cancellations, and minor property damage across Maui County. Fortunately, no fatalities were reported during the storm.
- Hurricane Lester (September 2016) – Hurricane Lester weakened and cleared the Hawaiian Islands without significant impacts. However, this event caused closures throughout Maui County and emergency shelters opened.
- Hurricane Lane (August 2018) – Hurricane Lane reached a Category 5 as it moved across the eastern and central Pacific (only the 5th on record in the Central Pacific basin) toward the Hawaiian Islands. Lane rapidly weakened as it approached the State of Hawaiʻi and veered away from the state rather than making landfall. However, Hurricane Lane was a slow-moving storm that still caused record-breaking rainfall around the state. It dropped 58 inches of rain on

the Island of Hawai'i, which is the second highest recorded rainfall from a hurricane in the United States (the record was 60.6 inches, set by Hurricane Harvey in 2017). In Maui County, rain bands soaked the eastern slopes of Maui Island, causing numerous landslides, especially on Hāna Highway. Parts of eastern Maui (the Pā'ia-Ha'ikū and Hāna Community Plan Areas) received upwards of 25 inches of rainfall. Severe road wash-out occurred on the western slopes of Maui. Flooding damages to infrastructure in Maui County were estimated at approximately $2 million. The figure below shows rainfall totals over the State of Hawai'i from Hurricane Lane. Further, gusty winds brought by Hurricane Lane fanned a series of wildfires in western Maui, which had been experiencing moderate drought conditions. Sustained winds of 30 mph and gusts of 50 mph produced by Hurricane Lane drove three wildfires that rapidly burned 2,000 acres and destroyed 21 residential structures, causing over $4 million in damages. This event resulted in a disaster declaration for Maui County, with damages estimated at $6.5 million.

- Tropical Storm Olivia (September 2018) – Tropical Storm Olivia made history as the first hurricane or tropical storm to make landfall of the Island of Maui since recording or of such storms began. Olivia brought heavy rain and sustained winds of over 40 mph. Flooding and landslides caused road closures, and several homes had to be evacuated due to rising water levels in streams and waterways. Power outages impacted about 8,000 customers. Olivia also made landfall on the Island of Lāna'i. No deaths or injuries were reported as a result of this tropical storm.

12.1.5 Probability of Future Occurrences

Probability Based on Previous Occurrences

The list of historic hurricane occurrences was used to calculate the probability of future occurrence of such events. Table 12-6 lists the number of events from various sources over the 67-year period from 1957 to 2024, which is the most complete period of record for all sources reviewed. Based on these records and input from the HMWG, the probability of occurrence for hurricane-related events in the County is considered "occasional."

Table 12-6. Probability of Future Hurricane Events in Maui County

Hazard Type	Number of Occurrences Between 1957 and 2024	Percent Chance of Occurring in Any Given Year
Hurricane, Tropical Storms	20	29.4%

Source: County of Maui, NOAA NCEI
Note: The time period presented in this table is the most complete period of record for the various data sources reviewed.

Effect of Climate Change on Future Probability

Climate change is expected to significantly increase the severity and intensity of tropical cyclones affecting Maui County. Since 1950, Maui County has experienced 50 percent fewer days with trade winds, four inches less annual precipitation, two degrees average temperature warming, and 34 more days over 90 degrees (Maui County 2022). These trends are expected to continue through the next century. Warming air and ocean temperatures create conditions for stronger hurricanes. As

temperatures continue to rise, the potential for stronger and more frequent tropical cyclones increases. In Maui County, this could mean a higher likelihood of experiencing direct hits from intense hurricanes, potentially causing catastrophic damage to the County's infrastructure, economy, and communities.

12.1.6 Cascading Impacts on Other Hazards

Secondary impacts of tropical cyclones include storm surge, high winds, landslides, flooding, coastal erosion, and high surf. High winds, heavy rainfall, and storm surge present a risk of drowning, structure collapse, fallen trees, and wind-driven objects. Powerful surges can turn floating debris into projectiles that can cause injuries, deaths, and property damage.

When a tropical cyclone makes landfall, winds can be even stronger at higher elevations due to reduced friction. Heavy precipitation during hurricanes can cause stormwater infrastructure to be compromised and can exacerbate high tide events. Heavy precipitation over long durations during tropical cyclone events can cause the soil to become loose and saturated, resulting in a high risk for landslide events.

Fires can also ignite from broken gas lines, ruptured tanks, or wildfires fanned by strong winds. Blizzard conditions from Kona storms may trap unprepared hikers at high elevations, such as those at Haleakalā National Park.

Public health impacts from hurricanes, tropical storms, and Kona storms are similar to those of coastal flooding and tsunamis. Aside from direct threats to life and property, hurricanes can result in the contamination of drinking water through saltwater intrusion, inundation of hazardous materials facilities, inundation of wastewater treatment plants, and broken utility or sewer lines. Flood water may contain these hazardous materials and be dangerous to traverse. In estuaries and wetlands, saltwater intrusion endangers public health, kills vegetation, and can send wildlife fleeing from flooded areas. Additionally, flooded structures or those with water damage from heavy rainfall may quickly develop mold or wood rot, posing serious health risks to inhabitants if not treated promptly.

Those living in low-lying areas, flood plains, along streams and gulches, or in areas along the shoreline are particularly susceptible to flooding associated with tropical cyclones. Community Plan Areas with populations situated near the coast such as West Maui, Kīhei-Mākena, Wailuku-Kahului, and Molokaʻi are not only susceptible to flooding and property loss due to storm surge, but also the run-off from upper elevations due to heavy rainfall.

12.2 VULNERABILITY AND IMPACT ASSESSMENT

A Hazus probabilistic analysis was performed to analyze the wind hazard losses for Maui County for the 100- and 500-year mean return period (MRP) events. The probabilistic Hazus hurricane model activates a database of thousands of potential storms that have tracks and intensities reflecting the full spectrum of hurricanes observed since 1886 and identifies those with tracks associated with Maui County. Hazus contains data on historical hurricane events and wind speeds. It also includes surface roughness and vegetation (tree coverage) maps for the area. Surface roughness and vegetation data

support the modeling of wind force across various types of land surfaces. Default demographics and updated building and critical facility inventories in Hazus were used for the analysis. Although damage is estimated at the census tract level, results were presented at the Community Plan Area level. A density analysis was used to extract the percentage of building structures that fall within each census tract and Community Plan Area. The percentage was multiplied against the results calculated for each tract and summed for each Community Plan Area.

12.2.1 Life, Health, and Safety

It is assumed that the entirety of each island's population, property, critical facilities, and environment are exposed to the wind, flooding, or storm surge impacts of tropical cyclones to some degree.

Overall Population

Maui County is home to more than 164,000 people and they are all at risk from wind and rainfall impacts during a hurricane, especially homes and facilities on exposed ridgelines. People living along the coast are at risk from storm surge during hurricanes. Table 12-7 displays the number of households and individuals that could potentially seek shelter during a 100- and 500-year hurricane. In the event of a 500-year hurricane, more than 500 people could seek shelter outside of their homes.

Table 12-7. Estimated Displaced Population from Hurricane

Community Plan Area	Total Population (2023 ACS)	100-Year MRP Hurricane		500-Year MRP Hurricane	
		Displaced Households	Persons Seeking Short-Term Sheltering	Displaced Households	Persons Seeking Short-Term Sheltering
Hāna	2,135	3	6	17	31
Kīhei-Mākena	29,174	0	0	10	9
Lānaʻi	3,333	0	0	0	0
Makawao-Pukalani-Kula	24,505	3	7	41	73
Molokaʻi	8,092	0	0	41	90
Pāʻia-Haʻikū	17,037	5	6	71	96
Wailuku-Kahului	58,606	0	0	97	199
West Maui	21,749	1	1	42	44
Maui County (Total)	164,632	12	20	319	542

Source: U.S. Census Bureau ACS 2023; Hazus v6.1

Socially Vulnerable Population

Impacts on homes and lifelines present particular hardships to vulnerable populations who may already experience challenges related to accessing information or services or adequately preparing their families and protecting their homes. These vulnerable populations may also struggle to recover in a timely manner due to socioeconomic constraints. Socially vulnerable populations are most susceptible to hurricane impacts, 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. Economically

disadvantaged populations in Hawai'i are vulnerable because they often lack the resources to adequately prepare for, respond to, and recover from a disaster. The population over the age of 65 is also more vulnerable because they may require extra time or outside assistance during evacuations and are more likely to seek or need medical attention that may not be available during a storm event. Those with Limited English Proficiency may not understand critical evacuation or warning messages.

12.2.2 General Building Stock

Damaging winds and heavy rains can impact coastal and inland buildings in Maui County, and storm surge can damage coastal structures. High winds associated with hurricanes, tropical storms, and/or Kona storms have the potential to severely damage homes and critical infrastructure such as roads, power delivery, and communication systems. Strong sustained winds and even stronger wind gusts associated with these storms can blow shingles, siding, awnings, and even roofs off buildings. Falling trees and tree limbs can damage structures. Objects picked up by wind can be hurled through the air, damaging structures and breaking windows when contact is made. In some cases, structures can be blown off foundations.

Further, heavy rains can cause riverine and flash flooding, which can inundate structures. Heavy rains can also seep through roofs and walls, especially ones that have been damaged by winds, causing water damage. Water damage can lead to structural damage, wood rot, and mold growth.

Storm surge can inundate buildings. As storm surges push breaking waves inland, the force of large, high-velocity waves can damage and destroy structures. This process can also cause severe erosion, which can undermine building foundations.

A Hazus analysis was conducted to understand the potential impact of hurricanes on the island's building stock. Table 12-8 and Table 12-9 display the residential, commercial, industrial, and other building stock losses that could occur during a 100- and 500-year hurricane. In both scenarios, the Wailuku-Kahului area has the potential to suffer the highest dollar amount of building damage. A 500-year hurricane could cause more than $745 million in total building stock losses.

Table 12-10 estimates the number of buildings by occupancy class that could suffer minor, moderate, severe, and destroyed damages during a 100- or 500-year hurricane. Residential structures are particularly at risk in the 500-year scenario, with almost 4,000 homes suffering at least minor damage.

Table 12-8. Building Loss Estimates for 100-Year Hurricane

Community Plan Area	Building Loss - 100-Year MRP Hurricane				
	Estimated Damage (All Occupancies)	Estimated Damage (Residential)	Estimated Damage (Commercial)	Estimated Damage (Industrial)	Estimated Damage (All Other Occupancies)
Hāna	$8,616,326	$6,420,186	$1,318,233	$78,766	$799,141
Kīhei-Mākena	$19,407,964	$17,060,149	$1,538,210	$174,300	$635,306
Lāna'i	$104,422	$85,008	$13,536	$27	$5,850

Community Plan Area	Building Loss - 100-Year MRP Hurricane				
	Estimated Damage (All Occupancies)	Estimated Damage (Residential)	Estimated Damage (Commercial)	Estimated Damage (Industrial)	Estimated Damage (All Other Occupancies)
Makawao-Pukalani-Kula	$23,513,676	$17,337,055	$1,883,848	$275,973	$4,016,800
Molokaʻi	$3,597,000	$2,848,399	$399,946	$90,000	$258,655
Pāʻia-Haʻikū	$15,678,293	$12,617,765	$1,627,857	$243,031	$1,189,640
Wailuku-Kahului	$38,486,863	$19,914,012	$10,207,855	$944,952	$7,420,044
West Maui	$35,147,800	$30,954,468	$3,220,406	$112,930	$859,997
Maui County (Total)	$144,552,345	$107,237,042	$20,209,892	$1,919,979	$15,185,432

Source: USACE NSI 2022; Hawaiʻi Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; Hazus v6.1; RSMeans 2024

Table 12-9. Building Loss Estimates for 500-Year Hurricane

Community Plan Area	Building Loss - 500-Year MRP Hurricane				
	Estimated Building Losses (All Occupancies)	Estimated Building Losses (Residential)	Estimated Building Losses (Commercial)	Estimated Building Losses (Industrial)	Estimated Damages (All Other Occupancies)
Hāna	$26,900,568	$20,326,693	$4,260,896	$290,944	$2,022,035
Kīhei-Mākena	$65,890,386	$56,746,648	$6,049,895	$1,317,086	$1,776,757
Lānaʻi	$2,158,765	$1,423,573	$331,883	$45,961	$357,347
Makawao-Pukalani-Kula	$82,267,454	$62,855,918	$6,568,691	$1,070,815	$11,772,031
Molokaʻi	$81,047,849	$55,559,408	$12,430,705	$9,296,273	$3,761,463
Pāʻia-Haʻikū	$84,186,470	$70,987,987	$6,946,265	$1,782,074	$4,470,144
Wailuku-Kahului	$230,456,603	$138,918,171	$53,001,606	$8,348,635	$30,188,191
West Maui	$172,761,142	$145,442,749	$19,006,574	$3,853,877	$4,457,941
Maui County (Total)	$745,669,237	$552,261,149	$108,596,516	$26,005,664	$58,805,909

Source: USACE NSI 2022; Hawaiʻi Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; Hazus v6.1; RSMeans 2024

Table 12-10. Expected Damage to Building Stock from 100- and 500-Year Hurricane

Occupancy Class	Total Number of Buildings in Occupancy	Severity of Expected Damage	100-Year MRP Hurricane		500-Year MRP Hurricane	
			Building Count	Percent Buildings in Occupancy Class	Building Count	Percent Buildings in Occupancy Class
Residential Exposure (Single	40,410	NONE	39,129	96.8%	33,968	86.8%
		MINOR	936	2.3%	3,970	10.1%
		MODERATE	308	0.8%	1,944	5.0%

Occupancy Class	Total Number of Buildings in Occupancy	Severity of Expected Damage	100-Year MRP Hurricane		500-Year MRP Hurricane	
			Building Count	Percent Buildings in Occupancy Class	Building Count	Percent Buildings in Occupancy Class
and Multi-Family Dwellings)		SEVERE	31	0.1%	311	0.8%
		DESTRUCTION	6	<0.1%	219	0.6%
Commercial Buildings	3,807	NONE	3,634	95.5%	3,087	84.9%
		MINOR	130	3.4%	464	12.8%
		MODERATE	40	1.1%	223	6.1%
		SEVERE	3	0.1%	32	0.9%
		DESTRUCTION	0	0.0%	0	0.0%
Industrial Buildings	851	NONE	824	96.8%	701	85.1%
		MINOR	21	2.5%	87	10.6%
		MODERATE	5	0.6%	43	5.2%
		SEVERE	1	0.1%	20	2.4%
		DESTRUCTION	0	0.0%	0	0.0%
Other[a]	480	NONE	453	94.4%	375	82.8%
		MINOR	20	4.2%	62	13.7%
		MODERATE	7	1.5%	36	7.9%
		SEVERE	0	0.0%	4	0.9%
		DESTRUCTION	0	0.0%	0	0.0%

Source: USACE NSI 2022; Hawai'i Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; Hazus v6.1
a. Other = Government, Religion, Agricultural, and Education

12.2.3 Community Lifelines and Other Critical Facilities

A Hazus analysis was conducted to understand the potential impact of hurricanes on the County's community lifeline facilities. Table 12-11 and Table 12-12 display the loss of days and damage that could occur to the Communications; Energy; Food, Hydration, Shelter; Hazardous Materials; Health and Medical; Safety and Security; Transportation; and Water Systems Community Lifelines during a 100- and 500-year hurricane.

Table 12-11. Damage to Community Lifelines from 100-Year Hurricane

Lifeline	Loss of Days	Average Percent Probability of Sustaining Damage 100-Year MRP Hurricane			
		Minor	Moderate	Severe	Complete
Communications	0	3.8%	1.3%	0.1%	<0.1%
Energy	0	5.8%	2.7%	0.3%	<0.1%
Food, Hydration, Shelter	0	2.1%	0.6%	0.1%	<0.1%
Hazardous Materials	0	0.0%	0.0%	0.0%	0.0%

Lifeline	Loss of Days	Average Percent Probability of Sustaining Damage 100-Year MRP Hurricane			
		Minor	Moderate	Severe	Complete
Health and Medical	0	1.6%	0.3%	<0.1%	0.0%
Safety and Security	9	2.5%	0.6%	<0.1%	<0.1%
Transportation	0	3.5%	1.1%	0.1%	<0.1%
Water Systems	0	2.2%	0.5%	0.1%	<0.1%

Source: Hawai'i Emergency Management Agency 2017; Hazus v6.1

Table 12-12. Damage to Community Lifelines from 500-Year Hurricane

Lifeline	Loss of Days	Average Percent Probability of Sustaining Damage 500-Year MRP Hurricane			
		Minor	Moderate	Severe	Complete
Communications	0	11.4%	7.5%	1.6%	<0.1%
Energy	0	16.0%	10.4%	2.0%	<0.1%
Food, Hydration, Shelter	0	10.5%	4.2%	1.4%	0.2%
Hazardous Materials	0	0.0%	0.0%	0.0%	0.0%
Health and Medical	67	7.3%	3.7%	0.4%	<0.1%
Safety and Security	256	8.5%	7.3%	1.1%	<0.1%
Transportation	0	14.2%	7.6%	0.8%	<0.1%
Water Systems	0	10.2%	3.3%	1.3%	<0.1%

Source: Hawai'i Emergency Management Agency 2017; Hazus v6.1

In addition to buildings and identified critical facilities, utility lines, roads, and bridges are vulnerable to the impact of hurricanes, tropical storms, and Kona storms. Severe winds associated with these storms can cause damage to communications infrastructure and utility poles, and above ground power lines can be blown down. When utility lines are damaged by hurricanes, the functionality of water, sewer, gas, and electricity systems may be compromised. Storm surges may cause saltwater intrusion into drinking water sources or overwhelm storm sewer systems, which can lead to urban flooding, especially in combination with heavy rainfall. Storm surge may also severely erode or undermine coastal highways and/or bridges. Heavy rains may trigger landslides that block or damage roadways. For instance, during Hurricane Lane, Hāna Highway was blocked in several places due to landslides.

Because of their geographic extent, roads and utility lines can have a greater chance of being impacted by hurricane events. Further, if any section of a road or utility line is damaged or flooded during a hurricane, the entire system may be impacted. For instance, a hurricane that causes one area of a road or a bridge to be impassible may block accessibility to other roads or locations until waters recede, debris is removed, or in the case of damage (e.g., undermining, scour, or washing out), until repairs can be completed.

Many roads may have a segment within a potential storm surge area rather than the entire road being within a risk area. Major routes identified as having segments within storm surge areas include

Honoapi`ilani Highway in West Maui, North and South Kīhei Road in Kīhei-Mākena, and South Puunene Avenue, Ka'ahumanu Avenue, and Kahului Beach Road in Wailuku-Kahului. On Moloka'i, Maunaloa Highway and Kamehameha V Highway are within storm surge areas with depths of up to 6 feet (Category 4). Kamehameha V Highway is within storm surge areas as it hugs the coast from Kaunakakai in central Moloka'i to Hālawa Beach Park on Moloka'i's eastern tip. Many county-owned local streets in these areas are also within surge areas.

12.2.4 Economy

Hurricanes, tropical storms, and Kona storms can have wide-reaching economic impacts. Direct economic impacts may result from destroyed buildings and infrastructure, including power utility poles and lines, potable water and wastewater facilities, bridges, and roadways. The force of storm surges may destroy piers, breakwaters, and seawalls. Ships, marinas, and fishing fleets may be battered, sunk, moored, or stranded, impacting the fishing and tourism industries. Confined harbors, especially in combination with storm tides, are vulnerable to surges. Business interruptions can occur, and damages or changes to eroded beaches may impact tourism for periods long after the storm.

Hurricane Iniki, the last major hurricane to significantly impact Hawai'i, primarily affected the Island of Kaua'i in 1992. The storm caused an estimated $7.4 billion in direct damage, and its economic impact was severe, with the unemployment rate on Kaua'i skyrocketing from 6.8 percent to 19.1 percent immediately after the storm. It is estimated that Kaua'i lost around 3,000 private sector jobs due to Iniki's devastation (Coffman and Noy 2011).

As demonstrated during the 2020 COVID-19 pandemic when the unemployment rate shot up to above 18 percent, Maui Island's economy is heavily dependent upon tourism and could face similar unemployment challenges if struck by a hurricane of Iniki's magnitude.

Hazus estimates the volume of debris that may be generated as a result of a hurricane event to enable the study region to prepare and rapidly and efficiently manage debris removal and disposal. Debris estimates are divided into four categories. Concrete and Steel includes reinforced concrete and steel that require special equipment to break it up before it can be transported. Brick and Wood includes glass, furniture, equipment, plaster walls, brick, wood, and other debris that can be loaded directly onto trucks with bulldozers.

The eligible tree debris columns (Eligible Tree Weight and Eligible Tree Volume) provide estimates of the weight and volume of downed trees that would likely be collected and disposed of at public expense. The eligible tree debris estimates produced by the Hazus Hurricane Model tend to underestimate reported volumes of debris brought to landfills for some of the events that occurred in the past several years. The underestimate suggests that there are sources of vegetative and nonvegetative debris that are not modeled in Hazus. For landfill estimation purposes, it is recommended that the Hazus debris volume estimates in Table 12-13 and Table 12-14 be treated as approximate lower bounds. Based on actual reported debris volumes, it is recommended that the Hazus results shown be multiplied by three to obtain approximate upper bound estimates of tons of debris that will be generated by a 100- and 500-year hurricane.

Table 12-13. Estimated Debris for 100-Year Hurricane

Community Plan Area	Estimated Debris Created During the 100-Year MRP Hurricane Wind Event			
	Brick and Wood (tons)	Concrete and Steel (tons)	Tree (tons)	Eligible Tree Volume (cubic yards)
Hāna	501	3	61,727	12,346
Kīhei-Mākena	1,615	0	542	217
Lānaʻi	2	0	0	0
Makawao-Pukalani-Kula	1,377	0	10,740	7,559
Molokaʻi	157	0	19,801	7,920
Pāʻia-Haʻikū	967	3	17,410	16,814
Wailuku-Kahului	2,485	0	9,165	7,170
West Maui	2,641	0	13,267	9,163
Maui County (Total)	9,745	6	132,652	61,190

Source: USACE NSI 2022; Hawai'i Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; Hazus v6.1

Table 12-14. Estimated Debris for 500-Year Hurricane

Community Plan Area	Estimated Debris Created During the 500-Year MRP Hurricane Wind Event			
	Brick and Wood (tons)	Concrete and Steel (tons)	Tree (tons)	Eligible Tree Volume (cubic yards)
Hāna	1,579	20	102,880	20,577
Kīhei-Mākena	5,093	6	813	325
Lānaʻi	123	0	9,028	2,708
Makawao-Pukalani-Kula	5,186	36	22,617	16,030
Molokaʻi	4,432	124	55,540	22,216
Pāʻia-Haʻikū	5,459	98	38,901	35,521
Wailuku-Kahului	14,424	118	23,569	16,845
West Maui	11,634	77	26,814	18,867
Maui County (Total)	47,930	479	280,162	133,089

Source: USACE NSI 2022; Hawai'i Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; Hazus v6.1

12.2.5 Natural, Historic and Cultural Resources

Natural Resources

Hurricanes can impact ecosystems and wildlife by triggering floods, leveling forests, and pushing saltwater inland. Pollution from hurricane debris has the potential to degrade wetland ecosystems and poison wildlife. Finally, new species have the potential to be carried to the County by storms.

Historic Resources

Hurricanes can cause significant roof damage to Maui County's historic buildings, temples, churches, and other historically significant sites, leading to the loss of irreplaceable heritage. Extreme rainfall and

winds can damage or destroy archaeological sites, burial grounds, and ancient petroglyphs, resulting in the loss of invaluable information about Maui's past, indigenous history, and heritage.

Cultural Resources

Hurricanes can disrupt access to natural resources essential for traditional practices, affecting the transmission of cultural knowledge to future generations. Additionally, museums and cultural institutions housing Hawaiian art, artifacts, and historical documents are at risk from roof damage and flooding.

12.2.6 Identified Vulnerability Issues

The County has identified the following vulnerabilities related to this hazard:

- Considering that the County has been in a period of drought for the past five years, an extreme rainfall event associated with a hurricane could overload existing drainage and stormwater systems.
- Storm surge from a hurricane could exacerbate existing coastal erosion issues and damage critical infrastructure located along the County's coasts.
- Older homes are at risk of wind-damaged roofs and structural collapse during hurricanes from wind pushing homes off their foundations.
- Existing hurricane shelters are not built to withstand a major hurricane.
- Heavy rainfall resulting from a tropical cyclone can block culverts, damage bridges, overtop reservoirs, and trigger landslides, potentially affecting homes, businesses, infrastructure, and transportation networks.
- Stormwater runoff increases debris and pollutants entering coastal environments and nearshore waters, endangering marine habitat and degrading beaches and shoreline areas frequented by residents and visitors.

12.3 FUTURE CHANGES THAT MAY AFFECT RISK

12.3.1 Potential or Planned Development

The Maui Planning Commission, in conjunction with the Planning Department, voted unanimously on November 14, 2023, to adopt significant amendments to the Maui Island Special Management Area and Shoreline Rules after many years of public input, community meetings, and public hearings. These new rules will streamline the permitting process in addition to leading the state in using the best available science on coastal erosion (land loss) and sea level rise to improve coastal resilience. New development built following this guidance will be at less risk from storm surge than structures located near the shore.

Given that the whole County is exposed to hurricane-strength winds and extreme rainfall, developers should consider the impact of these hazards on evacuation routes when planning new development.

12.3.2 Projected Changes in Population

An increase in population density can increase the number of persons exposed to hurricanes. People who move into older buildings may increase their overall vulnerability to wind exposure. The Department of Business, Economic Development and Tourism (DBEDT) produced population projections for the County from 2030 to 2050. According to these projections, Maui County's population is projected to grow to 173,520 by 2030, 181,000 by 2040, and 184,870 by 2050.

12.3.3 Climate Change

Hurricane and tropical storm frequency and intensity are projected to increase in the central Pacific region under climate warming scenarios. This phenomenon may be driven by warmer ocean waters, which feed tropical cyclone development. In addition, hurricane and tropical storm frequency in Maui County is highly variable based on ENSO patterns, as hurricanes are much more likely to impact Hawai'i during El Niño years. While it is unknown exactly how the timing and intensity of ENSO patterns will change in the future, climate model results indicate a doubling of El Niño and La Niña extremes in the 21st century when compared to the 20th century. Similarly, projected sea level rise combined with storm surges could mean that hurricanes impact areas further and further inland over time and could have impacts from which coastal communities are unable to fully recover. Further, warming ocean trends are known to cause coral bleaching episodes. Coral reefs provide protection against storm surges by forming an offshore barrier that works to dissipate wave energy.

12.3.4 Other Identified Conditions

Single-wall construction was a common residential construction method before plywood was readily available in Hawai'i and is still seen in what is known as "plantation houses." Single-wall construction homes do not have drywall, the electrical wiring is visible along walls, and the plumbing is often outside of the building. This is a method for building with no insulation and can only be used in warmer climates, like Hawai'i.

Single-wall homes have very little resistance to damage in high winds and this method of building was phased out as plywood and drywall became the norm for building new homes. This style is still seen in many of Maui County's historical buildings and there are retrofit options to make them more resistant to high winds while preserving the historic appearance of the buildings.

Post and pier foundations were the norm for economical building in Hawai'i before the nineties. The home's foundation is created with several posts resting on concrete blocks. A metal sheet, called a termite pan, sits between the post and the concrete blocks. The pieces are held together by friction and quite steady when natural disasters do not occur. During the high winds of a hurricane, the post can slip off the block. Following Hurricane Iniki, the County building code was revised to require foundations to be secured using foundation anchors, the technical term for this is ensuring a complete load path of connectors.

Finally, Hawaiian homes tend to have longer rafters to shield homes from the sun. At high wind speeds, these rafters can act almost like wings and lift the roof right off the house. Older homes were not built to secure the roof to the walls of the home. However, homes in Maui County are now required to have hurricane clips that secure the rafters to the walls and foundation anchors that lock the foundation in place.

13. LANDSLIDE

13.1 HAZARD PROFILE

13.1.1 Hazard Description

According to the U.S. Geological Survey (USGS), the term landslide includes a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Gravity acting on an over-steepened slope is the primary reason for a landslide, but other contributing factors include the following (USGS n.d.):

- Erosion by rivers, glaciers, or ocean waves create over steepened slopes
- Rock and soil slopes are weakened through saturation by snowmelt or heavy rains
- Earthquakes create stresses that make weak slopes fail
- Earthquakes of magnitude 4.0 and greater have been known to trigger landslides
- Volcanic eruptions produce loose ash deposits, heavy rain, and debris flows
- Excess weight from accumulation of rain or snow, stockpiling of rock or ore, from waste piles, or man-made structures may stress weak slopes to failure and other structures

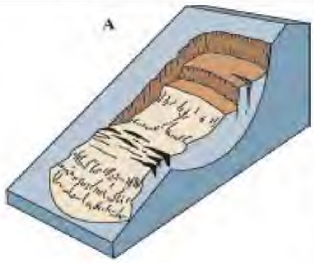
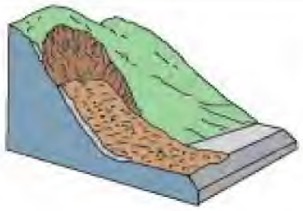
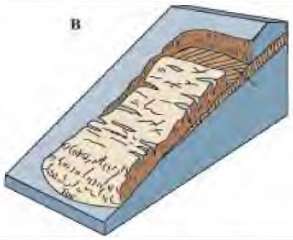
In areas burned by forest and brush fires, a lower precipitation threshold may initiate landslides as the vegetation and roots keeping the soil in place have burned away. Some landslides move slowly and cause damage gradually, whereas others move so rapidly that they can destroy property and take lives suddenly and unexpectedly.

Among the most destructive types of debris flows are those that accompany volcanic eruptions. A spectacular example in the United States was a massive debris flow resulting from the 1980 eruptions of Mount St. Helens, Washington. Areas near the bases of many volcanoes in the Cascade Mountain Range of California, Oregon, and Washington are at risk from the same types of flows during future volcanic eruptions.

Landslides may be triggered by both natural and human-caused changes in the environment. Natural causes can include heavy rain, rapid snow melt, steepening of slopes caused by erosion, earthquakes, and changes in groundwater levels. Human activities that contribute to slope failure include altering the natural slope gradient, steepening slopes by construction, increasing soil water content, and removing vegetation cover. Maui County is susceptible to all of these factors that trigger landslides.

The most common types of landslides are illustrated in Figure 13-1.

Figure 13-1. Major Types of Landslides

Rotational slides—Slides in which the surface of rupture is curved upward, and the slide movement rotates parallel to the ground surface. 	**Debris avalanches**—Debris flows that travel faster than about 10 miles per hour (mph). Speeds in excess of 20 mph are not uncommon, and speeds in excess of 100 mph, although rare, can occur. The slurry can travel miles from its source, growing as it descends, picking up trees, boulders, cars, and anything else in its path. 
Translational slides—Slides in which the mass moves along a roughly flat surface with little rotation. 	**Earthflows**—Landslides with an "hourglass" shape. The slope material liquefies and runs out, forming a bowl or depression at the head. 
Falls—Abrupt movements of geologic materials, such as rocks and boulders, that become detached from steep slopes or cliffs. Falls are strongly influenced by gravity, weathering, and the presence of water in a mineral's pores. 	**Creep**—Slow, steady, downward movements of slope-forming soil or rock. Creep is indicated by curved tree trunks, bent fences, or retaining walls, tilted poles or fences, and small soil ripples or ridges. 
Topples—Slides involving the forward rotation of a unit about some point under the actions of gravity and forces exerted by surrounding objects or by fluids in cracks. 	**Lateral Spreads**—Slides on very gentle slopes or flat terrain caused by liquefaction, the process whereby saturated, loose, sediments are transformed from a solid into a liquefied state. The failure starts suddenly in a small area and spreads rapidly. 
Debris flows—Rapid landslides in which loose soil, rock, organic matter, air, and water mobilize as a slurry that flows downslope. Commonly caused by intense surface water flow due to heavy rain or rapid snowmelt that erodes loose soil or rock on steep slopes. **Post-Wildfire Debris Flows**—Debris flows resulting from post-fire conditions, where burned soil surfaces enhance rainfall runoff that concentrates and picks up debris as it moves. 	

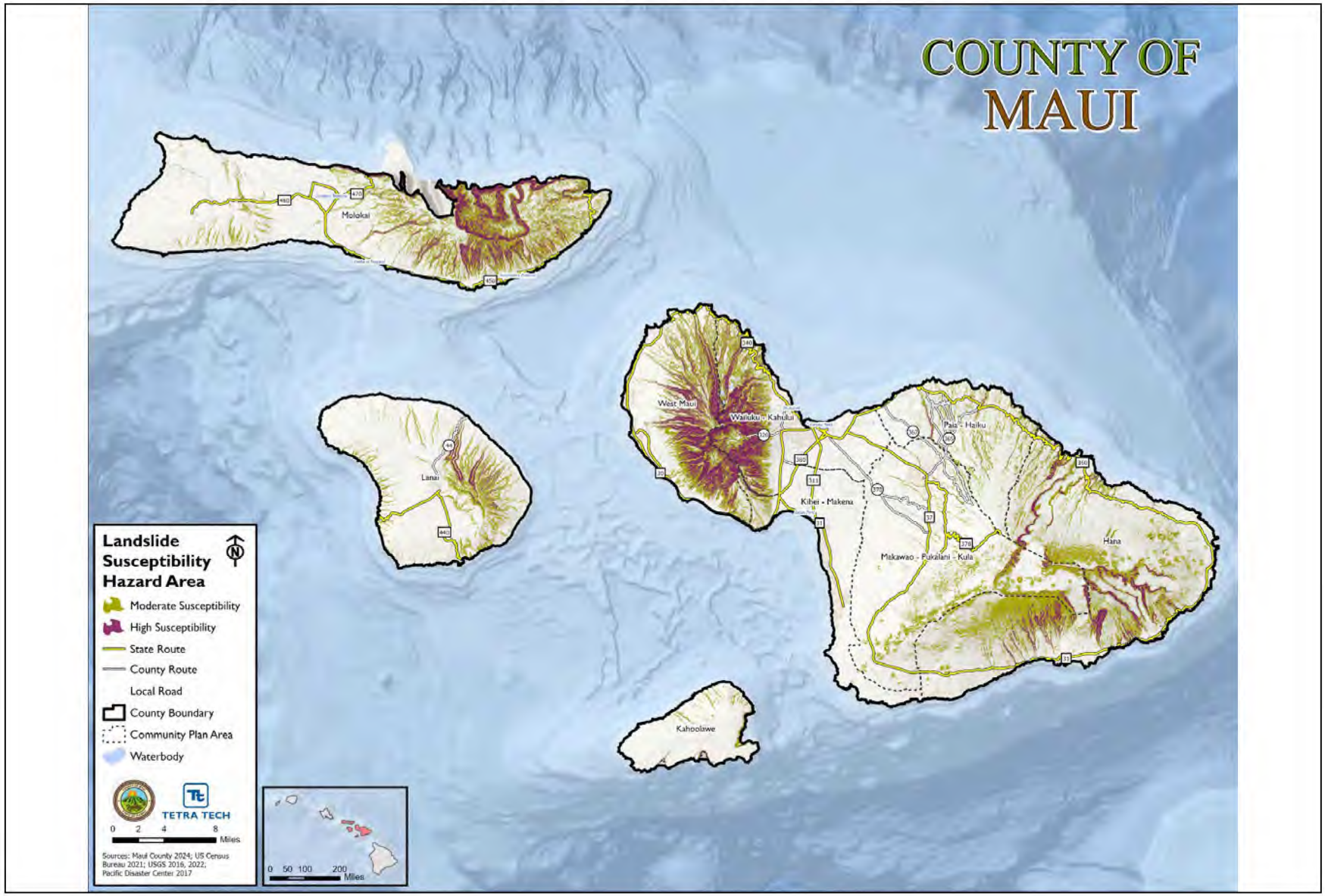
Source: (USGS 2004)

13.1.2 Location

Landslides occur along steep slopes when the pull of gravity can no longer be resisted. Heavy rain, especially on wildfire-scarred land where the ground is unstable due to vegetation loss, often catalyzes a landslide event. Human development can also exacerbate risk by building on previously undevelopable steep slopes and constructing roads by cutting through mountains. Maui Island is comprised of two mountainous areas – Haleakalā in the southeast and the West Maui Mountains in the northwest. The Islands of Lāna‘i and Moloka‘i also contain steep slopes associated with mountain ranges and extinct shield volcanoes. While susceptibility to landslides varies throughout the county, landslides are possible throughout the planning area.

Figure 13-2 shows the moderate to high landslide susceptibility in the County.

Figure 13-2. Landslide Susceptibility in Maui County



13.1.3 Extent

The extent of landslides in Maui County can be defined using various measures, including the USGS Landslide Susceptibility classifications for the State of Hawai'i. The highest category present in Maui County is "very high" susceptibility. Data on slope, faults, geology, forest loss, and road networks were combined by NASA to develop the susceptibility categories mapped in Figure 13-2. The categories are described in Table 13-1.

Table 13-1. Landslide Susceptibility

Category	Frequency
Very Low	<0.11
Low	0.11-0.49
Moderate	0.50-0.67
High	0.68-0.75
Very High	>0.75

Source: (Stanley and Kirschbaum 2017)

Landslide extent can also be measured in terms of size, such as the width of the slide or the tonnage of debris generated. For example, the May 2014 landslide on Hāna Highway was 100 feet long and 20 feet high, resulting in 2,000 cubic yards of debris being cleared. Larger, more severe landslide events are possible, depending on the velocity of the landslide.

Warning Time

Landslides can occur suddenly or slowly. The velocity may be a slow creep of inches per year for large, deep-seated landslides, while the runout from debris flows may be many feet per second. Earthquake-induced landslides, including rock avalanches, may be almost instantaneous.

The warning time for landslides depends on awareness of the hazard as well as monitoring and alert systems. Conducting assessments of pre-existing landsliding and areas that may be prone to landsliding develops awareness of the hazard and planning for potential slope movement, depending on slope angle, material, and water content. Some methods used to monitor landslides can provide an idea of the type of movement and the amount of time before failure. It is also possible to determine what areas are at risk during general time periods. Assessing geology, vegetation, amount of predicted precipitation, and potential earthquake ground motions can help in these assessments.

For landslides or debris flows that may be triggered by rainfall, improved forecasting of El Niño events or other potentially high rainfall years can provide some advanced warning. Rainfall forecasting allows for better preparation and response to potential slope failures and flood events. Warning signs for landslide activity include the following (USGS n.d.):

- Springs, seeps, or saturated ground in areas that have not typically been wet before
- New cracks or unusual bulges in the ground, street pavement, or sidewalk

- Soil moving away from foundations
- Ancillary structures, such as decks and patios, tilting and 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 roadbeds
- The rapid increase in creek water levels, possibly accompanied by increased turbidity
- A sudden increase in creek water levels while rain is still falling or just recently ended
- Sticking doors and windows, and visible open spaces indicating jambs and frames out of plumb
- A faint rumbling sound that increases in volume as the landslide nears
- Unusual sounds, such as trees cracking or boulders knocking together

13.1.4 Previous Occurrences

FEMA Disaster Declarations

Between 1954 and 2024, Maui County was included in five major disaster (DR) or emergency (EM) declarations for landslide-related events (FEMA 2024). Table 13-2 lists these declarations.

Table 13-2. FEMA Disaster Declarations for Landslide Events in Maui County

Event Date	Declaration Date	Declaration Number	Description
December 4, 2007 to December 7, 2007	February 6, 2008	DR-1743	Severe Storms, High Surf, Flooding, and Mudslides
March 3, 2012 to March 11, 2012	April 18, 2012	DR-4062	Severe Storms, Flooding, and Landslides
September 11, 2016 to September 14, 2016	October 6, 2016	DR-4282	Severe Storms, Flooding, Landslides, and Mudslides
March 8, 2021 to March 18, 2021	May 13, 2021	DR-4604	Severe Storms, Flooding, and Landslides
December 5, 2021 to December 10, 2021	February 15, 2022	DR-4639	Severe Storms, Flooding, and Landslides

Source: (FEMA 2024)

State Emergency Proclamations

The Governor of Hawai'i may declare a state of emergency by proclamation if an emergency or disaster has occurred or there is imminent danger or threat of an emergency or disaster in any portion of the state (Hawai'i State Legislature 2020). Between 2020 and 2024, Maui County was included in one landslide-related state emergency proclamation.

Table 13-3. State Emergency Proclamations for Dam Failure Events in Maui County, 2020 to 2024

Declaration Date	Description
March 9, 2021	Emergency Proclamation Related to Heavy Rains and Flooding

Source: (HI-EMA 2024)

USDA Declarations

The U.S. Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties contiguous to them. Between 2020 and 2024, Maui County was not included in any USDA landslide-related agricultural disaster declarations (USDA 2024).

All Recent Events

Table 13-4 lists major recorded landslide-related events that impacted Maui County between January 2020 and December 2024. These hazard events include debris flow, mudslides, as well as landslides. For earlier events, refer to the 2020 HMP.

Table 13-4. Landslide Events in Maui County (2020 to 2024)

Event Date	FEMA Declaration or State Proclamation Number	Location Impacted	Description
April 14, 2020	N/A	Keanae Hāna	A decaying front over the eastern part of the Aloha State, along with nearby surface and upper troughs, triggered heavy downpours and isolated thunderstorms over portions of the Big Island, Oahu, and Maui. The heavy rain caused ponding on roadways, and small stream and drainage ditch flooding. No serious injuries or property damage were reported. One landslide reported beyond Keanae at MM15. 1 lane is open. Hāna highway rock slide Mp.#46. 1 to 2 hour wait to clear slide. Dirt and Debris on road and in storm drains.
May 4,2020	N/A	Hāna	A landslide blocked one lane of Hāna Highway near Kipahulu. Repairs were estimated at $835,000 and were completed in September 2020.
March 9,2021	DR-4604	Keanae	Debris Flow: Hāna 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.
December 5-10, 2021	DR-4639	Maui County	A slow-moving weather system dumped more than 20 inches of rain on areas of Hawai‘i, at as much as 3 inches an hour. It caused widespread flooding, power outages, landslides, and damage.

Event Date	FEMA Declaration or State Proclamation Number	Location Impacted	Description
November 30, 2023	N/A	Statewide	A Kona low developed west-northwest of the Hawaiian Islands and brought periods of heavy rainfall and isolated thunderstorms. Heavy rainfall led to localized flash flooding and landslides across portions of the state. Periods of heavy rainfall led to an accumulation of water on the roadways which led to the closure of Piilani highway from mile marker 29-31, as well as mile marker 16. Hāna Highway was also closed near mile marker 40.

Source: (NOAA 2024) (County of Maui 2020) (HI-EMA 2023)

13.1.5 Probability of Future Occurrences

Probability Based on Previous Occurrences

Information on previous landslide occurrences in the County was used to calculate the probability of future occurrence of such events. Table 13-5 lists the number of events from various sources such from 1996 to 2024, which is the most complete period of record for all sources reviewed. Based on these records and input from the HMWG, the probability of occurrence for landslides in the County is considered “occasional.”

Table 13-5. Probability of Future Landslide Events in Maui County

Hazard Type	Number of Occurrences Between 1996 and 2024	Percent Chance of Occurring in Any Given Year
Landslide/Mudslide	22	76%
Debris Flow	2	6.9%
Total	24	83%

Source: (FEMA 2024) (County of Maui 2020) (HI-EMA 2023) (NOAA 2024)
Note: The time period presented in this table is the most complete period of record for the various data sources reviewed.

Effect of Climate Change on Future Probability

Climate change may impact storm patterns and increase the probability of more frequent, intense storms with varying duration. Climate projections for the State of Hawai‘i 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 (HI-EMA 2023).

Maui County’s topography is 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 experienced on Kaua'i 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 (HI-EMA 2023).

13.1.6 Cascading Impacts on Other Hazards

Landslides can cause secondary effects such as blocking roads, which can isolate residents and businesses and delay commercial, public, and private transportation. Other potential problems can result from landslides if vegetation or poles on slopes are knocked over, causing losses to power and communication lines. Landslides also have the potential of destabilizing the foundation of structures, which may result in monetary loss for residents. They can damage rivers or streams, potentially harming water quality, fisheries, and spawning habitat. Landslides into floodways can block the flow of water and cause flooding.

13.2 VULNERABILITY AND IMPACT ASSESSMENT

To assess Maui County's risk to the landslide hazard, a spatial analysis was conducted using landslide susceptibility data from the Pacific Disaster Center (2017) and USGS (2016). To determine what assets are exposed to landslide, the asset inventories prepared for this HMP (population, buildings, critical facilities) were overlaid with the moderate and high landslide susceptibility hazard areas. Assets with their centroid located in the hazard areas were totaled to estimate the numbers and values at risk from the impacts of landslides.

13.2.1 Life, Health, and Safety

Landslides can have significant impacts on life, health, and safety. They pose immediate threats to human lives, often resulting in injuries or fatalities. The sudden movement of earth can destroy homes and infrastructure, and disrupt essential services, leading to hazardous living conditions. Additionally, landslides can cause long-term health issues due to the displacement of communities and the potential for water contamination. Ensuring public safety and preparedness is crucial to mitigate these risks.

Overall Population

Generally, a landslide event is an isolated incident and impacts the population within the immediate area of the incident. Specifically, the population located downslope of high landslide incidence hazard areas are particularly vulnerable. In addition to causing damage to residential buildings and displacing residents, landslide events can block off or damage major roadways and inhibit travel for emergency responders or populations trying to evacuate the area.

As shown in Table 13-6, Maui County has a population total of 1,498, or 0.9 percent of the Community Plan Area total, located in the moderate landslide susceptibility area. Wailuku–Kahului has the highest number of persons (643) located in this hazard area out of all Community Plan Areas.

Table 13-6. Population in Moderate Landslide Susceptibility Hazard Area

Community Plan Area	Total Population (2023 ACS)	Population in the Moderate Landslide Susceptibility Hazard Area	
		Number of Persons	% of Plan Area Total
Hāna	2,135	33	1.5%
Kīhei-Mākena	29,174	0	0.0%
Lānaʻi	3,333	5	0.2%
Makawao-Pukalani-Kula	24,505	292	1.2%
Molokaʻi	8,092	34	0.4%
Pāʻia-Haʻikū	17,037	424	2.5%
Wailuku-Kahului	58,606	643	1.1%
West Maui	21,749	67	0.3%
Maui County (Total)	164,632	1,498	0.9%

Source: U.S. Census Bureau 2023 ACS; Pacific Disaster Center 2017; USGS 2016

Table 13-7 presents that a total of 21 persons in Maui County live within the High Landslide Susceptibility hazard area. Pāʻia–Haʻikū holds the highest number of persons (17) in this hazard area out of all the Community Plan Areas.

Table 13-7. Population in High Landslide Susceptibility Hazard Area

Community Plan Area	Total Population (2023 ACS)	Population in the High Landslide Susceptibility Hazard Area	
		Number of Persons	% of Plan Area Total
Hāna	2,135	2	0.1%
Kīhei-Mākena	29,174	0	0.0%
Lānaʻi	3,333	0	0.0%
Makawao-Pukalani-Kula	24,505	0	0.0%
Molokaʻi	8,092	2	<0.1%
Pāʻia-Haʻikū	17,037	17	0.1%
Wailuku-Kahului	58,606	0	0.0%
West Maui	21,749	0	0.0%
Maui County (Total)	164,632	21	<0.1%

Source: U.S. Census Bureau 2023 ACS; Pacific Disaster Center 2017; USGS 2016

Socially Vulnerable Population

Research has also shown that some populations, while they may not have more hazard exposure, may experience exacerbated impacts and prolonged recovery if/when impacted. For example, persons over the age of 65 and people below the poverty level are most vulnerable to geological hazards because of

the potential limited access to mobilization or medical resources if a landslide or subsidence event occurs. Populations with access and functional needs, as well as elderly populations and the very young, may be unable to evacuate quickly enough to avoid the impacts of a landslide. Other vulnerable groups may include those experiencing homelessness or residents and visitors whose primary language is not English.

The County has several socially vulnerable populations that may be more susceptible to the impacts of natural disasters, economic challenges, and other social and environmental stressors. Table 13-8 presents the estimated socially vulnerable populations living in the moderate landslide susceptibility hazard areas. There are 130 persons over the age of 65 years, 65 persons under the age of 5 years, 265 non-English speakers, 122 persons with a disability, and 216 living in poverty located in this hazard area.

Table 13-9 presents the estimated socially vulnerable populations living in the high landslide susceptibility hazard areas. There are two persons over the age of 65 years, one person under the age of 5 years, zero non-English speakers, one person with a disability, and one living in poverty located in this hazard area.

Table 13-8. Estimated Number of Vulnerable Persons Location in the Moderate Landslide Susceptibility Hazard Area

Community Plan Area	Estimated Number of Vulnerable Persons Located in the Moderate Landslide Susceptibility Hazard Area									
	Persons Over 65	Percent of Total	Persons Under 5	Percent of Total	Non-English Speaking Persons	Percent of Total	Persons with a Disability	Percent of Total	Persons in Poverty	Percent of Total
Hāna	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Kīhei-Mākena	437	27.0%	219	27.0%	545	27.0%	361	27.0%	507	27.0%
Lānaʻi	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Makawao-Pukalani-Kula	58	1.5%	62	1.5%	39	1.5%	46	1.5%	68	1.5%
Molokaʻi	5	<0.1%	3	<0.1%	5	<0.1%	4	<0.1%	7	<0.1%
Pāʻia-Haʻikū	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Wailuku-Kahului	125	1.2%	45	1.2%	130	1.2%	72	1.2%	87	1.2%
West Maui	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Maui County (Total)	130	1.6%	65	1.6%	265	1.6%	122	1.6%	216	1.6%

Source: U.S. Census Bureau 2023 ACS Vulnerable Population Totals; Pacific Disaster Center 2017; USGS 2016

Table 13-9. Estimated Number of Vulnerable Persons Location in the Moderate Landslide Susceptibility Hazard Area

Community Plan Area	Estimated Number of Vulnerable Persons Located in the Moderate Landslide Susceptibility Hazard Area									
	Persons Over 65	Percent of Total	Persons Under 5	Percent of Total	Non-English Speaking Persons	Percent of Total	Persons with a Disability	Percent of Total	Persons in Poverty	Percent of Total
Hāna	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Kīhei-Mākena	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Lānaʻi	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Makawao-Pukalani-Kula	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Molokaʻi	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Pāʻia-Haʻikū	2	0.1%	1	0.1%	0	0.0%	1	0.1%	1	0.1%
Wailuku-Kahului	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
West Maui	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Maui County (Total)	2	<0.1%	1	<0.1%	0	0.0%	1	<0.1%	1	<0.1%

Source: U.S. Census Bureau 2023 ACS Vulnerable Population Totals; Pacific Disaster Center 2017; USGS 2016

13.2.2 General Building Stock

All current and future buildings and infrastructure, including critical facilities, located within or downslope of landslide susceptibility areas are at risk of landslides. Landslides can directly damage structures by disrupting their foundations due to ground deformation and by the physical impact of debris moving downslope. As a landslide breaks away from a slope and moves, it creates an uneven surface, causing structural foundations and the structures themselves to experience settlement, cracking, and tilting. This deformation can occur slowly over years or rapidly within days or hours. Additionally, a water-saturated, fast-moving debris flow, or "mudslide," can destroy everything in its path, collapsing walls and shifting structures off their foundations.

There are 415 buildings with a replacement cost value of approximately $396 million built on lands within the moderate landslide susceptibility hazard area. The Community Plan Area of Wailuku-Kahului has the greatest number of buildings built in this area; 167 buildings (1.1 percent of its total building stock) with an estimated replacement cost of $189 million. Table 13-10 summarizes the number of buildings built in the moderate landslide susceptibility hazard area and the total replacement cost of these buildings by Community Plan Area.

Table 13-10. Replacement Cost Value of Buildings in the Moderate Landslide Susceptibility Hazard Area

	Community Plan Area Total Buildings		Buildings in the Moderate Landslide Susceptibility Hazard Area			
			Number of Buildings		Replacement Cost Value	
Community Plan Area	Count	Replacement Cost Value	Count	% of Plan Area Total	Value	% of Plan Area Total
Hāna	930	$741,266,476	15	1.6%	$10,726,406	1.4%
Kīhei-Mākena	7,613	$11,692,760,990	0	0.0%	$0	0.0%
Lānaʻi	1,258	$1,012,846,136	3	0.2%	$1,299,271	0.1%
Makawao-Pukalani-Kula	8,868	$6,037,317,698	102	1.2%	$76,706,414	1.3%
Molokaʻi	3,056	$2,384,451,998	13	0.4%	$6,230,478	0.3%
Pāʻia-Haʻikū	4,316	$2,686,054,376	102	2.4%	$94,217,951	3.5%
Wailuku-Kahului	15,444	$18,302,375,352	167	1.1%	$189,413,382	1.0%
West Maui	4,063	$8,896,487,618	13	0.3%	$17,811,278	0.2%
Maui County (Total)	45,548	$51,753,560,644	415	0.9%	$396,405,181	0.8%

Source: USACE NSI 2022; Hawai'i Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; RSMeans 2024; Pacific Disaster Center 2017; USGS 2016

Table 13-11 displays the buildings by general occupancy located within the moderate landslide susceptibility hazard area. This analysis estimates that the residential occupancy is the most exposed to this hazard area with 380 total buildings. The Community Plan Area of Wailuku-Kahului holds the highest number of resident buildings (145) in the hazard area.

Table 13-11. Buildings in the Moderate Landslide Susceptibility Hazard Area by General Occupancy Class

Community Plan Area	Buildings in the Moderate Landslide Susceptibility Hazard Area by General Occupancy Class			
	Residential	Commercial	Industrial	Other[a]
Hāna	13	2	0	0
Kīhei-Mākena	0	0	0	0
Lānaʻi	2	1	0	0
Makawao-Pukalani-Kula	99	2	1	0
Molokaʻi	12	1	0	0
Pāʻia-Haʻikū	98	1	2	1
Wailuku-Kahului	145	20	2	0
West Maui	11	2	0	0
Maui County (Total)	380	29	5	1

Source: USACE NSI 2022; Hawai'i Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; Pacific Disaster Center 2017; USGS 2016

a. Other = Government, Religion, Agricultural, and Education

Within the high landslide susceptibility hazards area, there are 10 buildings with a replacement cost value of approximately $15 million built on land within the high landslide susceptibility hazard area. The Community Plan Area of Pāʻia-Haʻikū has the greatest number of buildings built in this area; 4 buildings (0.1-percent of its total building stock) with an estimated replacement cost of $2.7 million. Table 13-12 summarizes the number of buildings built in the high landslide susceptibility hazard area and the total replacement cost of these buildings by Community Plan Area.

Table 13-13 displays the buildings by general occupancy located within the high landslide susceptibility hazard area. This analysis estimates that the residential occupancy is the most exposed to this hazard area with 6 total buildings. The Community Plan Area of Pāʻia-Haʻikū holds the highest number of resident buildings (4) in the hazard area.

13.2.3 Community Lifelines and Other Critical Facilities

Buildings, utilities, roads, and bridges are vulnerable to the impacts caused by landslides and other earth movements. When utility lines are damaged by landslides, the functionality of water, sewer, gas, and electricity systems may be compromised. Due to their geographic extent, roads and utility lines have a higher likelihood of being affected by landslide events. Furthermore, if any section of a road or utility line is damaged by a landslide, the entire system may be impacted. For example, a landslide that renders one area of a road or bridge impassable may block accessibility to other roads or locations.

In Maui County, there is one critical facility located in the moderate landslide susceptibility hazard area; this facility is located in the Hāna Community Plan Area. There are no critical facilities located in the high landslide susceptibility hazard area.

Table 13-12. Replacement Cost Value of Buildings in the High Landslide Susceptibility Hazard Area

Community Plan Area	Community Plan Area Total Buildings		Buildings in the High Landslide Susceptibility Area			
			Number of Buildings		Replacement Cost Value	
	Count	Replacement Cost Value	Count	% of Plan Area Total	Value	% of Plan Area Total
Hāna	930	$741,266,476	3	0.3%	$7,870,866	1.1%
Kīhei-Mākena	7,613	$11,692,760,990	0	0.0%	$0	0.0%
Lānaʻi	1,258	$1,012,846,136	0	0.0%	$0	0.0%
Makawao-Pukalani-Kula	8,868	$6,037,317,698	0	0.0%	$0	0.0%
Molokaʻi	3,056	$2,384,451,998	1	<0.1%	$142,151	<0.1%
Pāʻia-Haʻikū	4,316	$2,686,054,376	4	0.1%	$2,676,373	0.1%
Wailuku-Kahului	15,444	$18,302,375,352	2	<0.1%	$4,265,940	<0.1%
West Maui	4,063	$8,896,487,618	0	0.0%	$0	0.0%
Maui County (Total)	45,548	$51,753,560,644	10	<0.1%	$14,955,331	<0.1%

Source: USACE NSI 2022; Hawaiʻi Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; RSMeans 2024; Pacific Disaster Center 2017; USGS 2016

Table 13-13. Buildings in the High Landslide Susceptibility Hazard Area by Occupancy Class

Community Plan Area	Buildings in the High Landslide Susceptibility Hazard Area by General Occupancy Class			
	Residential	Commercial	Industrial	Other[a]
Hāna	1	2	0	0
Kīhei-Mākena	0	0	0	0
Lānaʻi	0	0	0	0
Makawao-Pukalani-Kula	0	0	0	0
Molokaʻi	1	0	0	0
Pāʻia-Haʻikū	4	0	0	0
Wailuku-Kahului	0	1	0	1
West Maui	0	0	0	0
Maui County (Total)	6	3	0	1

Source: USACE NSI 2022; Hawaiʻi Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; Pacific Disaster Center 2017; USGS 2016

a. Other = Government, Religion, Agricultural, and Education

13.2.4 Economy

Landslides can lead to significant economic losses through various mechanisms. Direct losses include damage to or destruction of structures, vehicles, and utility lines. Roads may suffer damage or become undermined, necessitating state or county expenditures to deploy crews for debris removal. Indirectly, landslides can disrupt business operations by obstructing access or interrupting utility services. Even

minor damage to a section of road or utility line can impact the entire system. For example, a landslide that renders a portion of a road impassable can hinder access to other roads or locations, impeding evacuations, delivery of goods and services, and disrupting schools and businesses. During the 2006 landslides associated with the Kiholo Bay and Mahukona earthquakes, damage to a truss bridge and road blockages isolated approximately 500 Maui residents.

13.2.5 Natural, Historic and Cultural Resources

Natural

The County's abundant natural resources are one of the many elements that attract visitors to the island, and as discussed, tourism is a major contributor to the local 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).

Furthermore, soil and sediment runoff can accumulate downslope potentially blocking waterways and roadways and impacting the quality of streams and other water bodies. Mudflows that erode into downstream waterways can threaten the life of freshwater species. The impacts of eroded landscape can travel for miles downstream into adjacent waterways and create issues for surrounding watersheds.

Historic

Landslide impacts on historic resources in Maui County are highest in areas near hillsides with unstable soil and erosion. Historical structures are often not built to modern building standards and are more prone to damage.

Cultural

Landslide impacts on cultural resources are akin to those on historic resources. Landslide events in the County can damage property and infrastructure around cultural landmarks, leading to reduced access and potential closures of these assets and areas. Additionally, the loss or harm to native species and ecosystems will adversely affect Hawaiian cultural traditions and practices, which are deeply connected to the natural environment.

13.2.6 Identified Vulnerability Issues

The County has identified the following vulnerabilities related to this hazard:

- Landslides have a history of closing roads to isolated communities, rendering them unreachable by first responders, especially when the soil becomes saturated during a period of high rainfall.
- A major landslide on roadway arteries, such as the Pali, would be disastrous for residents because more than 30,000 vehicles per day use that road. The alternative route (Kahakuloa)

doesn't have the capacity to serve West Maui's traffic needs. West Maui would be (for the most part) cut off from the major harbor, airport, and hospital until the road is reopened.

- County engineers do not have GIS layers that identify landslide hazard areas and historic landslide events.
- Power lines often follow roads and landslides can cause power outages.

13.3 FUTURE CHANGES THAT MAY AFFECT RISK

13.3.1 Potential or Planned Development

Any areas of growth could potentially be impacted by the landslide hazard if located within identified hazard zones. Generally, development on slopes is not recommended due to the increased risk of erosion, stormwater runoff, and flooding. Additional runoff can lead to sedimentation of downstream surface waters, damaging habitats and potentially harming property. Future development should also consider the geological makeup of the area; certain soils, such as those prone to liquefaction, require careful planning and mitigation measures.

Future changes to potential or planned development must account for landslide hazards. Development within hazard zones should incorporate robust risk assessments and implement strategies to mitigate landslide risks. This includes avoiding construction on unstable slopes, enhancing drainage systems to manage stormwater runoff, and reinforcing structures to withstand potential geological impacts.

In Maui County, 80 new developments (2.5 percent) fall within the moderate landslide susceptibility hazard area, with the highest in West Maui with 48 (8.4 percent), followed by Paia-Haiku with 16 (4.5 percent). Within the high landslide susceptibility hazard area, Maui County has a total of nine new developments (0.3 percent), with the highest count in West Maui with six (1.0 percent), and Hana with three (7.7 percent). All other planning areas report no new development within the high landslide susceptibility hazard area.

Table 13-14 and Table 13-15 breakdown new developments in both the moderate and high landslide susceptibility hazard area by community planning area.

Table 13-14. Number of New Development in the Moderate Landslide Susceptibility Hazard Area

Community Plan Area	Number of New Development in the Moderate Landslide Susceptibility Hazard Area	
	Count	% of Jurisdiction's Total
Hana	0	0.0%
Kahoolawe	0	0.0%
Kihei - Makena	0	0.0%
Lanai	0	0.0%

Makawao - Pukalani - Kula	7	1.1%
Molokai	2	1.8%
Paia - Haiku	16	4.5%
Wailuku - Kahului	7	0.9%
West Maui	48	8.4%
Maui County (Total)	**80**	**2.5%**

Source: *County of Maui 2025; Pacific Disaster Center 2017; USGS 2016*

Table 13-15.Number of New Development in the High Landslide Susceptibility Hazard Area

Community Plan Area	Number of New Development in the High Landslide Susceptibility Hazard Area	
	[illegible]	[illegible]
Hana	3	7.7%
Kahoolawe	0	0.0%
Kihei - Makena	0	0.0%
Lanai	0	0.0%
Makawao - Pukalani - Kula	0	0.0%
Molokai	0	0.0%
Paia - Haiku	0	0.0%
Wailuku - Kahului	0	0.0%
West Maui	6	1.0%
Maui County (Total)	**9**	**0.3%**

Source: *County of Maui 2025; Pacific Disaster Center 2017; USGS 2016*

13.3.2 Projected Changes in Population

An increase in population can significantly elevate the risk of landslides. Urbanization often leads to the expansion of urban areas into vulnerable regions, altering topography and increasing precipitation-triggered landslides. Population pressure can also result in deforestation as land is cleared for housing and agriculture, destabilizing the soil and heightening landslide risks. Additionally, the development of infrastructure such as roads and buildings can change natural drainage patterns and increase surface runoff, further triggering landslides. With more people living in landslide-prone areas, the potential for human and economic losses rises.

The Department of Business, Economic Development and Tourism (DBEDT) produced population projections for the County from 2030 to 2050. According to these projections, Maui County's population is projected to grow to 173,520 by 2030, 181,000 by 2040, and 184,870 by 2050.

13.3.3 Climate Change

Climate change is expected to alter storm patterns, leading to more frequent and intense storms in Maui County, despite an overall decline in rainfall. This could increase landslides and rockfalls due to heavier rain events. Warming temperatures may also prolong droughts, raising wildfire risks and reducing vegetation that stabilizes slopes. All of these factors would increase the probability of landslide occurrences in Maui County.

13.3.4 Other Identified Conditions

Areas with weak or fractured earth, such as those with clay-rich soils, are more prone to landslides. Additionally, the removal of vegetation, whether due to natural causes like wildfires or human activities, can reduce the stability of slopes and make them more susceptible to landslides. In coastal areas, erosion can undermine cliffs and slopes, leading to landslides.

14. TSUNAMI

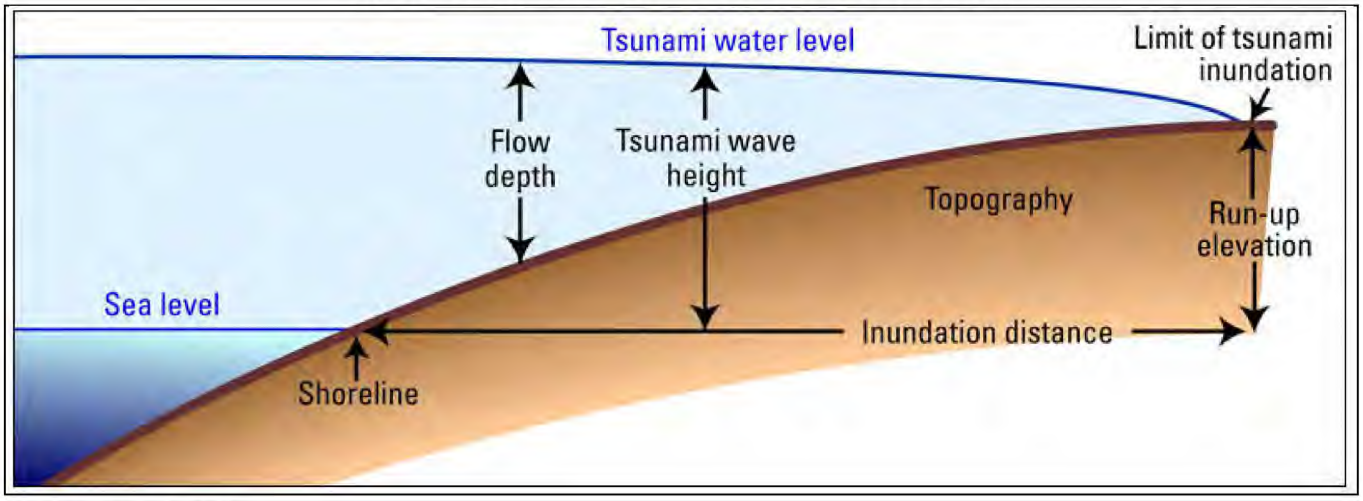
14.1 HAZARD PROFILE

14.1.1 Hazard Description

Tsunamis are a series of giant waves created by a disturbance such as an earthquake, landslide, volcanic eruption, or meteorite (NOAA 2024). From the area where the tsunami originates, waves travel outward in all directions. In the deep open ocean, a tsunami can move hundreds of miles per hour and may only be a few inches or feet high. As a tsunami travels inland and the ocean depth decreases, its wave height increases, potentially reaching heights of 100 feet or more.

Tsunamis are characterized as shallow-water waves, meaning the ratio between the water depth and its wavelength is very small. Unlike wind-generated surf waves, which have a period of 5 to 20 seconds and a wavelength of about 100 to 200 meters, a tsunami wave can have a period ranging from five minutes to two hours and an open ocean wavelength exceeding 100 miles (Pacific Tsunami Museum n.d.). Figure 14-1 illustrates the makeup of a tsunami and associated terminology.

Figure 14-1. Illustration of Tsunami Terminology



Source: (USGS 2008)

More than 95 percent of tsunamis result from subduction earthquakes, referred to as "tsunamigenic" earthquakes. These earthquakes generate tsunamis when the sea floor abruptly deforms and displaces the overlying water from its equilibrium position. The main factor determining 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.

Landslides are the second most common cause of tsunamis. A tsunami may be generated by a landslide originating above sea level but plunging into the sea or by a submarine landslide. Other

geologic disturbances, such as volcanic activity, can also generate tsunamis by displacing a large water mass from its equilibrium position.

When a tsunami reaches the shore, it may appear as a rapidly rising or falling tide, a series of breaking waves, or even a bore (a step-like wave with a steep breaking front). Although most people imagine a tsunami as a large, steep wave breaking on the shore, tsunamis generally appear as an advancing tide without a developed wave face and produce rapid flooding of low-lying coastal areas. Areas at greatest risk of tsunami impacts are those less than 25 feet above sea level and within a mile of the shoreline (FEMA 2022).

Reefs, bays, entrances to rivers, undersea features, and the slope of the beach all help to modify the tsunami as it approaches the shore. The long-period wave can bend around obstacles, allowing the tsunami to enter bays and gulfs with intricate shapes. Wave heights increase in bays that narrow from the entrance to the head but decrease in bays with narrow entrances. Shorelines protected by reefs typically do not sustain extensive damage from tsunamis as the reefs disperse the wave energy. Additionally, islands in a group may "shadow" one another, reducing the tsunami effect, and small islands may experience reduced runup as the tsunami waves refract around them.

14.1.2 Location

Maui County, along with the rest of the Hawaiian Islands, is vulnerable to tsunami events triggered by local sources or generated along the Pacific Ring of Fire. Tsunamis pose a significant threat to life and property for those living along or near the coastline. At sea level, there is no safe place during a tsunami. On low-lying shorelines, such as the river and stream valleys that characterize much of Hawai‘i, a tsunami can manifest as a rapidly rising high tide that inundates low coastal regions over several minutes. The return of these floodwaters to the sea causes extensive damage. At headlands, the refractive focusing of the wave crest leads to energy concentration and high-magnitude runup (HI-EMA 2023). Table 14-1 summarizes Maui inundation area estimates from the following sources:

- The **Great Aleutian Tsunami (GAT)** scenario models the potential impacts of a massive tsunami generated by a hypothetical M9.2 earthquake in the eastern Aleutian Islands. This scenario helps predict inundation areas and assess the risks of such an extreme event.
- The **School of Ocean and Earth Science and Technology (SOEST)** at the University of Hawai‘i plays a vital role in tsunami research. SOEST provides valuable data and models that are essential for assessing tsunami risks and impacts. Their research aids in the development of accurate evacuation maps and effective mitigation strategies.
- The **American Society of Civil Engineers (ASCE)** sets standards for designing structures to withstand natural hazards, including tsunamis. ASCE's guidelines and models are used to evaluate the vulnerability of buildings and infrastructure, ensuring they are resilient against tsunami impacts.

Figure 14-2 presents the tsunami hazard area for Maui County for the above scenarios. A more detailed view of the GAT scenario is provided in Figure 14-3.

Table 14-1. GAT, SOEST, and ASCE Inundation Areas

County	Total Area	GAT Hazard Area		SOEST Hazard Area		ASCE Hazard Area	
		Area	% of Total Area	Area	% of Total Area	Area	% of Total Area
County of Maui	1,176.28	16.63	1.41%	11.66	0.99%	24.02	2.04%

Source: (HI-EMA 2023)

Figure 14-2. Tsunami Hazard Area in Maui County

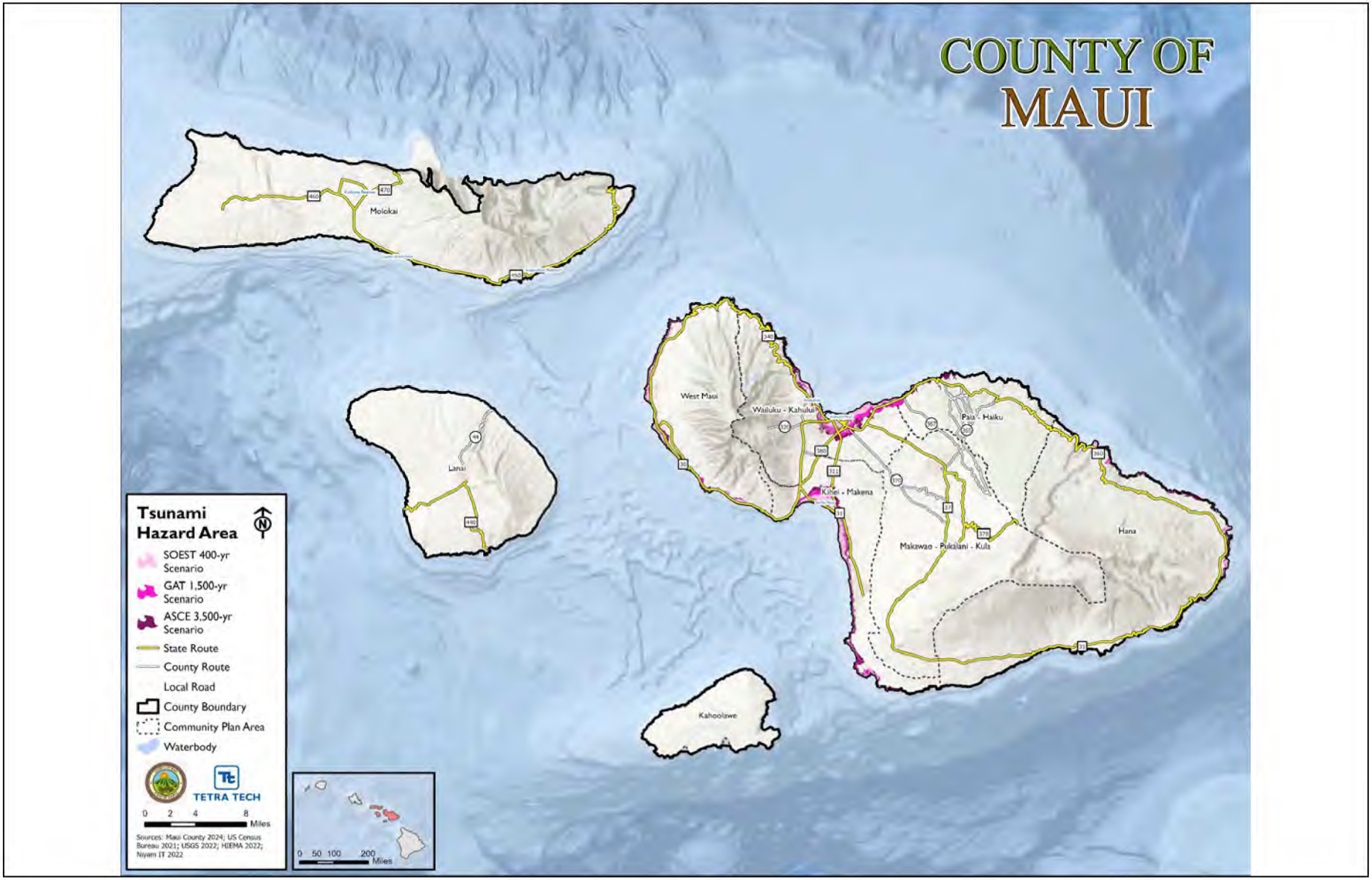
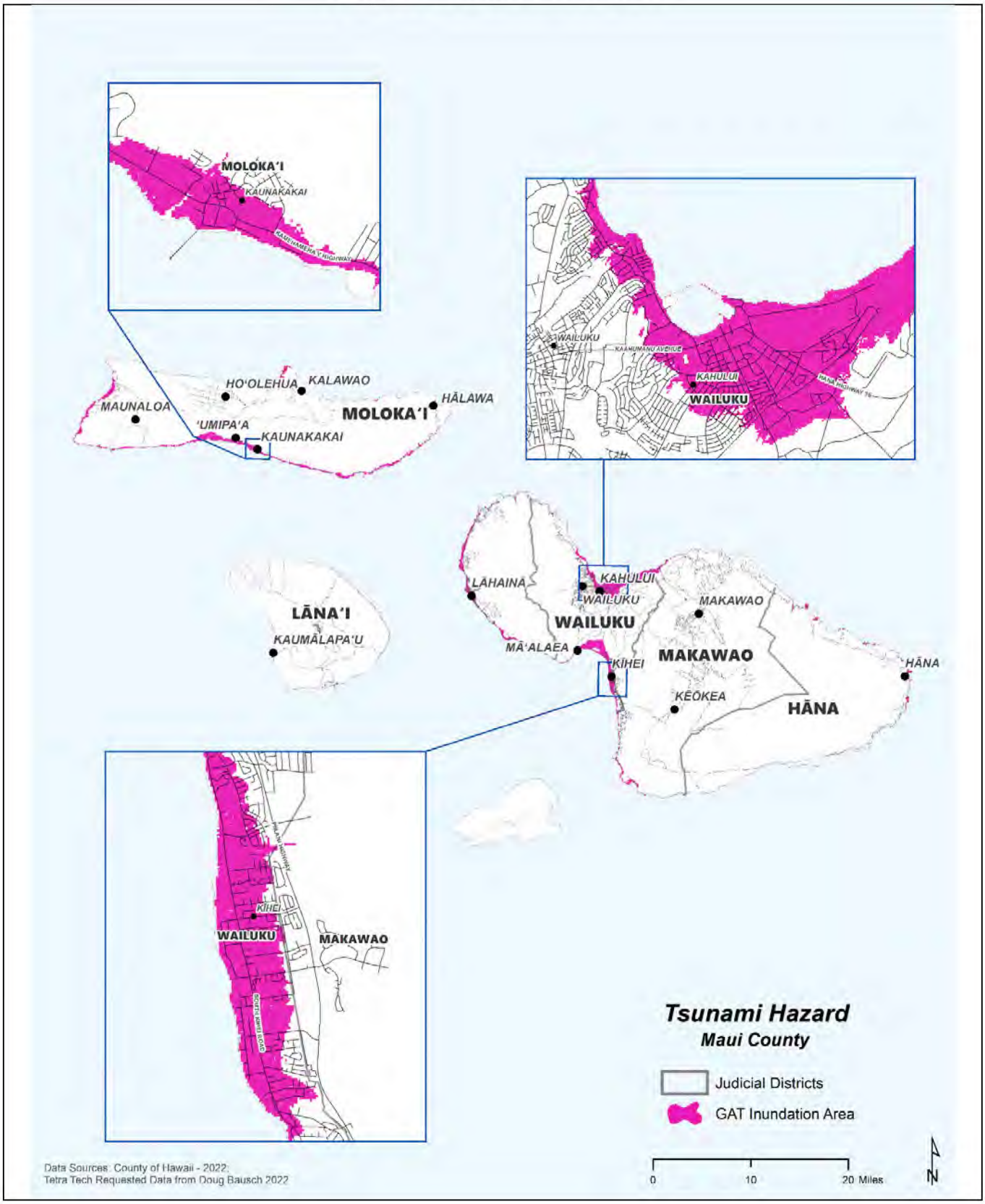


Figure 14-3. GAT Inundation Area



14.1.3 Extent

A tsunami's effect at the shoreline is measured in terms of runup height and inundation. 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 (HI-EMA 2023).

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 another area may experience large and violent destructive waves. Flooding tsunami waves can carry loose objects and people out to sea when they retreat.

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 Hawai'i (USGS n.d.). Improving techniques to understand the tsunami hazard is a continuous effort, particularly in identifying areas most likely to be flooded. The NWS maintains standard tsunami evacuation maps and extreme, worst-case scenario maps for the main Hawaiian Islands. The worst-case scenario maps are based on an M9.2 earthquake in the eastern Aleutian Islands that would generate a tsunami inundation area exceeding flooding observed from past historical events.

Hawai'i has the world's largest single integrated public safety outdoor siren warning system. The sirens produce a sound level of 121 decibels and are designed to be heard within a 3,400-foot radius, as specified by the manufacturer. This range may vary due to environmental and surrounding physical conditions. The sirens are battery-powered and use a photovoltaic charging system. The all-hazard siren system can be used for various natural and human-caused events but is primarily known for announcing tsunami evacuations. The sirens are part of the larger Hawai'i Statewide Alert and Warning System, including FEMA's Integrated Public Alert & Warning System, which uses both the Emergency Alert System and Wireless Emergency Alerts to alert the public.

Tsunami Warning Centers

Tsunami warning centers have been established worldwide 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 (NOAA 2025).

The Pacific Tsunami Warning Center (PTWC) provides the official tsunami warnings for the State of Hawai'i. The PTWC's products include warnings, watches, advisories, information statements, seismic information statements, and warning cancellations (NOAA 2025).

- **Tsunami Warning**—Issued when a significant tsunami is imminent or expected, with runup over one meter above sea level. Alerts the public and officials to take action, such as evacuating

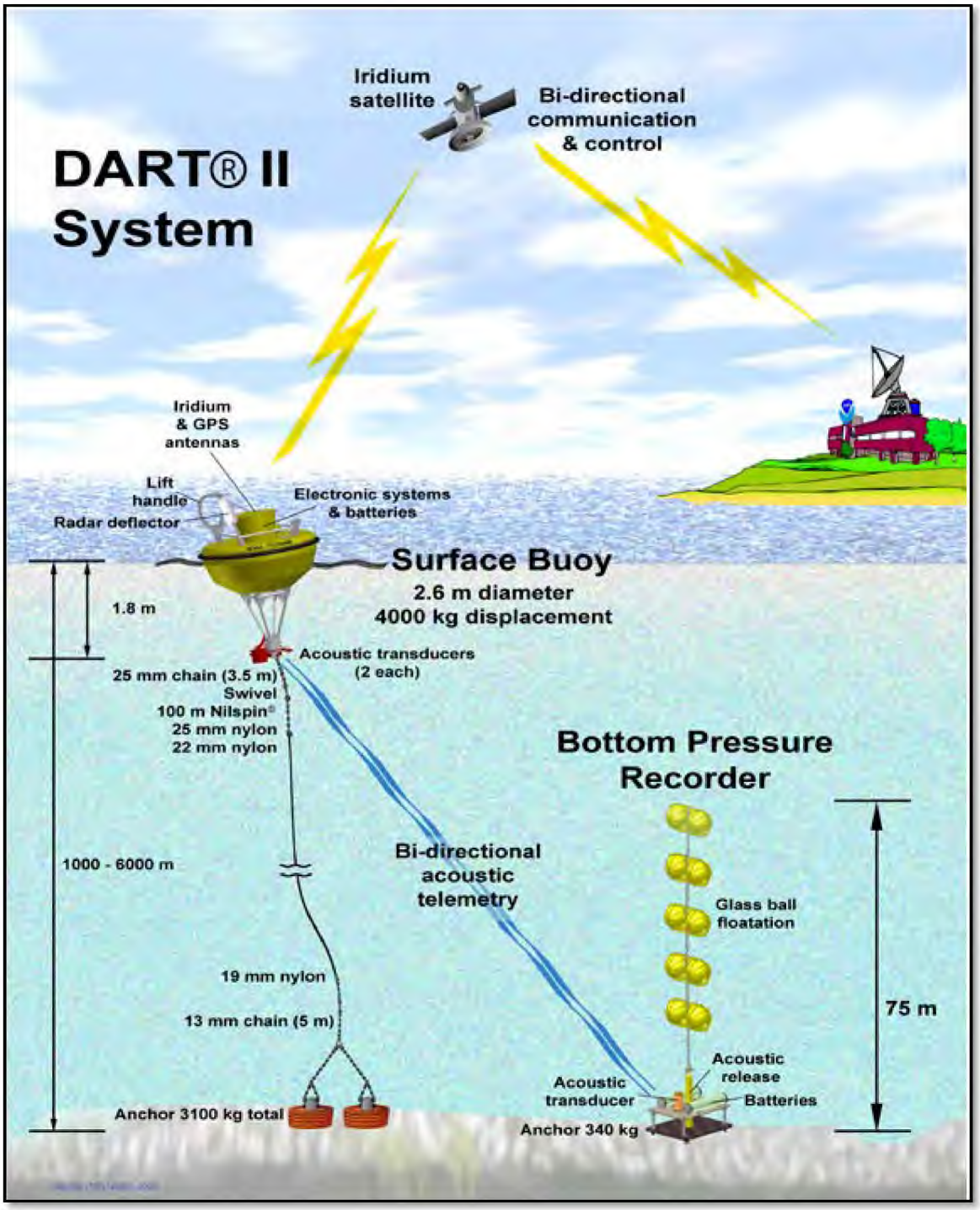
low-lying areas and repositioning ships. Warnings may be updated or canceled and are based on seismic information.

- **Tsunami Advisory**—Issued for tsunamis expected to make beaches and nearshore waters dangerous, with runup between 0.3 and 1.0 meters. Advisories warn of strong currents and waves but not significant inundation. Actions may include closing beaches and evacuating harbors.
- **Tsunami Watch**—Alerts officials and the public of a potential tsunami that may impact the area. Watches are based on seismic information and will be upgraded to a warning or advisory, or canceled, as more information becomes available.
- **Tsunami Information Statement**—Informs that an earthquake has occurred but poses no tsunami threat. Prevents unnecessary evacuations and may caution about minor wave activity. Can be updated or lead to a watch, advisory, or warning if needed.
- **Tsunami Warning Cancellation**—Indicates the end of the tsunami threat after sea level data confirms no further danger. Issued after damaging tsunamis when waves fall below danger levels. Sirens signal the end of the warning.

Deep-ocean Assessment and Reporting of Tsunami

NOAA, as part of the U.S. National Tsunami Hazard Mitigation Program, implemented the Deep-Ocean Assessment and Reporting of Tsunami (DART) project to ensure the detection of tsunamis and acquire data critical for real-time forecasts. DART systems consist of an anchored seafloor bottom pressure recorder and a moored surface buoy for real-time communications. An acoustic link transmits data from the recorder on the seafloor to the surface buoy, which then sends the data to the National Weather Service Telecommunications Gateway. The gateway distributes the data in real-time to the Tsunami Warning Centers. Figure 14-4 depicts the operation of the DART System (NOAA Center for Tsunami Research n.d.).

Figure 14-4. Operations of the DART II System



Source: (NDBC n.d.)

14.1.4 Previous Occurrences

FEMA Disaster Declarations

Between 1954 and 2024, Maui County was included in three major disaster (DR) or emergency (EM) declarations for tsunami-related events, as shown in Table 14-2 (FEMA 2024).

Table 14-2. FEMA Disaster Declarations for Tsunami Events in Maui County

Event Date	Declaration Date	Declaration Number	Description
March 16, 1957	March 16, 1957	DR-71	Tidal Wave
May 25, 1960	May 25, 1960	DR-101	Tidal Waves
March 11, 2011	April 8, 2011	DR-1967	Tsunami Waves

Source: (FEMA 2024)

State Emergency Proclamations

The Governor of Hawai'i may declare a state of emergency by proclamation if an emergency or disaster has occurred or there is imminent danger or threat of an emergency or disaster in any portion of the state (Hawai'i State Legislature 2020). Between 2020 and 2024, Maui County was not included in any tsunami-related state emergency proclamations.

USDA Declarations

The U.S. Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and counties contiguous to them. Between 2020 and 2024, Maui County was not included in any USDA tsunami-related agricultural disaster declarations (USDA 2024).

All Recent Events

For this HMP Update, tsunami events and associated runups were summarized between 2020 and 2024. According to the NOAA National Centers for Environmental Information database, between 2020 and 2024, no recorded tsunamis originated in Maui County. However, the County has experienced impacts of recent tsunami events in the form of runup, as shown in Table 14-3. For earlier events, refer to the previous HMP.

Table 14-3. Tsunami Events in Maui County, 2020 to 2024

Event Date	Event Description
March 25, 2020	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 Hawai'i counties. Kahului (Maui) had a maximum water height of 0.08 meters
October 19, 2020	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.

Event Date	Event Description
March 4, 2021	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. Kahului (Maui) had a maximum water height of 0.18 meters.
July 29, 2021	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 Hawai'i Counties. Kahului (Maui) had a maximum water height of 0.13 meters.
August 12, 2021	The source of the tsunami was in the Southern Atlantic Ocean. Runup was measured in all counties. Kahului (Maui) had a maximum water height of 0.17 meters.
January 15, 2022	The source of the tsunami was the volcanic eruption of Hunga Tonga-Hunga Ha'apai 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 Hawai'i County had $75,000 in damages. Runup was measured in all counties. Kahului (Maui) had a maximum water height of 0.83 meters.

Source: (NOAA 2024)

14.1.5 Probability of Future Occurrences

Probability Based on Previous Occurrences

The above information on previous tsunami occurrences in the County only accounts for a fraction of the total number of tsunami events that have impacted Maui. There have been three tsunami federal disaster declarations in the 67-year period from 1957 to 2024. These events are summarized in Table 14-4 and serve as the basis for calculating the probability of future occurrence of tsunami events on the island. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on these records and input from the HMWG, the probability of the occurrence of a tsunami in Maui County is considered "rare."

Table 14-4. Probability of Future Tsunami Events in Maui County

Hazard Type	Number of Occurrences Between 1957 and 2024	Percent Chance of Occurring in Any Given Year
Tsunami	3	4.5%

Source: (FEMA 2024)
Note: The probability is based on three federal disaster declarations during the reference period.

Effect of Climate Change on Future Probability

Climate-related geological changes can increase the incidence of earthquakes and volcanic eruptions, heightening the threat of tsunamis. The warming of the atmosphere and oceans, along with the melting of ice sheets and glaciers, is causing the global mean sea level to rise. This rise in sea levels, exacerbated by climate change, allows tsunamis to travel further inland, causing more damage. Consequently, rising sea levels increase the extent of coastal flooding from tsunamis, as they create waves that flood low-lying coastal areas (NOAA 2023).

Additionally, climate change could impact the earthquakes and landslides that generate tsunamis. Melting glaciers may induce tectonic activity, while heavy rainfall from storm events can cause soil instability, increasing the likelihood of landslides into water bodies, which can generate tsunamis. Even modest sea level rises 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 heightening the risk of local tsunamis (HI-EMA 2023).

14.1.6 Cascading Impacts on Other Hazards

In addition to the immense hydraulic force of tsunami waves, floating debris carried by a tsunami can pose significant risks to human lives and damage inland structures. Flooding from tsunamis can contaminate drinking water and facilitate the spread of disease.

Tsunami inundation can lead to erosion and scouring, debris movement and impact, water contamination, and disease spread due to standing water. The loss of wetlands from erosion and wetland migration caused by tsunami inundation can diminish the natural filtration provided by wetland plants, increasing the likelihood of water quality issues. Healthy coastal ecosystems, fisheries, tourism, human health, and public safety can be severely impacted or lost due to tsunamis.

Furthermore, indirect economic costs, such as lost business, and adverse socio-psychological impacts on residents and tourists can significantly affect communities.

14.2 VULNERABILITY AND IMPACT ASSESSMENT

To assess Maui County's risk of the tsunami hazard, a spatial analysis was conducted using data obtained from Hawai'i Emergency Management Agency (2022) and Niyam IT (2022). To determine what assets are exposed to tsunami, the asset inventories prepared for this HMP (population, buildings, critical facilities) were overlaid with the SOEST Standard Evacuation Zone (400-year scenario), the Great Aleutian Tsunami (GAT) extreme evacuation zone (1,500-year scenario), and the American Society of Civil Engineers (ASCE) inundation scenario (3,500-year) hazard areas. Assets with their centroid located in the hazard areas were totaled to estimate the numbers and values at risk from the impacts of tsunami. To estimate potential losses associated with a tsunami, a Level 2 Hazus coastal flood analysis was performed using asset inventories prepared for this HMP and the standard and extreme tsunami hazard area flood depth grids.

14.2.1 Life, Health, and Safety

Tsunamis present serious risks to life and have historically been the deadliest natural hazard in the Hawaiian Islands. The primary cause of death during a tsunami is drowning, but the powerful currents can also turn floating debris into dangerous projectiles, leading to injuries, fatalities, and property damage. Additionally, fires can ignite from broken gas lines or ruptured tanks, further exacerbating the destruction.

Overall Population

The public health impacts of tsunamis are similar to those of coastal flooding. Beyond the immediate threats to life and property, tsunamis can contaminate drinking water through saltwater intrusion, inundation of hazardous materials facilities, or wastewater treatment plants. Floodwaters may carry hazardous materials, making them dangerous to traverse. Furthermore, flooded structures can quickly develop mold or wood rot, posing serious health risks to inhabitants if not properly treated. These cascading effects highlight the broad and severe impact tsunamis can have on the overall population, affecting physical safety, long-term public health, and community well-being. Table 14-5 presents the overall population in the SOEST (400-year scenario), the GAT (1,500-year scenario), and the ASCE (3,500-year) tsunami inundation hazard areas.

For the SOEST (400-year) inundation zone, Maui County has a total of 10,385 persons, which is 6.3 percent of the Community Plan Area total. The Kīhei–Mākena Community Plan Area has the highest number of persons in this hazard area, with 4,126 individuals (14.1 percent of the Community Plan Area). However, the West Maui Community Plan Area has the highest percentage of its total population in the hazard area, with 15.7 percent, or 3,421 persons.

For the GAT (3,500-year) inundation zone, Maui County has a total of 21,689 persons, which is 13.2 percent of the Community Plan Area total. The Wailuku–Kahului Community Plan Area has the highest number of persons in this hazard area, with 8,360 individuals (14.3 percent of the Community Plan Area). The Kīhei-Mākena Community Plan Area has the highest percentage of its total population in the hazard area, with 24.4 percent, or 7,126 persons.

For the ASCE (3,500-year) inundation zone, Maui County has a total of 33,139 persons, which is 20.1 percent of the Community Plan Area total. The Wailuku–Kahului Community Plan Area has the highest number of persons in this hazard area, with 14,643 individuals (25.0 percent of the Community Plan Area). The Kīhei-Mākena Community Plan Area has the highest percentage of its total population in the hazard area, with 39.2 percent, or 11,428 persons.

Table 14-5. Population in the Tsunami Inundation Hazard Areas

Community Plan Area	Total Population (2023 ACS)	Population in the SOEST (400-year) Tsunami Inundation Hazard Area		Population in the GAT (1,500-year) Tsunami Inundation Hazard Area		Population in the ASCE (3,500-year) Tsunami Inundation Hazard Area	
		Number of Persons	% of Plan Area Total	Number of Persons	% of Plan Area Total	Number of Persons	% of Plan Area Total
Hāna	2,135	125	5.9%	191	8.9%	135	6.3%
Kīhei-Mākena	29,174	4,126	14.1%	7,126	24.4%	11,428	39.2%
Lānaʻi	3,333	0	0.0%	0	0.0%	0	0.0%
Makawao-Pukalani-Kula	24,505	0	0.0%	0	0.0%	0	0.0%
Molokaʻi	8,092	0	0.0%	0	0.0%	0	0.0%
Pāʻia-Haʻikū	17,037	268	1.6%	966	5.7%	1,832	10.8%
Wailuku-Kahului	58,606	2,445	4.2%	8,360	14.3%	14,643	25.0%

Community Plan Area	Total Population (2023 ACS)	Population in the SOEST (400-year) Tsunami Inundation Hazard Area		Population in the GAT (1,500-year) Tsunami Inundation Hazard Area		Population in the ASCE (3,500-year) Tsunami Inundation Hazard Area	
		Number of Persons	% of Plan Area Total	Number of Persons	% of Plan Area Total	Number of Persons	% of Plan Area Total
West Maui	21,749	3,421	15.7%	5,046	23.2%	5,101	23.5%
Maui County (Total)	164,632	10,385	6.3%	21,689	13.2%	33,139	20.1%

Source: U.S. Census Bureau 2023 ACS; Hawai'i Emergency Management Agency 2022; Niyam IT 2022

Socially Vulnerable Population

Socially vulnerable populations, such as the economically disadvantaged, elderly, and those with disabilities, face heightened risks during tsunami events due to several factors. Limited financial resources can prevent economically disadvantaged individuals from adequately preparing for or recovering from a tsunami, and they may live in housing that is more susceptible to damage. Elderly and disabled individuals often have mobility issues that hinder quick evacuation and may require assistance, which can be scarce during emergencies. Access to timely and accurate information about tsunami warnings and evacuation procedures can be limited for these groups due to language barriers, lack of communication devices, or isolation.

Health concerns are also significant, as the elderly and those with pre-existing conditions may need medical attention during and after a tsunami, but medical facilities may be overwhelmed or inaccessible. Additionally, tsunamis can disrupt transportation and communication networks, isolating communities and making it difficult for emergency services to reach those in need. These factors contribute to the increased vulnerability of socially disadvantaged groups, underscoring the importance of considering their needs in disaster preparedness and response plans.

Table 14-6 through Table 14-8 present the estimated socially vulnerable populations within the SOEST (400-year), GAT (1,500-year), and ASCE (3,500-year) tsunami inundation hazard areas. In Maui County, the SOEST (400-year) hazard area includes 2,059 persons over the age of 65, 565 children under the age of 5, 402 non-English speakers, 1,066 individuals with disabilities, and 964 persons living in poverty.

Table 14-6 Estimated Number of Vulnerable Persons Located in the SOEST (400-year) Tsunami Inundation Hazard Area

Community Plan Area	Estimated Number of Vulnerable Persons Located in the SOEST (400-year) Tsunami Inundation Hazard Area									
	Persons Over 65		Persons Under 5		Non-English Speaking Persons		Persons with a Disability		Persons in Poverty	
	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total
Hāna	33	5.8%	5	4.9%	2	5.1%	13	5.6%	19	5.7%
Kīhei-Mākena	864	14.1%	188	14.1%	120	14.1%	445	14.1%	410	14.1%
Lānaʻi	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Makawao-Pukalani-Kula	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Molokaʻi	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Pāʻia-Haʻikū	44	1.6%	17	1.5%	2	1.2%	22	1.5%	30	1.5%
Wailuku-Kahului	480	4.2%	123	4.2%	132	4.1%	269	4.2%	178	4.2%
West Maui	638	15.7%	232	15.7%	146	15.7%	317	15.7%	327	15.7%
Maui County (Total)	2,059	6.2%	565	6.3%	402	6.6%	1,066	6.0%	964	6.0%

Source: U.S. Census Bureau 2023 ACS Vulnerable Population Totals; Hawaiʻi Emergency Management Agency 2022; Niyam IT 2022

Table 14-7. Estimated Number of Vulnerable Persons Located in the GAT (1,500-year) Tsunami Inundation Hazard Area

Community Plan Area	Estimated Number of Vulnerable Persons Located in the GAT (1,500-year) Tsunami Inundation Hazard Area									
	Persons Over 65		Persons Under 5		Non-English Speaking Persons		Persons with a Disability		Persons in Poverty	
	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total
Hāna	50	8.9%	9	8.8%	3	7.6%	20	8.6%	30	9.0%
Kīhei-Mākena	1,493	24.4%	325	24.4%	207	24.3%	769	24.4%	708	24.4%
Lānaʻi	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Makawao-Pukalani-Kula	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Molokaʻi	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Pāʻia-Haʻikū	160	5.7%	64	5.7%	9	5.5%	80	5.6%	110	5.6%
Wailuku-Kahului	1,644	14.3%	421	14.2%	454	14.3%	920	14.3%	611	14.2%
West Maui	941	23.2%	343	23.2%	215	23.1%	468	23.2%	482	23.2%
Maui County (Total)	4,288	13.0%	1,162	13.0%	888	14.6%	2,257	12.8%	1,941	12.2%

Source: U.S. Census Bureau 2023 ACS Vulnerable Population Totals; Hawaiʻi Emergency Management Agency 2022; Niyam IT 2022

Table 14-8. Estimated Number of Vulnerable Persons Located in the ASCE (3,500-year) Tsunami Inundation Hazard Area

Community Plan Area	Estimated Number of Vulnerable Persons Located in the ASCE (3,500-year) Tsunami Inundation Hazard Area									
	Persons Over 65		Persons Under 5		Non-English Speaking Persons		Persons with a Disability		Persons in Poverty	
	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total
Hāna	35	6.2%	6	5.9%	2	5.1%	14	6.0%	21	6.3%
Kīhei-Mākena	2,395	39.2%	521	39.1%	333	39.1%	1,233	39.2%	1,136	39.2%
Lānaʻi	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Makawao-Pukalani-Kula	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Molokaʻi	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Pāʻia-Haʻikū	304	10.7%	121	10.7%	17	10.4%	152	10.7%	210	10.7%
Wailuku-Kahului	2,879	25.0%	739	25.0%	795	25.0%	1,613	25.0%	1,071	25.0%
West Maui	951	23.4%	346	23.4%	218	23.4%	474	23.5%	488	23.5%
Maui County (Total)	6,564	19.9%	1,733	19.4%	1,365	22.4%	3,486	19.7%	2,926	18.3%

Source: U.S. Census Bureau 2023 ACS Vulnerable Population Totals; Hawaiʻi Emergency Management Agency 2022; Niyam IT 2022

For the GAT (1,500-year) hazard area, Maui County has 4,288 persons over the age of 65, 1,162 children under the age of 5, 888 non-English speakers, 2,257 individuals with disabilities, and 1,941 persons living in poverty. Lastly, the ASCE (3,500-year) hazard area totals include 6,564 persons over the age of 65, 1,733 children under the age of 5, 1,365 non-English speakers, 3,486 individuals with disabilities, and 2,926 persons living in poverty. For a detailed breakdown of these numbers by Community Plan Area, please refer to the tables below.

Tsunami events can have devastating impacts on communities, often leading to the displacement of residents and the need for emergency shelter. Table 14-9 provides an overview of the number of individuals displaced or seeking shelter due to a standard and extreme tsunami event by Community Planning Area. In Maui County, a standard tsunami event is projected to displace approximately 6,814 individuals, with an estimated 1,112 requiring short-term shelter. The Kīhei-Mākena Community Planning Area is expected to be the most affected, with 3,177 displaced with an estimated 435 needing short-term shelter.

In the event of an extreme tsunami, it is estimated that 33,684 people in Maui County would be displaced, with 2,380 requiring short-term shelter. The Wailuku-Kahului Community Planning Area is projected to have the highest number of displaced individuals, 16,819 total, with an estimated 1,169 requiring short-term shelter.

Table 14-9. Populations Displaced or Seeking Short-Term Sheltering Due to Tsunami

Community Plan Area	Total Population (2023 ACS)	Population in the Standard Tsunami Hazard Area		Population in the Extreme Tsunami Hazard Area	
		Displaced Population	Persons Seeking Short-Term Sheltering	Displaced Population	Persons Seeking Short-Term Sheltering
Hāna	2,135	61	26	65	24
Kīhei-Mākena	29,174	3,177	435	10,952	651
Lānaʻi	3,333	0	0	0	0
Makawao-Pukalani-Kula	24,505	0	0	0	0
Molokaʻi	8,092	0	0	0	0
Pāʻia-Haʻikū	17,037	87	18	554	63
Wailuku-Kahului	58,606	2,582	421	16,819	1,169
West Maui	21,749	907	212	5,294	473
Maui County (Total)	164,632	6,814	1,112	33,684	2,380

Source: U.S. Census Bureau 2023 ACS; Hawaiʻi Emergency Management Agency 2022; Niyam IT 2022; Hazus v6.1

14.2.2 General Building Stock

Buildings Located in the Tsunami Hazard Areas

All current and future buildings and infrastructure, including critical facilities, located within low-lying coastal areas are considered at risk of tsunami. Table 14-10 summarizes the number of structures located in the SOEST (400-year), the GAT (1,500-year), and the ASCE (3,500-year) tsunami inundation hazard areas by Community Plan Area. There are 3,438 buildings (7.5 percent of the total building stock) located in the SOEST (400-year) tsunami inundation hazard area with an estimated $9.6 billion of replacement cost value (building and content replacement costs). There are 6,464 buildings (14.2 percent of the total building stock) located in the GAT (1,500-year) tsunami inundation hazard area with an estimated $16 billion of replacement cost value. Lastly, in the ASCE (3,500-year) tsunami inundation hazard area, there are 9,237 buildings (20.3 percent of the total building stock) with an estimated $18.5 billion of replacement cost value.

Table 14-11 summarizes buildings in the tsunami inundation hazard areas by occupancy class. In the SOEST (400-year) tsunami inundation hazard area, there are 2,156 residential properties, 1,001 commercial properties, 193 industrial properties, and 88 governmental, religious, agricultural, and education properties. In the GAT (1,500-year) tsunami inundation hazard area, there are 4,622 residential properties, 1,430 commercial properties, 278 industrial properties, and 134 governmental, religious, agricultural, and education properties. Lastly, in the ASCE (3,500-year) tsunami inundation hazard area, there are 7,203 residential properties, 1,565 commercial properties, 310 industrial properties, and 159 governmental, religious, agricultural, and education properties.

Estimated Cost of Damage

Table 14-12 summarizes the estimated building losses due to standard and extreme tsunami hazard events by Community Plan Area. In Maui County, the standard tsunami impacts are estimated to cause approximately $325 million in damage, with residential properties accounting for the majority of this damage ($165 million). The Wailuku-Kahului Community Plan Area is expected to experience the highest losses across all occupancies combined, with an estimated $150 million in damages. For extreme tsunami impacts, the estimated damage rises to approximately $16 billion, with residential properties again seeing the majority of the damage ($8 billion) in Maui County. The Wailuku-Kahului Community Plan Area is projected to incur the highest losses across all occupancies combined, with an estimated $7.4 billion in damages.

Table 14-10. Buildings in the Tsunami Inundation Hazard Areas

Community Plan Area	Community Plan Area Total Buildings		Number of Buildings in Hazard Area		Replacement Cost Value in Hazard Area	
	Number of Buildings	Replacement Cost Value	Count	% of Plan Area Total	Value	% of Plan Area Total
Buildings in the SOEST (400-year) Tsunami Inundation Hazard Area						
Hāna	930	$741,266,476	53	5.7%	$22,986,102	3.1%
Kīhei-Mākena	7,613	$11,692,760,990	1,231	16.2%	$2,670,224,577	22.8%
Lānaʻi	1,258	$1,012,846,136	0	0.0%	$0	0.0%
Makawao-Pukalani-Kula	8,868	$6,037,317,698	0	0.0%	$0	0.0%
Molokaʻi	3,056	$2,384,451,998	0	0.0%	$0	0.0%
Pāʻia-Haʻikū	4,316	$2,686,054,376	110	2.5%	$106,309,045	4.0%
Wailuku-Kahului	15,444	$18,302,375,352	1,322	8.6%	$4,031,203,906	22.0%
West Maui	4,063	$8,896,487,618	722	17.8%	$2,790,441,925	31.4%
Maui County (Total)	45,548	$51,753,560,644	3,438	7.5%	$9,621,165,554	18.6%
Buildings in the GAT (1,500-year) Tsunami Inundation Hazard Area						
Hāna	930	$741,266,476	79	8.5%	$32,126,936	4.3%
Kīhei-Mākena	7,613	$11,692,760,990	2,001	26.3%	$4,243,999,009	36.3%
Lānaʻi	1,258	$1,012,846,136	0	0.0%	$0	0.0%
Makawao-Pukalani-Kula	8,868	$6,037,317,698	0	0.0%	$0	0.0%
Molokaʻi	3,056	$2,384,451,998	0	0.0%	$0	0.0%
Pāʻia-Haʻikū	4,316	$2,686,054,376	319	7.4%	$284,023,304	10.6%
Wailuku-Kahului	15,444	$18,302,375,352	2,997	19.4%	$6,640,075,460	36.3%
West Maui	4,063	$8,896,487,618	1,068	26.3%	$4,770,568,188	53.6%
Maui County (Total)	45,548	$51,753,560,644	6,464	14.2%	$15,970,792,897	30.9%

Community Plan Area	Community Plan Area Total Buildings		Number of Buildings in Hazard Area		Replacement Cost Value in Hazard Area	
	Number of Buildings	Replacement Cost Value	Count	% of Plan Area Total	Value	% of Plan Area Total
Buildings in the ASCE (3,500-year) Tsunami Inundation Hazard Area						
Hāna	930	$741,266,476	56	6.0%	$22,098,304	3.0%
Kīhei-Mākena	7,613	$11,692,760,990	3,066	40.3%	$5,376,319,294	46.0%
Lānaʻi	1,258	$1,012,846,136	0	0.0%	$0	0.0%
Makawao-Pukalani-Kula	8,868	$6,037,317,698	0	0.0%	$0	0.0%
Molokaʻi	3,056	$2,384,451,998	0	0.0%	$0	0.0%
Pāʻia-Haʻikū	4,316	$2,686,054,376	537	12.4%	$381,259,095	14.2%
Wailuku-Kahului	15,444	$18,302,375,352	4,466	28.9%	$8,073,091,666	44.1%
West Maui	4,063	$8,896,487,618	1,112	27.4%	$4,626,371,718	52.0%
Maui County (Total)	45,548	$51,753,560,644	9,237	20.3%	$18,479,140,077	35.7%

Source: USACE NSI 2022; Hawai'i Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; RSMeans 2024; Hawai'i Emergency Management Agency 2022; Niyam IT 2022

Table 14-11. Buildings in the Tsunami Inundation Hazard Areas by General Occupancy Class

Community Plan Area	Number of Buildings in Hazard Area			
	Residential	Commercial	Industrial	Other[a]
SOEST (400-year) Tsunami Inundation Hazard Area				
Hāna	49	3	0	1
Kīhei-Mākena	938	240	31	22
Lānaʻi	0	0	0	0
Makawao-Pukalani-Kula	0	0	0	0
Molokaʻi	0	0	0	0
Pāʻia-Haʻikū	62	43	3	2
Wailuku-Kahului	551	570	150	51
West Maui	556	145	9	12
Maui County (Total)	2,156	1,001	193	88
GAT (1,500-year) Tsunami Inundation Hazard Area				
Hāna	75	3	0	1
Kīhei-Mākena	1,620	309	44	28
Lānaʻi	0	0	0	0
Makawao-Pukalani-Kula	0	0	0	0
Molokaʻi	0	0	0	0
Pāʻia-Haʻikū	223	86	6	4
Wailuku-Kahului	1,884	822	206	85
West Maui	820	210	22	16
Maui County (Total)	4,622	1,430	278	134
ASCE (3,500-year) Tsunami Inundation Hazard Area				
Hāna	53	2	0	1
Kīhei-Mākena	2,598	367	65	36
Lānaʻi	0	0	0	0
Makawao-Pukalani-Kula	0	0	0	0
Molokaʻi	0	0	0	0
Pāʻia-Haʻikū	423	102	7	5
Wailuku-Kahului	3,300	856	213	97
West Maui	829	238	25	20
Maui County (Total)	7,203	1,565	310	159

Source: USACE NSI 2022; Hawaiʻi Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; Hawaiʻi Emergency Management Agency 2022; Niyam IT 2022

a. Other = Government, Religion, Agricultural, and Education

Table 14-12 Estimated Losses from Tsunami Impacts on Buildings

Community Plan Area	Total Replacement Cost Value (RCV)	Estimated Damage to Structure and Content				
		Total		Estimated Loss for Residential Properties	Estimated Loss for Commercial Properties	Estimated Loss for All Other Occupancies
		Estimated Loss for All Occupancies	Percent of Total			
Standard Tsunami Impacts on Buildings						
Hāna	$741,266,476	$931,471	0.1%	$800,676	$130,796	$0
Kīhei-Mākena	$11,692,760,990	$100,305,594	0.9%	$79,337,769	$18,353,051	$2,614,775
Lānaʻi	$1,012,846,136	$0	0.0%	$0	$0	$0
Makawao-Pukalani-Kula	$6,037,317,698	$0	0.0%	$0	$0	$0
Molokaʻi	$2,384,451,998	$0	0.0%	$0	$0	$0
Pāʻia-Haʻikū	$2,686,054,376	$5,266,220	0.2%	$4,894,003	$367,938	$4,280
Wailuku-Kahului	$18,302,375,352	$150,250,760	0.8%	$42,109,950	$90,480,118	$17,660,692
West Maui	$8,896,487,618	$68,390,287	0.8%	$37,454,157	$26,316,477	$4,619,653
Maui County (Total)	$51,753,560,644	$325,144,332	0.6%	$164,596,554	$135,648,379	$24,899,399
Extreme Tsunami Impacts on Buildings						
Hāna	$741,266,476	$11,148,205	1.5%	$11,148,205	$0	$0
Kīhei-Mākena	$11,692,760,990	$4,314,690,645	36.9%	$3,086,394,080	$902,614,290	$325,682,276
Lānaʻi	$1,012,846,136	$0	0.0%	$0	$0	$0
Makawao-Pukalani-Kula	$6,037,317,698	$0	0.0%	$0	$0	$0
Molokaʻi	$2,384,451,998	$0	0.0%	$0	$0	$0
Pāʻia-Haʻikū	$2,686,054,376	$219,298,968	8.2%	$87,120,194	$112,716,552	$19,462,221
Wailuku-Kahului	$18,302,375,352	$7,443,829,811	40.7%	$1,973,416,543	$3,749,216,878	$1,721,196,390
West Maui	$8,896,487,618	$3,924,597,130	44.1%	$2,807,297,529	$962,685,757	$154,613,844
Maui County (Total)	$51,753,560,644	$15,913,564,758	30.7%	$7,965,376,551	$5,727,233,476	$2,220,954,731

Source: USACE NSI 2022; Hawaiʻi Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; Hazus v6.1; RSMeans 2024

14.2.3 Community Lifelines and Other Critical Facilities

Tsunamis pose a significant threat to community lifelines and critical facilities, disrupting essential services and hindering emergency response and recovery efforts. Water systems, including treatment plants, pipelines, and distribution networks, can be severely damaged, leading to contamination and loss of potable water, which compromises public health and sanitation. Transportation infrastructure, such as roads, bridges, and airports, is highly susceptible to tsunami damage, impeding evacuation efforts and delaying the arrival of emergency services. This destruction can isolate communities and hinder the delivery of essential supplies.

Energy infrastructure, including power plants, substations, and transmission lines, is also vulnerable, resulting in widespread power outages that affect other critical services like health care and telecommunications. Communication networks, including cell towers and fiber optic cables, can be disrupted, making it challenging to coordinate emergency response efforts and communicate with the public, leading to delays in disseminating vital information. Healthcare facilities, such as hospitals and clinics, may be damaged or flooded, reducing their capacity to provide medical care to those injured during the tsunami, and exacerbating the impact on vulnerable populations. Emergency services, including fire stations and police stations, can be impacted, limiting their ability to respond effectively to the disaster and resulting in delayed rescue operations and increased risk to public safety.

The interdependency between these lifelines means that damage to one sector can have cascading effects on others, compounding the disruption of services and delaying recovery efforts. Addressing these vulnerabilities through proactive hazard mitigation planning is essential to enhance community resilience and ensure a swift and effective response to tsunami events. Table 14-13 summarizes the critical facilities within the tsunami inundation hazard areas by Community Plan Area.

There are 53 critical facilities located within the SOEST (400-year) hazard area, with the Water Systems sector comprising the largest portion at 20 facilities. The Wailuku-Kahului Community Plan Area contains the highest number of critical facilities in this hazard area, totaling 29. In the GAT (1,500-year) hazard area, Maui County has 64 critical facilities, with the Water Systems sector again having the most at 23 facilities. The Wailuku-Kahului Community Plan Area leads all Plan Areas with 38 facilities. For the ASCE (3,500-year) hazard area, Maui County has a total of 81 critical facilities, with the Water Systems sector accounting for 29 of these. The Wailuku-Kahului Community Plan Area has the highest number of critical facilities, totaling 42.

In July 2020, a new $7.7 million Moloka'i Base Yard was opened in Ho'olehua. This highway base yard is located outside the tsunami inundation zone, unlike the former building, which was within the zone, putting employees at risk and hindering response efforts. The new location reduces vulnerability and provides a safe place for Moloka'i Public Works employees to respond to emergency situations, including tsunamis (Maui Now 2020).

Table 14-13. Number of Facilities in the Tsunami Inundation Hazard Area, by Lifeline Category

Community Plan Area	By Lifeline Category									Total	
	Communications	Energy	Food, Hydration, Shelter	Hazardous Materials	Health & Medical	Safety & Security	Transportation	Water Systems	Other Critical Facilities	Count	% of Plan Area Total
Number of Facilities in the SOEST (400-year) Tsunami Inundation Hazard Area											
Hāna	1	0	0	0	0	0	0	2	1	4	30.8%
Kīhei-Mākena	1	0	1	0	2	1	0	6	1	12	35.3%
Lānaʻi	0	0	0	0	0	0	0	0	0	0	0.0%
Makawao-Pukalani-Kula	0	0	0	0	0	0	0	0	0	0	0.0%
Molokaʻi	0	0	0	0	0	0	0	0	0	0	0.0%
Pāʻia-Haʻikū	0	1	0	0	0	1	0	0	0	2	14.3%
Wailuku-Kahului	2	1	0	0	2	1	8	10	5	29	28.4%
West Maui	0	0	1	0	2	1	0	2	0	6	15.0%
Maui County (Total)	4	2	2	0	6	4	8	20	7	53	19.3%
Number of Facilities in the GAT (1,500-year) Tsunami Inundation Hazard Area											
Hāna	1	0	0	0	0	0	0	2	1	4	30.8%
Kīhei-Mākena	1	0	1	0	2	1	0	7	1	13	38.2%
Lānaʻi	0	0	0	0	0	0	0	0	0	0	0.0%
Makawao-Pukalani-Kula	0	0	0	0	0	0	0	0	0	0	0.0%
Molokaʻi	0	0	0	0	0	0	0	0	0	0	0.0%
Pāʻia-Haʻikū	0	1	0	0	0	1	0	1	0	3	21.4%
Wailuku-Kahului	3	1	0	0	2	3	11	12	6	38	37.3%
West Maui	0	0	1	0	2	2	0	1	0	6	15.0%
Maui County (Total)	5	2	2	0	6	7	11	23	8	64	23.3%
Number of Facilities in the ASCE (3,500-year) Tsunami Inundation Hazard Area											
Hāna	1	0	0	0	0	0	0	2	0	3	23.1%

Community Plan Area	By Lifeline Category									Total	
	Communications	Energy	Food, Hydration, Shelter	Hazardous Materials	Health & Medical	Safety & Security	Transportation	Water Systems	Other Critical Facilities	Count	% of Plan Area Total
Kīhei-Mākena	2	0	1	0	2	2	0	8	1	16	47.1%
Lānaʻi	0	0	0	0	0	0	0	0	0	0	0.0%
Makawao-Pukalani-Kula	0	0	0	0	0	0	0	0	0	0	0.0%
Molokaʻi	0	0	0	0	0	0	0	0	0	0	0.0%
Pāʻia-Haʻikū	0	1	0	0	0	2	0	1	1	5	35.7%
Wailuku-Kahului	4	2	0	0	3	5	12	11	5	42	41.2%
West Maui	0	0	3	0	2	3	0	7	0	15	37.5%
Maui County (Total)	7	3	4	0	7	12	12	29	7	81	29.5%

Source: Hawaiʻi Emergency Management Agency 2017, 2022; Niyam IT 2022

14.2.4 Economy

Tsunamis can have wide-reaching economic impacts on Maui County. Direct economic consequences may arise from the destruction of buildings and infrastructure, including power utility poles and lines, potable water and wastewater facilities, and roadways. The force of tsunami waves can devastate piers, breakwaters, and seawalls. Ships, marinas, and fishing fleets may be battered, sunk, moored, or stranded, severely affecting the fishing and tourism industries.

Business interruptions are likely, and damages or alterations to impacted beaches can affect tourism for extended periods after the tsunami. Additionally, the county may experience a decline in tourist numbers due to perceived risks associated with visiting post-tsunami. This reduction in tourism can lead to significant revenue losses for local businesses and the overall economy. The cumulative effect of these disruptions can hinder economic growth, necessitate substantial recovery efforts, and potentially alter the long-term economic landscape of Maui County.

Debris management may also be a large expense after a tsunami event. Hazus-MH estimates the amount of debris generated from the standard and extreme tsunami events. The model breaks down debris into three categories: (1) finishes (drywall, insulation, etc.), (2) structural (wood, brick, etc.), and (3) foundations (concrete slab and block, rebar, etc.). The distinction is made because of the different types of equipment needed to handle the debris. See Table 14-14 for a breakdown of estimated debris created during both a standard tsunami and extreme tsunami event in the Community Plan Area.

For a standard tsunami event, the total amount of debris generated is estimated to be 3,583 tons, with the Kīhei-Mākena Community Plan Area experiencing the highest amount at 1,246 tons. In the case of an extreme tsunami event, Maui County is projected to generate a total of 392,783 tons of debris, with the Wailuku-Kahului Community Plan Area accounting for the largest portion at 242,179 tons.

14.2.5 Natural, Historic and Cultural Resources

Natural

Tsunamis can significantly alter the landscape, both above and below the water. In some areas, the land may rise, while in others, it may fall. Flooding can extend to unexpected areas if the coast subsides, and tsunami barriers may fail or be overtopped. Associated landslides and sediment shifts can render waterways unnavigable. Other potential consequences include permanent changes to beaches and other coastal features, loss of or changes to wildlife habitats, and alterations in the quality and availability of fresh water. Inundation by salt water, whether short or long term, can render agricultural land useless.

The force of the water, along with pollutants, toxic substances, sediment, marine debris, and invasive species, can also harm agricultural land and natural resources both onshore and offshore. Changes to these resources can affect the services they provide, such as biological, ecological, protective, and recreational functions (NOAA 2023).

Table 14-14. Estimated Debris Created During a Standard and Extreme Tsunami

Community Plan Area	Estimated Debris Created			
	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Standard Tsunami				
Hāna	42	34	5	3
Kīhei-Mākena	1,246	1,246	0	0
Lānaʻi	0	0	0	0
Makawao-Pukalani-Kula	0	0	0	0
Molokaʻi	0	0	0	0
Pāʻia-Haʻikū	64	62	1	1
Wailuku-Kahului	1,207	1,084	70	52
West Maui	1,024	998	16	10
Maui County (Total)	3,583	3,424	92	66
Extreme Tsunami				
Hāna	116	110	4	3
Kīhei-Mākena	67,525	43,313	15,135	9,076
Lānaʻi	0	0	0	0
Makawao-Pukalani-Kula	0	0	0	0
Molokaʻi	0	0	0	0
Pāʻia-Haʻikū	5,165	2,318	1,479	1,368
Wailuku-Kahului	242,179	53,618	103,578	84,984
West Maui	77,798	42,045	24,230	11,523
Maui County (Total)	392,783	141,404	144,426	106,954

Source: USACE NSI 2022; Hawaiʻi Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; Hazus v6.1

Tsunamis can also destroy coral reefs and mangrove forests, which are crucial for coastal protection and biodiversity. The loss of these natural barriers can increase vulnerability to future storms and erosion. Additionally, the deposition of salt and debris can alter soil composition, making it less fertile and more prone to erosion.

The impact on fisheries can be profound, as the destruction of breeding grounds and changes in water quality can reduce fish populations. This, in turn, affects the livelihoods of local communities that depend on fishing. The disruption of ecosystems can have cascading effects, leading to long-term ecological imbalances (WWF n.d.) Overall, the environmental damage caused by tsunamis can have lasting effects on natural resources, requiring extensive restoration efforts and long-term monitoring to mitigate the impacts.

Historic

Tsunamis can have devastating effects on historic resources, causing both immediate and long-term damage. Historic buildings, monuments, and landmarks located near the coast are at high risk of being

damaged or destroyed by the powerful force of tsunami waves, resulting in the loss of irreplaceable cultural heritage. The force of the water can erode foundations and walls, while sediment deposition can bury or obscure historic sites, making restoration efforts challenging and sometimes impossible. The inundation of saltwater can cause significant damage to the materials and structural integrity of historic buildings, as wood, metal, and other materials can deteriorate rapidly when exposed to saltwater, leading to long-term preservation issues.

Tsunamis can also wash away or bury artifacts, making them difficult to recover or permanently destroying valuable historical and archaeological information. Additionally, tsunamis can change the topography of coastal areas, altering the context in which historic sites are situated, which can affect their historical significance and interpretation.

Cultural

Many Native Hawaiian cultural resources are located near the shore and are threatened by tsunami events. These include fishing and cultural practices that are integral to the community's heritage. The population, built environment, and cultural sites located on Hawaiian Home Lands are particularly vulnerable to the tsunami hazard (HI-EMA 2023). According to the State HMP, Maui County has a total of 0.1 square miles, or 0.1 percent of the total area (102.6 square miles) of Hawaiian Home Lands located within the GAT inundation area. For the SOEST inundation area, there are no Hawaiian Home Lands located within this area. Lastly, 0.5 square miles, or 0.4 percent of the total area, are located within the ASCE inundation area (HI-EMA 2023).

Tsunamis can destroy sacred sites and disrupt traditional fishing practices and other cultural activities, profoundly impacting the community's way of life. The loss of these cultural resources can diminish the community's connection to its history and traditions, affecting cultural identity and continuity.

Overall, the cultural damage caused by tsunamis can have lasting effects, requiring extensive restoration efforts and long-term monitoring to mitigate the impacts.

14.2.6 Identified Vulnerability Issues

The County has identified the following vulnerabilities related to this hazard:

- 29.5 percent of the County's critical infrastructure and community lifeline facilities are located within a tsunami inundation zone.
- More than 20 percent of Maui County's residents live in a tsunami inundation zone.

14.3 FUTURE CHANGES THAT MAY AFFECT RISK

14.3.1 Potential or Planned Development

Development in tsunami-prone areas can increase the vulnerability of structures and populations, as buildings, infrastructure, and communities located near the coast are at higher risk of damage or destruction from tsunami waves. Additionally, planned development can impact the availability and

accessibility of evacuation routes, making it crucial to incorporate efficient evacuation plans and routes to minimize casualties during a tsunami event. The resilience of infrastructure, such as water supply, wastewater treatment, and power facilities, is also critical. Development plans should consider the potential impact of tsunamis and include measures to harden infrastructure against wave inundation (Structure Magazine 2024).

In the SOEST (400-year) tsunami inundation hazard area, 151 new developments across Maui County area located within this area, accounting for 4.6 percent of all new development. The highest number of new developments is in Wailuku-Kahului with 63 (8.4 percent), followed by Kihei-Makena with 56 (10.9 percent), and then West Maui with 31 (5.4 percent). Hana reports minimal exposure with one (2.6 percent), while the remaining planning areas show no new development in the hazard area.

Under the GAT (1,500-year) tsunami inundation hazard scenario, 290 new developments across Maui County are located within the hazard area, representing 8.9 percent of all new development. The highest concentrations are in Wailuku-Kahului with 127 (16.9 percent), Kihei-Makena with 100 (19.4 percent), and West Maui with 55 (9.6 percent). Smaller exposures are seen in Paia-Haiku with seven new developments (2.0 percent) and Hana with one (2.6 percent), while all remaining planning areas report no new development in the hazard area.

Under the ASCE (3,500-year) tsunami inundation hazard scenario, 432 new developments in Maui County fall within the hazard area, accounting for 13.3 percent of all new development. The highest number of new developments are in Kihei-Makena with 184 (35.7 percent), Wailuku-Kahului with 163 (21.7 percent), and West Maui with 70 (12.2 percent). Smaller exposures are seen in Paia-Haiku with 14 new developments (3.9 percent) and Hana with one (2.6 percent), while the remaining planning areas report no new development in this hazard area.

Table 14-15 through Table 14-17 display the number of new developments located within tsunami inundation hazard areas across Maui County.

Table 14-15. Number of New Development in the SOEST (400-year) Tsunami Inundation Hazard Area

Community Plan Area	Number of New Development in the SOEST (400-year) Tsunami Inundation Hazard Area	
	[illegible]	[illegible]
Hana	1	2.6%
Kahoolawe	0	0.0%
Kihei - Makena	56	10.9%
Lanai	0	0.0%
Makawao - Pukalani - Kula	0	0.0%
Molokai	0	0.0%

Paia - Haiku	0	0.0%
Wailuku - Kahului	63	8.4%
West Maui	31	5.4%
Maui County (Total)	**151**	**4.6%**

Source: *County of Maui 2025; Hawai'i Emergency Management Agency 2022; Niyam IT 2022*

Table 14-16. Number of New Development in the GAT (1,500-year) Tsunami Inundation Hazard Area

Community Plan Area	Number of New Development in the GAT (1,500-year) Tsunami Inundation Hazard Area	
	[illegible]	[illegible]
Hana	1	2.6%
Kahoolawe	0	0.0%
Kihei - Makena	100	19.4%
Lanai	0	0.0%
Makawao - Pukalani - Kula	0	0.0%
Molokai	0	0.0%
Paia - Haiku	7	2.0%
Wailuku - Kahului	127	16.9%
West Maui	55	9.6%
Maui County (Total)	**290**	**8.9%**

Source: *County of Maui 2025; Hawai'i Emergency Management Agency 2022; Niyam IT 2022*

Table 14-17. Number of New Development in the ASCE (3,500-year) Tsunami Inundation Hazard Area

Community Plan Area	Number of New Development in the ASCE (3,500-year) Tsunami Inundation Hazard Area	
	[illegible]	[illegible]
Hana	1	2.6%
Kahoolawe	0	0.0%
Kihei - Makena	184	35.7%
Lanai	0	0.0%

Makawao - Pukalani - Kula	0	0.0%
Molokai	0	0.0%
Paia - Haiku	14	3.9%
Wailuku - Kahului	163	21.7%
West Maui	70	12.2%
Maui County (Total)	**432**	**13.3%**

Source: *County of Maui 2025; Hawai'i Emergency Management Agency 2022; Niyam IT 2022*

14.3.2 Projected Changes in Population

Although population increases do not affect the incidence of tsunamis, analysis in this chapter has shown that certain Community Plan Areas have populations at higher risk from tsunami events. The Department of Business, Economic Development and Tourism (DBEDT) produced population projections for the County from 2030 to 2050. According to these projections, Maui County's population is projected to grow to 173,520 by 2030, 181,000 by 2040, and 184,870 by 2050.

14.3.3 Climate Change

Climate-related geological changes, such as increased earthquakes and volcanic eruptions, heighten the threat of tsunamis. Rising global sea levels, driven by warming oceans and melting ice sheets, allow tsunamis to travel further inland, causing greater damage and increasing coastal flooding. Climate change can also affect the earthquakes and landslides that generate tsunamis, with melting glaciers potentially inducing tectonic activity and heavy rainfall leading to soil instability. Even modest sea level rises can significantly increase the frequency and intensity of flooding from tsunamis, making future smaller tsunamis as impactful as larger ones today. A warming climate thus elevates the risk of landslides and local tsunamis.

14.3.4 Other Identified Conditions

Understanding local bathymetry and topography is crucial for tsunami mitigation and planning, as different areas will experience varying levels of impact based on their specific geographical features. Limiting new development in tsunami hazard zones and adopting building codes that address tsunami risks can reduce potential damage, making thoughtful land-use planning essential for protecting vulnerable areas. Additionally, protecting natural barriers like coral reefs and mangrove forests can help reduce the impact of tsunamis, as these natural features play a crucial role in coastal protection (NOAA 2023).

15. VOLCANIC HAZARDS

15.1 HAZARD PROFILE

15.1.1 Hazard Description

A volcano is an opening in the earth's crust through which molten rock, called magma, and gases escape to the surface. Volcanoes form in three different types of tectonic settings: 1) subduction zone volcanoes are the most violent and destructive, and form where one tectonic plate is subducted under another; 2) rift volcanoes are the most common and form where two tectonic plates are spreading apart; and 3) hot spot are volcanic centers that are typically 60 to 120 miles across. Hawai'i 's hot spot volcanoes include Kīlauea, Mauna Loa, Hualālai, Mauna Kea, and Haleakalā. Kīlauea has erupted almost continuously from 1983 to 2018. Mauna Loa, the largest volcano on earth, has erupted 34 times since 1843. Haleakalā has erupted at least ten times in the past 1,000 years (USGS n.d.).

The U.S. Geological Survey (USGS) has assessed the threat level of all potentially active volcanoes in the United States—volcanoes that likely erupted within the last 10,000 years—on a 5-level scale from very low threat to very high threat (Ewert et. al 2018). This assessment includes consideration of 15 hazard factors, such as how often the volcano eruptions, and how hazardous its eruptions can be, and 9 exposure factors, including how many people and what infrastructure could be exposed to future activity. In Maui County, there is one potentially active volcano, Haleakalā, which makes up the eastern side of Maui Island, and it is classified as a moderate threat volcano.

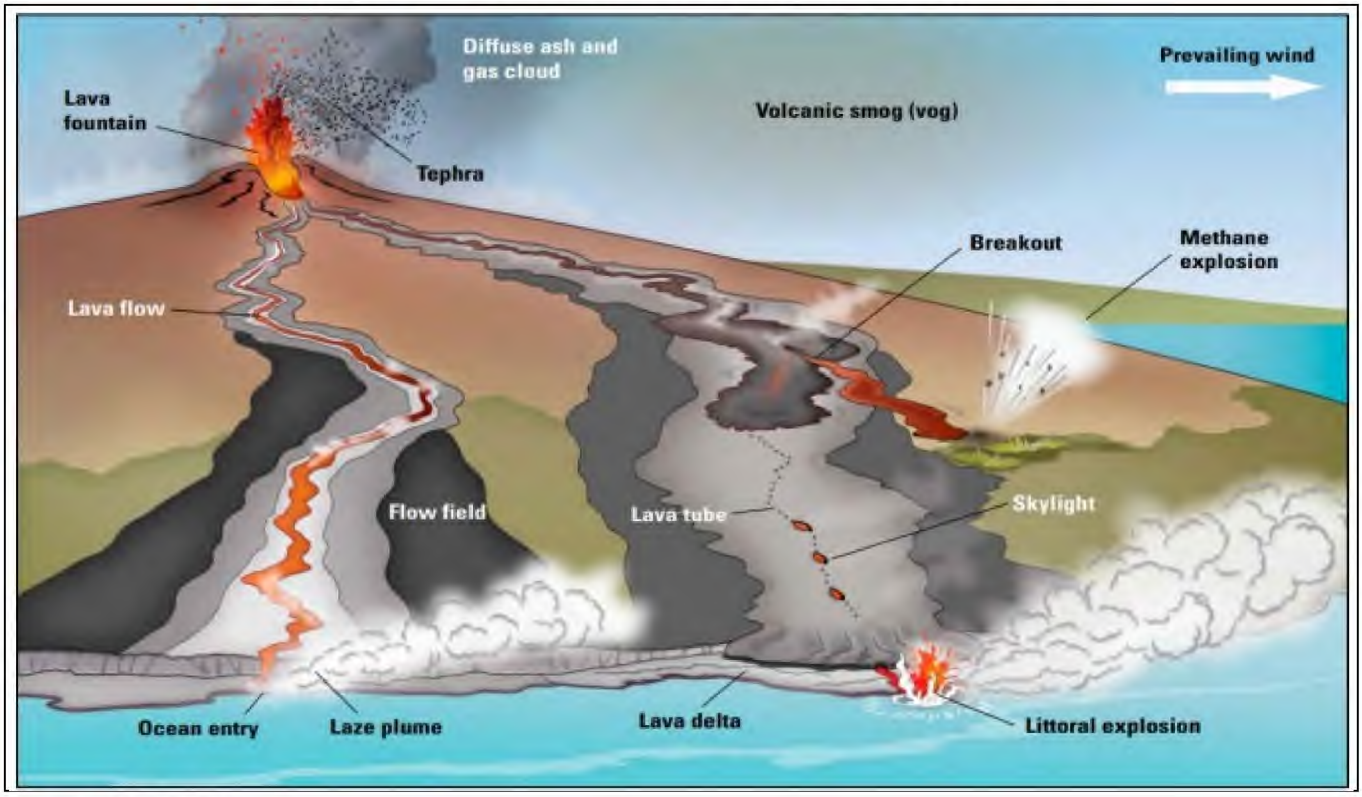
Hawaiian volcanoes are primarily shield volcanoes, which develop as lava flows create gently sloping, shield-like mountains. These are the largest volcanoes on earth, with notable examples including Mauna Loa in Hawai'i County and Haleakalā in Maui County. Unlike volcanic activity at subduction zones (e.g., Mount Shasta, Mount Saint Helens), Hawaiian volcanoes produce more fluid basalt magmas, which are typically less explosive. Basalt lava flows exhibit two morphologies, globally recognized by their Hawaiian names, ʻaʻā and pāhoehoe. Eruptions from shield volcanoes are generally non-explosive unless water enters the vent system (USGS 2024). The understanding of the eruptive process, including explosive activity, remains incomplete, as experts have only observed and recorded a small fraction of Hawaiian volcano life cycles. Shield volcanoes predominantly erupt at their summits or along rift zones. Figure 15-1 illustrates the composition of a shield volcano.

Volcanic activity presents a range of hazards that can significantly impact both the environment and human communities:

- **Lava Flows, Domes, and Dome Collapses**—Lava flows typically move slowly and follow predictable paths, posing a minimal threat to human life. However, during an effusive eruption, partially solidified lava may accumulate at the vent, forming a lava dome. If the dome becomes too steep, it can collapse, releasing pyroclastic flows that are as hazardous as those from explosive eruptions.

- **Pyroclastic Flows**—These are fast-moving, ground-hugging flows of hot ash, pumice, rock fragments, and volcanic gas, capable of reaching speeds over 60 miles per hour. With temperatures exceeding 930 degrees Fahrenheit, pyroclastic flows can burn and carbonize wood. Their travel distance depends on the surrounding topography and the volume of magma released.

Figure 15-1. Shield Volcano and Lava Field Components



Source: (USGS 2019)

- **Lahars**—Lahars are debris flows consisting of volcanic particles mixed with water. They can form when pyroclastic flows enter water bodies, flow over snow and ice, or when heavy rain falls on loose volcanic debris. Lahars can travel up to 100 miles per hour and cover distances as far as 190 miles, potentially transitioning into normal floodwaters downstream.
- **Volcanic Ash and Tephra Fall**—Explosive eruptions propel fragments and gas into the air, forming an eruption column that can reach stratospheric heights. Tephra, including volcanic ash and larger rock fragments, poses aviation hazards and settles as tephra fall. The size and thickness of tephra deposits generally decrease with distance from the eruption.
- **Volcanic Gas or Fog (Vog)**—Eruptions release noxious gases such as water vapor, carbon dioxide, sulfur dioxide, hydrogen sulfide, carbon monoxide, and chlorine. These gases can mix with atmospheric moisture to create volcanic smog (vog) and acid rain, posing health risks like respiratory illnesses, contaminated water, and crop damage. Additionally, when lava enters the ocean, it produces laze (lava haze), a gas plume that causes skin and eye irritation and breathing difficulties. Laze was notably formed during the 2018 Kilauea eruption.

15.1.2 Location

Maui County faces two types of volcanic hazards: lava flows and vog. Lava flows pose a risk only to the Island of Maui, potentially from an eruption of Haleakalā, a shield volcano with a moderate threat level according to the USGS. It is important to note that the other volcanoes in Maui County are considered extinct (Sherrod, et. al 2021).

Lava Flows

The USGS Hawaiian Volcano Observatory (HVO) monitors active volcanoes in the state of Hawai'i , including Haleakalā. A 2006 USGS HVO study delineated lava flow hazard areas for Maui County that may pose a hazard to communities (Sherrod, et. al 2006). 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. Haleakalā is the only volcano in the Hawaiian Islands outside of Island of Hawai'i, that has erupted during the last few hundred years. The most recent lava flow, which erupted sometime between 1449 and 1633 C.E., featured lava issued from two vents on the southwest rift—one at an altitude of 575 feet and the other at 1,200 feet—and formed a flow that went into the sea (Sherrod, et. al 2006). This fresh flow is crossed by the road that follows the coastline from Mākena to Keoneoio, at the head of La Perouse Bay.

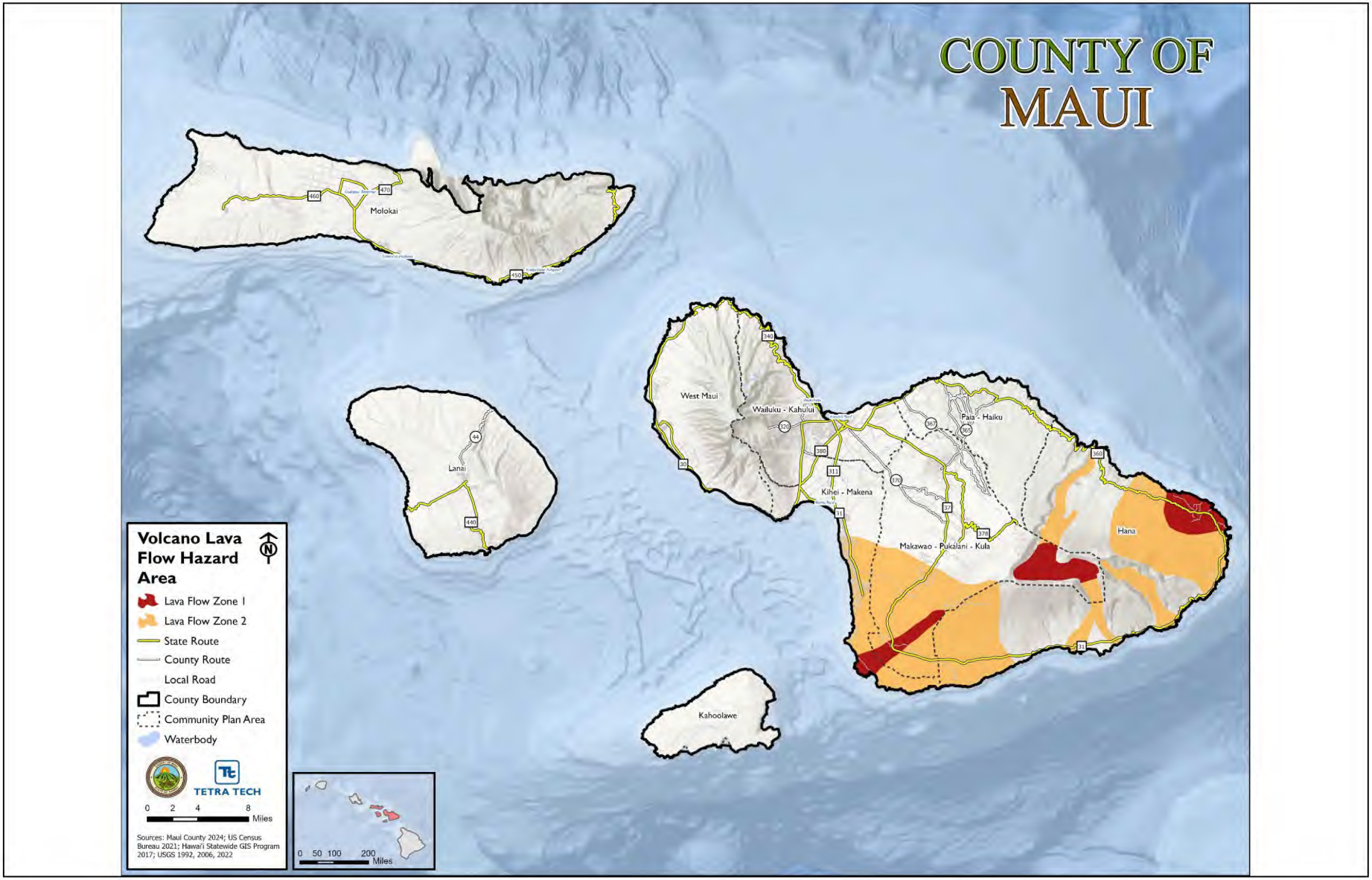
The lava flow zones for Maui are designed to show the relative lava flow hazard across the island and are suitable for general planning purposes. The lower the number zone, the greater the severity of the hazard. The lava flow zones in each County are classified differently, meaning Zone 1 in the County of Maui is not equivalent to Zone 1 in the County of Hawai'i. 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. According to the 2023 State of Hawai'i Hazard Mitigation Plan Update, an area of 216.5 square miles (18.4 percent) in Maui County is located within the lava flow high risks zones. The descriptions of the lava zones for Maui County can be found below in Table 15-1, as well as Figure 15-2 which illustrates the lava flow hazard areas in the County.

Table 15-1. Lava Flow Hazard Zone Descriptions for Maui County

Hazard Zone	Description
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 Ka'upo and Ko'olau 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.

Source: (Sherrod, et. al 2006)

Figure 15-2. Lava Flow Hazard Areas in Maui County



Vog

Vog ("volcanic smog"), originating from volcanic activity, has the potential to impact various areas within Maui County. The primary source of vog at present is the active Kīlauea volcano on the Island of Hawai'i. Kīlauea is the most active volcano in the world, with 76 eruptions between 1840 and 2024, including a 35-year long eruption from 1983 to 2018. Vog from this volcano can be blown to Maui County during Kona storms or non-trade wind conditions.

On Maui Island, vog is funneled through the central valley between Haleakalā and the west Maui mountains. This unique topography means that vog can affect not only the southern coast in Kīhei-Mākena but also extend to the agricultural areas of central and upcountry Maui. Additionally, densely populated areas such as Wailuku and Kahului on the northern shore can experience vog impacts. The islands of Lāna'i and Moloka'i are less frequently affected by vog due to their greater distance from the sources on the Island of Hawai'i.

15.1.3 Extent

Haleakalā has erupted approximately 15 times over the last 1,500 years, with the most recent eruption occurring sometime between 1449 and 1633 C.E. on the volcano's southwest flank. At that time, the area was not populated. Determining the possible extent of a future lava flow event in Maui County is challenging due to the lack of recent eruptions. Lava flows can destroy homes, businesses, roadways, and other infrastructure. Haleakalā's past eruptions are generally considered non-explosive, especially compared to subduction zone volcanoes, but are likely to produce more tephra than Kīlauea and Mauna Loa volcanoes on the Island of Hawai'i.

The extent of vog hazards depends on the amount of magma degassed, the concentration of gas in that magma, or weather and conditions at the time of the eruption, and the distance from the erupting volcano. Most vog in Maui County will be caused by erupting volcanoes on the Island of Hawai'i.

Warning Time

In modern times, most eruptions from Hawaiian volcanoes are forecasted due to weeks or months of precursory activity, such as seismicity, and ground deformation. However, volcanic activity can also occur with little advanced warning. For example, the 2018 eruption on the lower East Rift Zone was preceded by a few days of warning.

On May 1 at 4:54 am, HVO issued a notice stating that a collapse of the Pu'u 'Ō'ō crater floor on Kīlauea Volcano's East Rift Zone had increased seismicity and deformation along the rift zone, with activity extending as far east as Hwy 130. A new lava outbreak was possible, and residents of lower Puna were advised to stay alert. Later that morning, at 8:49 am, HVO issued another Volcano Activity Notice, highlighting the potential for a new outbreak if activity intensified. Residents were urged to monitor Hawai'i County Civil Defense messages. The eruption began on May 3, just before 5 pm. Although initial notices did not specifically mention lower Puna, inflation at Pu'u 'Ō'ō had been observed since March 2018. A mid-April notice from HVO indicated increased pressurization beneath Pu'u 'Ō'ō,

suggesting the possibility of a new vent forming either on the cone or along adjacent areas of the East Rift Zone.

Volcano-alert notifications are produced by volcano observatory scientists based on data from monitoring networks, direct observations, and satellite sensors. These notifications are issued for both increasing and decreasing volcanic activity and include information about the nature of the unrest or eruption, potential or current hazards, and likely outcomes. The USGS employs a nationwide volcano alert-level system to characterize conditions at U.S. volcanoes, with levels Normal, Advisory, Watch, or Warning. Notifications about the status of volcanic activity are issued through the five regional U.S. volcano observatories.

This alert-level system helps to communicate the extent of volcanic hazards, providing crucial information for preparedness and response efforts. The USGS alert-level system for volcanic activity has two parts, as described by Table 15-2 and Table 15-3.

Table 15-2. 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: (USGS 2022)

Table 15-3. 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: (USGS 2022)

15.1.4 Previous Occurrences

FEMA Disaster Declarations

Between 1954 and 2024, Maui County was included in one major disaster (DR) or emergency (EM) declaration for volcanic-related events, as listed in Table 15-4 (FEMA 2024).

Table 15-4. FEMA Disaster Declarations for Volcanic Hazards Events in Maui County

Event Date	Declaration Date	Declaration Number	Description
April 1, 1955	April 1, 1955	DR-32 (Statewide)	Volcano

Source: (FEMA 2024)

State Emergency Proclamations

The Governor of Hawai'i may declare a state of emergency by proclamation if an emergency or disaster has occurred or there is imminent danger or threat of an emergency or disaster in any portion of the state (Hawai'i State Legislature 2020). Between 2020 and 2024, Maui County was not included in any volcanic hazards-related state emergency proclamations (HI-EMA 2024).

USDA Declarations

The U.S. Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties contiguous to them. Between 2020 and 2024, Maui County was not included in any USDA volcanic hazards-related agricultural disaster declarations (USDA 2024).

All Recent Events

Between 2020 and 2024, there have been no known major recorded volcanic hazard-related events that impacted Maui County since the previous HMP was developed. For earlier events, refer to the 2020 HMP.

15.1.5 Probability of Future Occurrences

Probability Based on Previous Occurrences

The probability of future volcanic hazards in Maui County is influenced by the historical activity of its volcanoes and ongoing monitoring efforts. Haleakalā, the primary volcano on Maui, has erupted approximately 15 times over the past 1,500 years, with the most recent eruption occurring sometime between 1449 and 1633 C.E. While Haleakalā is currently classified at activity level Normal/Green, that is in typical background, non-eruptive state, the potential for future eruptions remains, albeit with a low probability in the near term (USGS n.d.). Based on these records and input from the HMWG, the probability of occurrence for volcanic hazards events in the County is considered "unlikely" or having less than a 1 percent chance of occurrence (see Table 15-5).

Table 15-5. Probability of Future Lava Flow Events in Maui County

Hazard Type	Number of Occurrences Between 1955 and 2024	Percent Chance of Occurring in Any Given Year
Lava Flow	0	<1%

Source: (FEMA 2024) (NOAA 2024) (County of Maui 2020) (HI-EMA 2023)
Note: The time period presented in this table is the most complete period of record for the various data sources reviewed.

The likelihood of vog (volcanic smog) impacting Maui County is higher due to the frequent activity of Kīlauea on the Island of Hawai'i. Vog episodes can occur when wind patterns transport volcanic gases from Kīlauea to Maui, particularly during Kona storms or non-trade wind conditions. These episodes can vary in frequency and intensity, depending on the level of volcanic activity and prevailing weather conditions. More recently, vog occurrences in Maui County include:

- **April 25, 2008**: The Island of Maui District Health Office issued an advisory due to vog from Kīlauea's summit vent, urging residents with respiratory conditions to take precautions. Sulfur dioxide levels around the observatory reached 1 part per million for 2 hours.
- **January 2015**: A surface ridge altered the typical trade wind pattern, bringing vog from Kīlauea as far as Kaua'i. The vog was so thick that a kayaker became disoriented and had to be rescued by the Coast Guard.
- **May 2018**: A new eruption at Kīlauea began, lasting through August 2018, causing potentially hazardous vog conditions in Maui County.
- **December 2022**: Mauna Loa's first eruption in nearly 40 years spread vog across the State of Hawai'i , including Maui County.
- **January 2023**: Emissions from the new eruption at Kīlauea's summit reached across most of the main Hawaiian Islands as a result of light winds ahead of an approaching cold front.
- **February/March 2025**: Southerly and southeasterly winds sent vog from the ongoing December 2024 eruption up the island chain. Air quality monitoring stations on Maui recorded elevated levels of particulates and the Hawai'i State Department of Health warned residents statewide of the vog hazard.

Overall, while the probability of a significant volcanic eruption on Maui itself is relatively low (see Table 15-6), the county remains susceptible to vog from volcanoes on the Island of Hawai'i. Based on these records and input from the Hazard Mitigation Working Group, the probability of occurrence for volcanic hazards events in the County is considered "occasional."

Table 15-6. Probability of Future Vog Events in Maui County

Hazard Type	Number of Occurrences Between 2008 and 2025	Percent Chance of Occurring in Any Given Year
Vog	6	33.3%

Source: (FEMA 2024) (NOAA 2024) (County of Maui 2020) (HI-EMA 2023)
Note: The time period presented in this table is the most complete period of record for the various data sources reviewed.

Effect of Climate Change on Future Probability

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. Projections indicate potential changes in wind and rainfall activity. Any changes in wind and rainfall frequency and intensity may alter the dispersion of volcanic gas emissions, adversely impacting human health (HI-EMA 2023).

The massive outpouring of gases and ash from very large explosive volcanic eruptions can influence climate patterns for years, but the types of volcanic activity that could impact climate are not those typically associated with Hawaiian volcanoes.

15.1.6 Cascading Impacts on Other Hazards

Volcanic hazards in Maui County can trigger cascading impacts, creating complex multi-hazard scenarios. For instance, eruptions from Haleakalā can destabilize slopes. As volcanic ash and debris accumulate, they increase the weight on slopes, potentially leading to landslides. Volcanic activity can also alter drainage patterns and block rivers with lava flows (rarely in the Hawaiian Islands) or ash deposits, leading to flooding. Additionally, the heat from lava flows can ignite vegetation, resulting in wildfires that spread rapidly, especially in dry conditions.

Air quality in Maui County can be significantly degraded by volcanic eruptions, as large amounts of gases are released into the atmosphere, which creates vog and can subsequently cause respiratory problems and exacerbate health issues, particularly for vulnerable populations. Rain falling when vog is present can become acidic, which can damage infrastructure. Acid rain and acidic compounds on volcanic ash can potentially contaminate surface water supplies, making it unsafe for drinking and irrigation, leading to water shortages and affecting agricultural productivity. In rare cases, fluorine toxicity in livestock can occur when fluorine-bearing volcanic ash covers grazing pastures.

Lava flows can also severely damage infrastructure, including roads, bridges, and buildings, and lava flows, gas, ash, and related hazards can disrupt transportation and communication networks.

15.2 VULNERABILITY AND IMPACT ASSESSMENT

To assess Maui County's risk of volcanic hazard, a spatial analysis was conducted using data provided by the Hawai'i Statewide GIS Program (2017) and USGS (1992, 2006). To determine what assets are exposed to volcanic hazards, the asset inventories prepared for this HMP (population, buildings, critical facilities) were overlaid with the Maui Lava Flow Hazard Zones 1 and 2. Assets with their centroid located in the zones were totaled to estimate the numbers and values at risk from volcanic impacts.

15.2.1 Life, Health, and Safety

Volcanic hazards pose significant risks to the life, health, and safety of residents. These hazards include lava flows, volcanic smog (vog), and other related phenomena, which can have severe impacts on communities.

Overall Population

Volcanic hazards can significantly impact the vulnerability of the overall population in several ways. Health risks arise from exposure to volcanic ash and gases, such as sulfur dioxide, which can cause respiratory issues, eye irritation, and other health problems, leading to increased medical visits and strain on healthcare systems. Infrastructure damage from lava flows and ashfall can disrupt daily life by damaging or destroying homes, roads, and utilities, hindering emergency response efforts, and causing long-term economic impacts. Air quality degradation from volcanic eruptions affects the general population's ability to engage in outdoor activities and can lead to long-term health issues.

Additionally, volcanic gas, aerosols, and acid rain can contaminate surface water supplies, making it unsafe for drinking and irrigation, leading to water shortages and affecting agricultural productivity, which impacts food security. Evacuations and displacement due to lava flows can cause significant disruption to communities and strain resources, especially considering that most of the population believes that Haleakalā is a dormant volcano. Understanding these impacts is crucial for developing an effective mitigation strategy to protect the general population from volcanic hazards. Table 15-7 in the Maui Lava Flow Hazard Zones 1 and 2.

Table 15-7. Population in the Maui Lava Flow Zone 1 and Zone 2

Community Plan Area	Total Population (2023 ACS)	Population in the Maui Lava Flow Zone 1		Population in the Maui Lava Flow Zone 2	
		Number of Persons	% of Plan Area Total	Number of Persons	% of Plan Area Total
Hāna	2,135	662	31.0%	1,211	56.7%
Kīhei-Mākena	29,174	39	0.1%	19,047	65.3%
Lānaʻi	3,333	0	0.0%	0	0.0%
Makawao-Pukalani-Kula	24,505	35	0.1%	1,102	4.5%
Molokaʻi	8,092	0	0.0%	0	0.0%
Pāʻia-Haʻikū	17,037	0	0.0%	0	0.0%
Wailuku-Kahului	58,606	0	0.0%	0	0.0%
West Maui	21,749	0	0.0%	0	0.0%
Maui County (Total)	164,632	736	0.4%	21,360	13.0%

Source: U.S. Census Bureau 2023 ACS; Hawai'i Statewide GIS Program 2017; USGS 1992, 2006

Socially Vulnerable Population

Sensitive populations, including young children and individuals with preexisting respiratory conditions such as asthma, emphysema, bronchitis, and chronic lung or heart disease, may react to even low levels of sulfur dioxide. Prolonged or repeated exposure to higher levels can increase vulnerability to vog impacts. Common symptoms of vog exposure include headaches, breathing difficulties, increased susceptibility to respiratory ailments, watery eyes, and sore throat.

According to available hazard information, all populations within Maui County may be exposed to vog. Additionally, residents in the Pāʻia-Haʻikū, Makawao-Pukalani-Kula, and Hāna Community Plan Areas,

as well as the eastern portions of the Kīhei-Mākena and Wailuku-Kahului Community Plan Areas, may face lava flow hazards. Lava flows can permanently alter the landscape and destroy everything in their path, leading to complete property loss. This presents significant hardships, particularly for those with socioeconomic limitations. Lava flows may also disrupt essential services such as electricity and communications, and damage infrastructure like roadways, which can hinder evacuation or access to health care.

Vog irritates mucous membranes and is especially harmful to those with preexisting respiratory conditions. Populations without access to health insurance may delay seeking critical medical treatment.

Table 15-8 and Table 15-9 list the estimated number of vulnerable persons located in the Maui Lava Flow Hazard Zones 1 and 2. In Zone 1, there are 190 persons over the age of 65 years, 33 persons under the age of 5 years, 13 non-English speakers, 78 persons with a disability, and 109 living in poverty located in this hazard area. The majority of the socially vulnerable populations in Zone 1 are located in the Community Plan Area of Hāna. In Zone 2, there are 4,557 persons over the age of 65 years, 987 persons under the age of 5 years, 598 non-English speakers, 2,295 persons with a disability, and 2,203 living in poverty located in this hazard area. The Community Plan Area of Kīhei–Mākena has the highest concentration of vulnerable populations.

Table 15-8. Estimated Number of Vulnerable Persons Located in the Maui Lava Flow Zone 1

Community Plan Area	Estimated Number of Vulnerable Persons Located in the Moderate Landslide Susceptibility Hazard Area									
	Persons Over 65	Percent of Total	Persons Under 5	Percent of Total	Non-English Speaking Persons	Percent of Total	Persons with a Disability	Percent of Total	Persons in Poverty	Percent of Total
Hāna	175	31.0%	31	30.3%	12	30.4%	71	30.6%	103	30.8%
Kīhei-Mākena	8	0.1%	1	0.1%	1	0.1%	4	0.1%	3	0.1%
Lānaʻi	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Makawao-Pukalani-Kula	7	0.1%	1	0.1%	0	0.0%	3	0.1%	3	0.1%
Molokaʻi	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Pāʻia-Haʻikū	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Wailuku-Kahului	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
West Maui	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Maui County (Total)	190	0.6%	33	0.4%	13	0.2%	78	0.4%	109	0.7%

Source: U.S. Census Bureau 2023 ACS Vulnerable Population Totals; Hawaiʻi Statewide GIS Program 2017; USGS 1992, 2006

Table 15-9. Estimated Number of Vulnerable Persons Located in the Maui Lava Flow Zone 2

Community Plan Area	Estimated Number of Vulnerable Persons Located in the Moderate Landslide Susceptibility Hazard Area									
	Persons Over 65	Percent of Total	Persons Under 5	Percent of Total	Non-English Speaking Persons	Percent of Total	Persons with a Disability	Percent of Total	Persons in Poverty	Percent of Total
Hāna	320	56.7%	57	55.8%	22	55.6%	131	56.4%	190	56.8%
Kīhei-Mākena	3,992	65.3%	869	65.3%	555	65.2%	2,055	65.3%	1,893	65.3%
Lānaʻi	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Makawao-Pukalani-Kula	245	4.5%	61	4.4%	21	4.3%	109	4.5%	120	4.5%
Molokaʻi	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Pāʻia-Haʻikū	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Wailuku-Kahului	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
West Maui	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Maui County (Total)	4,557	13.8%	987	11.0%	598	9.8%	2,295	13.0%	2,203	13.8%

Source: U.S. Census Bureau 2023 ACS Vulnerable Population Totals; Hawaiʻi Statewide GIS Program 2017; USGS 1992, 2006

15.2.2 General Building Stock

All buildings and infrastructure, including critical facilities, within lava flow hazard zones are considered at risk. This includes the Pāʻia-Haʻikū, Makawao-Pukalani-Kula, and Hāna Community Plan Areas, as well as the eastern portions of the Kīhei-Mākena and Wailuku-Kahului Community Plan Areas.

Additionally, all buildings and infrastructure in Maui County are at risk from vog. While vog primarily impacts human health, it can also cause significant damage to buildings and infrastructure through corrosion. Acid aerosols from vog increase corrosion on any exposed metal along the path of the downwind vog plume, affecting metal roofing, fencing, waterlines, water tanks, farm equipment, and exposed steel structures such as transmission towers and bridges. Even in relatively dry downwind areas, severe corrosion can lead to substantial economic losses. Dew formation, rather than infrequent rainfall, drives this corrosion. During the evening hours, as the dew point temperature is approached, acid aerosols form an extremely corrosive film on metallic surfaces. With daily replenishment of fresh acid from vog and nightly condensation of moisture, it is reasonable to anticipate much more rapid deterioration of exposed metal surfaces than would occur in similar environments not exposed to vog.

There are 318 buildings with a replacement cost value of approximately $237 million within the lava flow zone 1 hazard area. The Community Plan Area of Hāna has the greatest number of buildings built in this area; 296 buildings (31.8 percent of its total building stock) with an estimated replacement cost of $226 million. Table 15-10 summarizes the number of buildings built in the Maui Lava Flow Hazard Zone 1 and the total replacement cost of these buildings by Community Plan Area.

Table 15-10. Replacement Cost Value of Buildings in the Maui Lava Flow Zone 1

	Community Plan Area Total Buildings		Buildings in the Maui Lava Flow Zone 1			
			Number of Buildings		Replacement Cost Value	
Community Plan Area	Count	Replacement Cost Value	Count	% of Plan Area Total	Value	% of Plan Area Total
Hāna	930	$741,266,476	296	31.8%	$225,688,931	30.4%
Kīhei-Mākena	7,613	$11,692,760,990	9	0.1%	$5,564,361	<0.1%
Lānaʻi	1,258	$1,012,846,136	0	0.0%	$0	0.0%
Makawao-Pukalani-Kula	8,868	$6,037,317,698	13	0.1%	$5,308,518	0.1%
Molokaʻi	3,056	$2,384,451,998	0	0.0%	$0	0.0%
Pāʻia-Haʻikū	4,316	$2,686,054,376	0	0.0%	$0	0.0%
Wailuku-Kahului	15,444	$18,302,375,352	0	0.0%	$0	0.0%
West Maui	4,063	$8,896,487,618	0	0.0%	$0	0.0%
Maui County (Total)	45,548	$51,753,560,644	318	0.7%	$236,561,810	0.5%

Source: USACE NSI 2022; Hawaiʻi Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; RSMeans 2024; Hawaiʻi Statewide GIS Program 2017; USGS 1992, 2006

Table 15-11 displays the buildings by general occupancy located within the Maui Lava Flow Hazard Zone 1. This analysis estimates that the residential occupancy is the most exposed to this hazard area with 280 total buildings. The Community Plan Area of Hāna holds the highest number of residential buildings (259) in the hazard area.

Table 15-11. Buildings in the Maui Lava Flow Hazard Zone 1 by General Occupancy Class

Community Plan Area	Buildings in the Maui Lava Flow Hazard Zone 1 by General Occupancy Class			
	Residential	Commercial	Industrial	Other[a]
Hāna	259	30	2	5
Kīhei-Mākena	9	0	0	0
Lānaʻi	0	0	0	0
Makawao-Pukalani-Kula	12	1	0	0
Molokaʻi	0	0	0	0
Pāʻia-Haʻikū	0	0	0	0
Wailuku-Kahului	0	0	0	0
West Maui	0	0	0	0
Maui County (Total)	280	31	2	5

Source: USACE NSI 2022; Hawai'i Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; Hawai'i Statewide GIS Program 2017; USGS 1992, 2006

a. Other = Government, Religion, Agricultural, and Education

There are 5,903 buildings with a replacement cost value of approximately $9 billion within the Maui Lava Flow Hazard Zone 2. The Community Plan Area of Kīhei-Mākena has the greatest number of buildings built in this area; 4,990 buildings (65.5 percent of its total building stock) with an estimated replacement cost of $8.3 billion. Table 15-12 summarizes the number of buildings built in the Maui Lava Flow Hazard Zone 2 and the total replacement cost of these buildings by Community Plan Area.

Table 15-13 displays the buildings by general occupancy located within the Maui Lava Flow Hazard Zone 2. This analysis estimates that the residential occupancy is the most exposed to this hazard area with 4,330 total buildings. The Community Plan Area of Kīhei-Mākena holds the highest number of residential buildings (4,330) in the hazard area.

Table 15-12. Replacement Cost Value of Buildings in the Maui Lava Flow Hazard Zone 2

Community Plan Area	Community Plan Area Total Buildings		Buildings in the Maui Lava Flow Hazard Zone 2			
			Number of Buildings		Replacement Cost Value	
	Count	Replacement Cost Value	Count	% of Plan Area Total	Value	% of Plan Area Total
Hāna	518	55.7%	$442,421,177	59.7%	518	55.7%
Kīhei-Mākena	4,990	65.5%	$8,315,572,759	71.1%	4,990	65.5%
Lānaʻi	0	0.0%	$0	0.0%	0	0.0%
Makawao-Pukalani-Kula	395	4.5%	$313,239,594	5.2%	395	4.5%

Community Plan Area	Community Plan Area Total Buildings		Buildings in the Maui Lava Flow Hazard Zone 2			
			Number of Buildings		Replacement Cost Value	
	Count	Replacement Cost Value	Count	% of Plan Area Total	Value	% of Plan Area Total
Molokaʻi	0	0.0%	$0	0.0%	0	0.0%
Pāʻia-Haʻikū	0	0.0%	$0	0.0%	0	0.0%
Wailuku-Kahului	0	0.0%	$0	0.0%	0	0.0%
West Maui	0	0.0%	$0	0.0%	0	0.0%
Maui County (Total)	5,903	13.0%	$9,071,233,531	17.5%	5,903	13.0%

Source: USACE NSI 2022; Hawaiʻi Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; RSMeans 2024; Hawaiʻi Statewide GIS Program 2017; USGS 1992, 2006

Table 15-13. Buildings in the Maui Lava Flow Hazard Zone 2 by General Occupancy Class

Community Plan Area	Buildings in the Maui Lava Flow Hazard Zone 2 by General Occupancy Class			
	Residential	Commercial	Industrial	Other[a]
Hāna	474	32	7	5
Kīhei-Mākena	4,330	545	74	41
Lānaʻi	0	0	0	0
Makawao-Pukalani-Kula	373	14	5	3
Molokaʻi	0	0	0	0
Pāʻia-Haʻikū	0	0	0	0
Wailuku-Kahului	0	0	0	0
West Maui	0	0	0	0
Maui County (Total)	5,177	591	86	49

Source: USACE NSI 2022; Hawaiʻi Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; Hawaiʻi Statewide GIS Program 2017; USGS 1992, 2006

a. Other = Government, Religion, Agricultural, and Education

15.2.3 Community Lifelines and Other Critical Facilities

Lava flows can destroy buildings, roads, bridges, and other critical infrastructure in their path, leading to complete property loss and significant economic hardships, especially for vulnerable populations. Volcanic activity can also disrupt essential services such as electricity, water supply, and telecommunications.

Table 15-14 shows the number of critical facilities located in the Maui Lava Flow Hazard Zone 1. There are a total of five facilities located in this hazard area with the highest number among the Safety and Security lifeline (3). The Community Plan Area of Hāna encompasses several critical facilities within the hazard zone, including one in Energy, three in Safety and Security, and one in Transportation.

Table 15-15 shows the number of critical facilities located in the Maui Lava Flow Hazard Zone 2. There are a total of 33 facilities located in this hazard area with the highest number among the Water Systems lifeline (11). The Community Plan Area of Kīhei-Mākena contains the highest number of facilities (24), including the largest number of Water Systems (11).

15.2.4 Economy

Natural disasters can have a devastating impact on local economies. Over a 12-month period, the 2018 Kīlauea eruption on the Island of Hawai'i caused more than $415 million in tourism losses and resulted in 2,950 people losing their jobs (Hawai'i 2020). These losses will be felt especially in areas dependent upon one industry. A month after the Lahaina Wildfire, the Hawai'i Department of Business, Economic Development and Tourism (DBEDT) estimated that the daily total business revenue of destroyed Lahaina businesses was $2.7 million (DBEDT 2023).

Volcanic activity can significantly impact Maui's economy through various channels. One of the most immediate effects is on tourism, a critical sector for the island. Eruptions can deter visitors due to safety concerns and travel disruptions, such as flight cancellations and road closures caused by ashfall (Global Rescue 2025). This reduction in tourist arrivals and spending can have a substantial negative effect on local businesses and employment.

Property and infrastructure damage is another major concern. Lava flows can destroy homes, businesses, and essential infrastructure like roads, bridges, and power lines. The costs associated with repairing and rebuilding these structures can strain local resources and budgets, leading to long-term financial challenges for the community.

The agricultural sector is significantly impacted by volcanic activity. Lava, ash, and gas can damage crops and soil, reducing agricultural productivity and causing financial losses for farmers (USGS 2015). This not only affects the local food supply but also the broader economy, as agriculture is a vital part of Maui's economic landscape. The agricultural district covers 387,665 acres, or 52.1 percent of the County's total area, underscoring its importance to the region (Hawai'i State Office of Planning 2020).

Table 15-14. Number of Facilities in the Maui Lava Flow Hazard Zone 1, by Lifeline Category

Community Plan Area	Number of Facilities in the Maui Lava Flow Hazard Zone 1, by Lifeline Category									Total Facilities in Hazard Area	
	Communications	Energy	Food, Hydration, Shelter	Hazardous Materials	Health & Medical	Safety & Security	Transportation	Water Systems	Other Critical Facilities	Count	% of Plan Area Total
Hāna	0	1	0	0	0	3	1	0	0	5	38.5%
Kīhei-Mākena	0	0	0	0	0	0	0	0	0	0	0.0%
Lānaʻi	0	0	0	0	0	0	0	0	0	0	0.0%
Makawao-Pukalani-Kula	0	0	0	0	0	0	0	0	0	0	0.0%
Molokaʻi	0	0	0	0	0	0	0	0	0	0	0.0%
Pāʻia-Haʻikū	0	0	0	0	0	0	0	0	0	0	0.0%
Wailuku-Kahului	0	0	0	0	0	0	0	0	0	0	0.0%
West Maui	0	0	0	0	0	0	0	0	0	0	0.0%
Maui County (Total)	0	1	0	0	0	3	1	0	0	5	1.8%

Source: Hawaiʻi Emergency Management Agency 2017; Hawaiʻi Statewide GIS Program 2017; USGS 1992, 2006

Table 15-15. Number of Facilities in the Maui Lava Flow Hazard Zone 2, by Lifeline Category

Community Plan Area	Number of Facilities in the Maui Lava Flow Hazard Zone 2, by Lifeline Category									Total Facilities in Hazard Area	
	Communications	Energy	Food, Hydration, Shelter	Hazardous Materials	Health & Medical	Safety & Security	Transportation	Water Systems	Other Critical Facilities	Count	% of Plan Area Total
Hāna	1	0	1	0	1	0	0	0	2	5	38.5%
Kīhei-Mākena	1	0	1	0	3	5	1	11	2	24	70.6%
Lānaʻi	0	0	0	0	0	0	0	0	0	0	0.0%
Makawao-Pukalani-Kula	2	0	0	0	2	0	0	0	0	4	16.7%
Molokaʻi	0	0	0	0	0	0	0	0	0	0	0.0%
Pāʻia-Haʻikū	0	0	0	0	0	0	0	0	0	0	0.0%
Wailuku-Kahului	0	0	0	0	0	0	0	0	0	0	0.0%
West Maui	0	0	0	0	0	0	0	0	0	0	0.0%
Maui County (Total)	4	0	2	0	6	5	1	11	4	33	12.0%

Source: Hawaiʻi Emergency Management Agency 2017; Hawaiʻi Statewide GIS Program 2017; USGS 1992, 2006

15.2.5 Natural, Historic and Cultural Resources

Natural

Volcanic activity in Maui County can have severe impacts on natural resources. Vog can cause respiratory health effects similar to those in humans and can also lead to the death of wildlife and livestock due to contaminated food consumption. Animals that graze, such as wildlife and livestock, can die after ingesting water or grass heavily contaminated by volcanic particles. When vog mixes with moisture on plant leaves, it can cause severe chemical burns, damaging or killing the plants. Sulfur dioxide (SO2) gas can also diffuse through leaves, creating acidic conditions within plant tissue (HI-EMA 2023).

Another significant concern is the deposition of fluoride salts carried by vog onto forage crops. Scientific literature has documented numerous events where sheep, cattle, and horses have suffered significant losses due to acute and chronic exposure to fluoride salts. A study conducted in 2010 by Donald Thomas and Trisha Macomber on the effects of fluoride and sulfates on forage lands downwind of Kīlauea's Halemaumau Crater found that forage samples contained fluoride and sulfate values higher than recommended by the World Health Organization (WHO). Although elevated concentrations of these compounds induce adverse health and nutritional effects on grazing animals, they do not impact the quality of meat from those animals for public consumption.

The effects of sulfur dioxide exposure on plants vary between species, age, and dosage. These effects may include reduced seed germination, enhanced susceptibility to other diseases, foliar necrosis, epicuticular wax erosion, rupture of the epidermis, reduced chlorophyll content, increased membrane permeability of plant leaves, decreased plant growth, and even plant death. Farmers downwind of Kīlauea have experienced immediate and severe losses due to exposure to high concentrations of sulfur dioxide and sulfuric acid aerosols. Over time, ranches have found that horses, cattle, and goats have developed serious health impairments consistent with chronic fluoride exposure and severe mineral deficiencies. Additionally, there has been accelerated corrosion of fencing, pipelines, and ranching equipment, with anecdotal reports suggesting service life losses of 60 to 70 percent (HI-EMA 2023).

The impacts from gas discharge are based on existing rates from fixed emission locations. If discharge rates from Kīlauea significantly increase or Mauna Loa erupts, the gas impacts will correspondingly rise, affecting air quality and health. Coastal features, reefs, and other marine habitats, although not located in lava flow hazard areas, may be impacted once the lava reaches the ocean. The interaction between lava and seawater can produce harmful gases and alter marine ecosystems.

The State HMP identifies the environmental resources within Maui County that are situated in the lava flow hazard area, as detailed in Table 15-16.

Table 15-16. Environmental Resources Located in the Lava Flow Hazard Area

Environmental Asset	Total Asset Area (in square miles)	Lava Flow Hazard Area	Hazard Area as Percent of Total Area
Critical Habitat[a]	293	92	31.2%
Wetlands	1,382	39	2.8%
Parks and Reserves	409	72	17.6%
Reefs[b]	26	0	0.0%
Total[c]	2,110	202	9.6%

Source: (HI-EMA 2023)

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.

Historic

Volcanic activity can significantly impact historic resources, which include physical structures, artifacts, and sites of historical importance. Eruptions can lead to the complete destruction of historic buildings and monuments through lava flows and ashfall. Tephra deposits can cover and infiltrate historic sites, causing structural damage and complicating access and preservation efforts. The weight of tephra can collapse roofs and other structures, while its acidic components can corrode materials (USGS 2015).

Additionally, volcanic eruptions often trigger landslides and lahars, which can bury historic sites under thick layers of mud and debris, leading to the loss of valuable archaeological information and making excavation and preservation challenging. The intense heat from lava flows and pyroclastic surges can cause thermal damage to historic materials, including the cracking and melting of stone, ceramics, and metals. Furthermore, volcanic eruptions can alter the landscape and environment around historic sites, affecting their preservation. Changes in vegetation, soil composition, and water sources can impact the stability and accessibility of these resources.

Cultural

Volcanic activity poses significant threats to cultural resources in Maui County. Cultural sites are non-renewable resources, and lava flows can cut off or cover these sites and native lands, leading to irreversible loss. As shown in Table 15-17, a large percentage of the Hawaiian Home Lands in Maui are located in lava flow hazard areas, making them particularly vulnerable (HI-EMA 2023).

Table 15-17. Hawaiian Home Lands Located in Lava Flow Hazard Area in Maui County

Total Area (in square miles)	Lava Flow Hazard Area	Hazard Area as % of Total
102.6	34.9	34.0%

Source: (HI-EMA 2023)

Additionally, the deposition of volcanic ash and gases can damage culturally significant plants and landscapes. Sulfur dioxide (SO2) and other volcanic gases can cause severe chemical burns to plants

and create acidic conditions within plant tissues, affecting traditional agricultural practices and the availability of culturally important plants.

The economic and social disruptions caused by volcanic activity can also indirectly impact cultural resources. The destruction of infrastructure and displacement of communities can lead to the abandonment of cultural sites and practices, further eroding the cultural heritage of the region.

15.2.6 Identified Vulnerability Issues

The County has identified the following vulnerabilities related to this hazard:

- There is a general perception among residents that Haleakalā is a dormant volcano.
- There are no structural mitigation measures that can protect structures or infrastructure from lava flow.
- Air quality measurements and historical data are not available to track vog. The HMWG was unaware of any sulfur dioxide sensors in Maui County and the Hawai'i Department of Health has only two particulate (PM2.5) sensors.

15.3 FUTURE CHANGES THAT MAY AFFECT RISK

15.3.1 Potential or Planned Development

Potential and planned development in Maui can significantly increase the island's vulnerability to volcanic activity. New infrastructure, including buildings, roads, and utilities, is susceptible to volcanic hazards such as lava flows. Potential and planned development in Maui can significantly increase the island's vulnerability to volcanic activity. New infrastructure, including buildings, roads, and utilities, is susceptible to volcanic hazards such as lava flows.

In Maui County, 13 new developments are located within Lava Flow Zone 1, representing 0.4 percent of all new development. The vast majority of these are in Hana with 12 (30.8 percent), with only one development (0.2 percent) in Kihei-Makena. All other community planning areas report no new development in this lava flow zone.

Additionally, in the Lava Flow Zone 2 hazard area, there are a total of 475 new developments located within Maui County, accounting for 14.6 percent of all new development. The majority are in Kihei-Makena with 389 (75.4 percent), followed by Makawao-Pukalani-Kula with 62 (9.9 percent) and Hana with 24 new developments (61.5 percent). All other community planning areas report no new development in this hazard zone. Table 15-18 and Table 15-19 display the number of new developments by community planning area for each lava flow zone.

Table 15-18. Number of New Development in the Lava Flow Zone 1 Hazard Area

Community Plan Area	Number of New Development in the Lava Flow Zone 1 Hazard Area

Hana	12	30.8%
Kahoolawe	0	0.0%
Kihei - Makena	1	0.2%
Lanai	0	0.0%
Makawao - Pukalani - Kula	0	0.0%
Molokai	0	0.0%
Paia - Haiku	0	0.0%
Wailuku - Kahului	0	0.0%
West Maui	0	0.0%
Maui County (Total)	**13**	**0.4%**

Source: *County of Maui 2025; Hawai'i Statewide GIS Program 2017; USGS 1992, 2006*

Table 15-19. Number of New Development in the Lava Flow Zone 2 Hazard Area

Community Plan Area	Number of New Development in the Lava Flow Zone 2 Hazard Area	
Hana	24	61.5%
Kahoolawe	0	0.0%
Kihei - Makena	389	75.4%
Lanai	0	0.0%
Makawao - Pukalani - Kula	62	9.9%
Molokai	0	0.0%
Paia - Haiku	0	0.0%
Wailuku - Kahului	0	0.0%
West Maui	0	0.0%
Maui County (Total)	**475**	**14.6%**

Source: *County of Maui 2025; Hawai'i Statewide GIS Program 2017; USGS 1992, 2006*

15.3.2 Projected Changes in Population

As populations grow, particularly in areas near active volcanoes, the potential for human exposure to volcanic hazards increases. The influx of people into these regions heightens the risk of casualties and economic losses from hazards such as lava flows and volcanic gases. This increased exposure necessitates more robust emergency response and evacuation efforts, which can be challenging to coordinate and resource effectively during a volcanic crisis. Additionally, higher population densities can lead to environmental degradation, exacerbating the effects of volcanic hazards. For instance, deforestation and land-use changes can elevate the risk of landslides and lahars during an eruption.

The Department of Business, Economic Development and Tourism (DBEDT) produced population projections for the County from 2030 to 2050. According to these projections, Maui County's population is projected to grow to 173,520 by 2030, 181,000 by 2040, and 184,870 by 2050.

15.3.3 Climate Change

Climate change is not expected to increase the likelihood of volcanic events, but future conditions may affect the dispersion and impact areas of volcanic hazards. Changes in wind and rainfall patterns could alter the spread of volcanic gas emissions, potentially harming human health.

15.3.4 Other Identified Conditions

When assessing the future risk of volcanic hazards, several critical factors must be considered. Monitoring volcanic gas emissions, such as sulfur dioxide, carbon dioxide, and hydrogen sulfide, is essential as these gases can signal changes in volcanic activity. Increased emissions often indicate that magma is moving closer to the surface, which can precede an eruption. Additionally, hydrological conditions play a significant role in volcanic hazards. The presence of water, such as lakes, rivers, or groundwater, can interact with magma to produce explosive eruptions or contribute to the formation of lahars, which are dangerous volcanic mudflows. Understanding the geological history of a volcano is also crucial. By studying previous eruptions, their frequency, magnitude, and types of volcanic activity, researchers can gain valuable insights into the volcano's behavior and potential future activity.

16. WILDFIRE

16.1 HAZARD PROFILE

16.1.1 Hazard Description

Wildfire Ignition

Wildfires are uncontrolled fires that burn in natural areas like forests, grasslands, or prairies. They can spread quickly, burning brush, trees, and structures located in the path of the flames (DHS 2024). Wildfires can be caused by natural or human factors. According to the Hawai'i Wildfire Management Organization (HWMO), more than 99 percent of wildfires in Hawai'i are initiated by human behavior such as smoking in wooded areas or improperly extinguishing campfires.

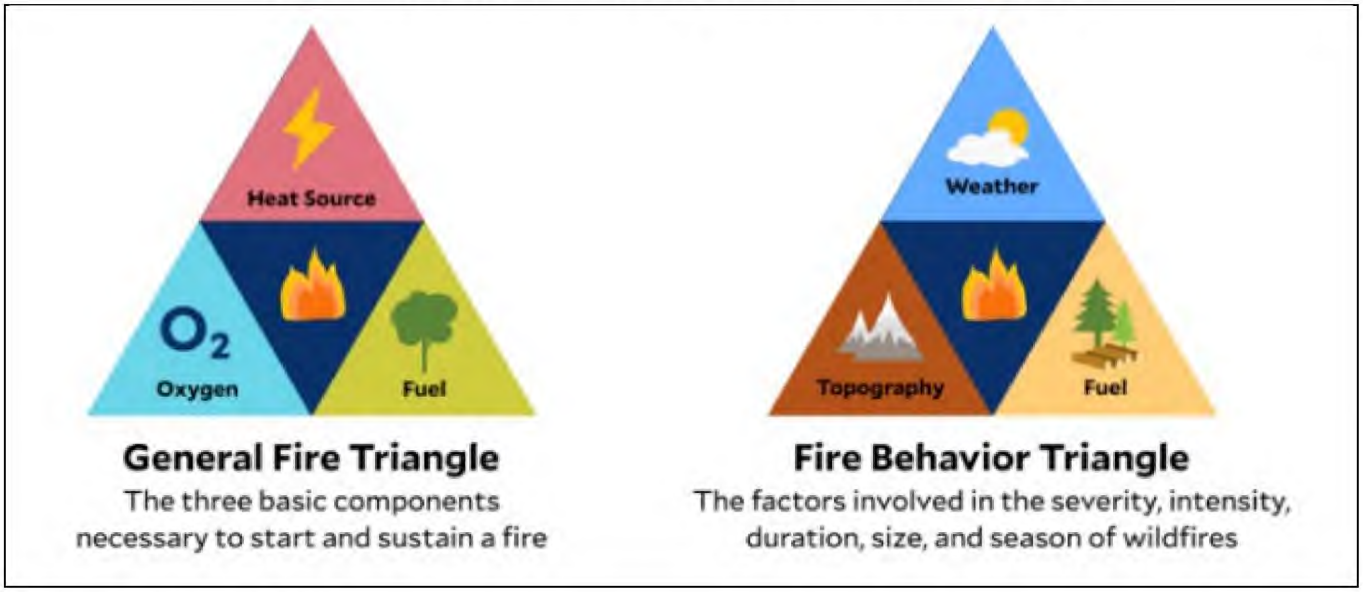
The probability of wildfires depends on local weather, vegetation, and human activities. Temperature, moisture, and wind conditions are factors in where a wildland fire will occur. Drier, leeward locations are more prone to wildfires, especially during periods of drought. Outdoor activities such as camping, debris burning, and construction can increase the risk of wildfires, particularly if fire prevention measures are not followed. Cyclical climate events like El Niño and La Niña can dramatically affect wildfire risk, with more fires typically observed during El Niño years when conditions are warmer and drier. In Hawai'i, non-native, fire-prone grasses and shrubs further contribute to the wildfire hazard.

Three elements are essential for the creation and maintenance of any fire, as depicted in the fire triangle (shown in Figure 16-1):

- **Heat**—A heat source is necessary for the initial ignition of fires and is also generated by the fire itself. For a fire to grow, heat must be transferred to the initial and surrounding fuel, removing moisture from nearby fuel and enabling it to ignite or travel more easily.
- **Fuel**—Wildfire fuel has both external and internal properties. External properties include the type and characteristics of the fuel material, while internal properties address aspects of fuel chemistry. Fuel is characterized by its moisture content, size and shape, quantity, and location (ground, surface, ladder, or aerial).
- **Oxygen**—Air contains about 21 percent oxygen, and most fires require air with at least 16 percent 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.

The ignition of a wildfire depends on the chemical reaction between these components. A fire is extinguished when insufficient heat is generated, water is used to reduce the heat level, fuel is exhausted, removed, or isolated, or the oxygen supply is limited, thereby breaking a side of the triangle or preventing the chemical reaction (Fire Risk Assessment Network n.d.).

Figure 16-1. General Fire Triangle and Fire Behavior Triangle



Source: (Yale University 2021)

Wildfire Spread

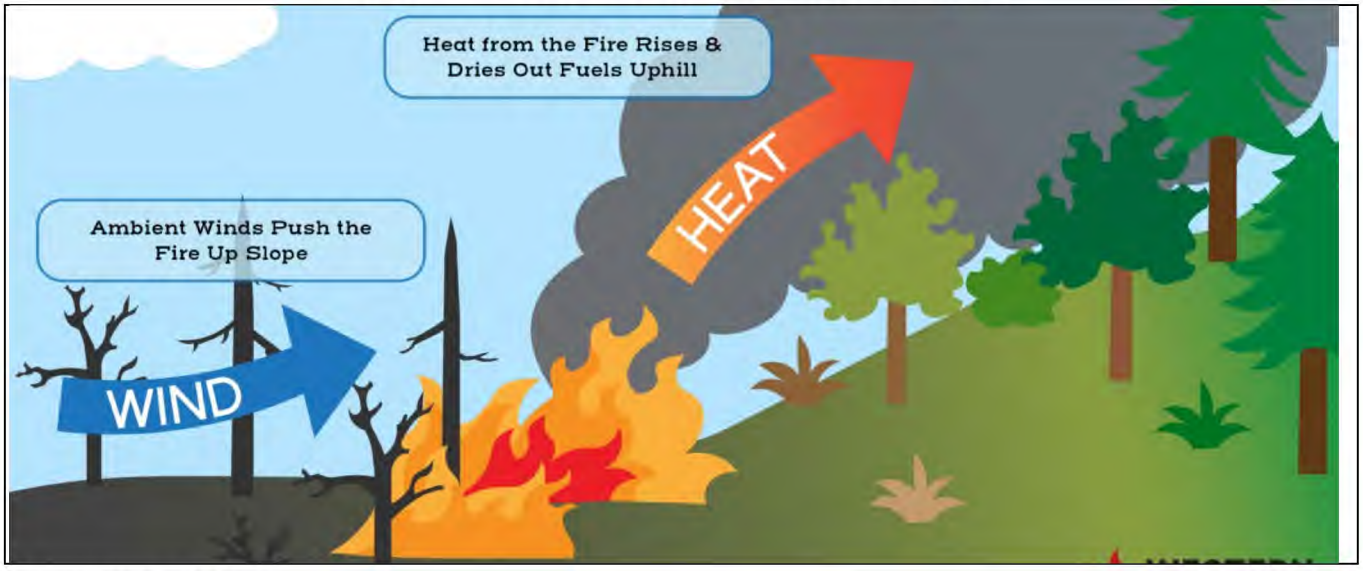
Fire behavior describes the manner in which fuels ignite, flames develop, and fire spreads. The "fire behavior triangle" illustrates how the three primary factors—fuel, topography, and weather—influence wildfire behavior (see Figure 16-1). For example, drier and warmer weather combined with dense fuel loads and steeper slopes will cause more hazardous fires than light fuels on flat ground (NPS 2017).

Wildfires spread through available combustible vegetation. Wind-carried embers can ignite distant areas as they travel for miles before landing on dry, flammable surfaces. Topography can also influence wildfire behavior, as fires tend to spread uphill, in the same direction as ambient wind. Rising heat dries out the fuel further up the slope, making the landscape more susceptible to ignition (see Figure 16-2).

Wildfire Types

The U.S. Forest Service identifies three types of wildfires (see Table 16-1) that represent the range or severity of wildfire events. Ground fires, often started by lightning or human carelessness, burn on or below the forest floor. Surface fires, the most common type, burn along the forest floor, moving slowly and damaging or killing trees. Crown fires spread rapidly by wind, moving quickly by jumping along the tops of trees.

Figure 16-2. Why Wildfires Spread Faster Uphill



Source: (WFCA 2024)

Table 16-1. Types of Wildfires (USDA)

Type of Wildfire	Definition	Example
Ground Fire	Also known as subsurface fires, ground fires can occur in areas with large accumulations of dead vegetation over time, such as humus and peat. They move slowly beneath the surface terrain, making them difficult to see from above. If enough dry fuel is available, ground fires can be extremely difficult to put out. In some cases, ground fires can continue to smolder underground throughout the winter and reignite aboveground in the spring. This scenario is more likely during a period of prolonged drought.	
Surface Fire	Surface fires burn along the ground without significant movement into the understory or overstory vegetation. They burn in litter (a dead fuel) and vegetation (a live fuel) at or near the surface of the ground. They can also consume surface vegetation, such as shrubs and grasses. Surface fires are the easiest wildfires to put out.	
Crown Fire	Crown fires create a solid wall of flame from the surface through the canopy fuel layers and can be very destructive. Crown fires are normally associated with an understory fire that moves into the tree crowns and spreads from top to top of trees and/or shrubs. A crown fire is the most dangerous type of wildfire. It burns extremely hot and often spreads rapidly through the interconnected branches of trees.	

Source: (WFCA n.d.)

16.1.2 Location

Maui County is characterized by vegetated areas and steep slopes, which are conducive to wildfires. Wildfires are more common in leeward areas of the county, as the trade winds bring moisture to windward regions.

Communities at Risk

Hawai'i Department of Land and Natural Resources (DLNR) wildfire risk area maps show communities at risk of wildfire on the major Hawaiian Islands, categorized into low, medium, and high-risk wildfire areas. Figure 16-3 shows the mapping for Maui County. Maps of wildfire risk by Community Plan Area are provided in Appendix H.

The DLNR mapping is based on nationwide data on wildland-urban interface (WUI) areas produced at the University of Wisconsin's SILVIS Lab. The WUI is the area where urban development meets vegetated, wildfire-prone undeveloped lands. The SILVIS Lab defines the WUI as composed of two types of communities (USDA 2005):

- **Intermix communities** are places where housing and vegetation intermingle, with continuous wildland vegetation covering more than 50 percent of the area and more than one house per 40 acres.
- **Interface communities** are areas with more than one house per 40 acres, less than 50 percent vegetation, and location within 1.5 miles of an area over 1,325 acres that is more than 75 percent vegetated. The minimum size limit ensures that areas surrounding small urban parks are not classified as interface WUI.

Wildfire Ignition Point Density

Wildfire ignition density maps are derived from the location of past wildfires. The Pacific Fire Exchange at the University of Hawai'i at Manoa provides data that includes wildfire ignition points from 2005 through 2020 (Pacific Fire Exchange 2023). This updated dataset continues to be compiled and quality controlled by the HWMO and includes the location, date of occurrence, and area burned for wildfire incidents reported by the National Park Service, the Hawai'i Division of Forestry and Wildlife, and all four County fire departments.

Figure 16-4 shows the wildfire ignition point density between 2005 and 2020 for Maui County. Lower density does not necessarily mean there were fewer ignitions, it may indicate the need for better mapping technology and fire tracking procedures.

Figure 16-3. Communities at Risk Wildfire Hazard Area, Maui County

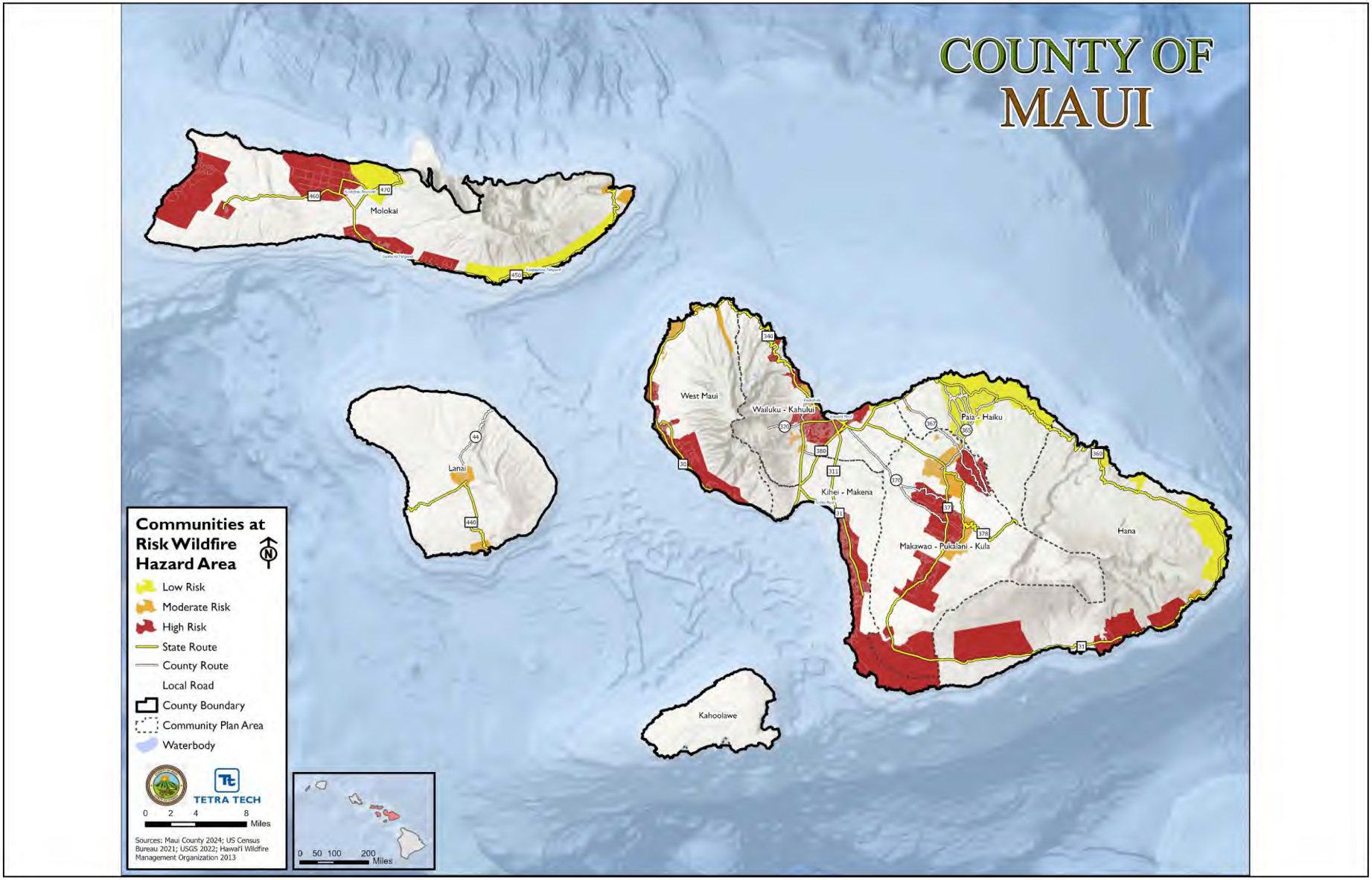
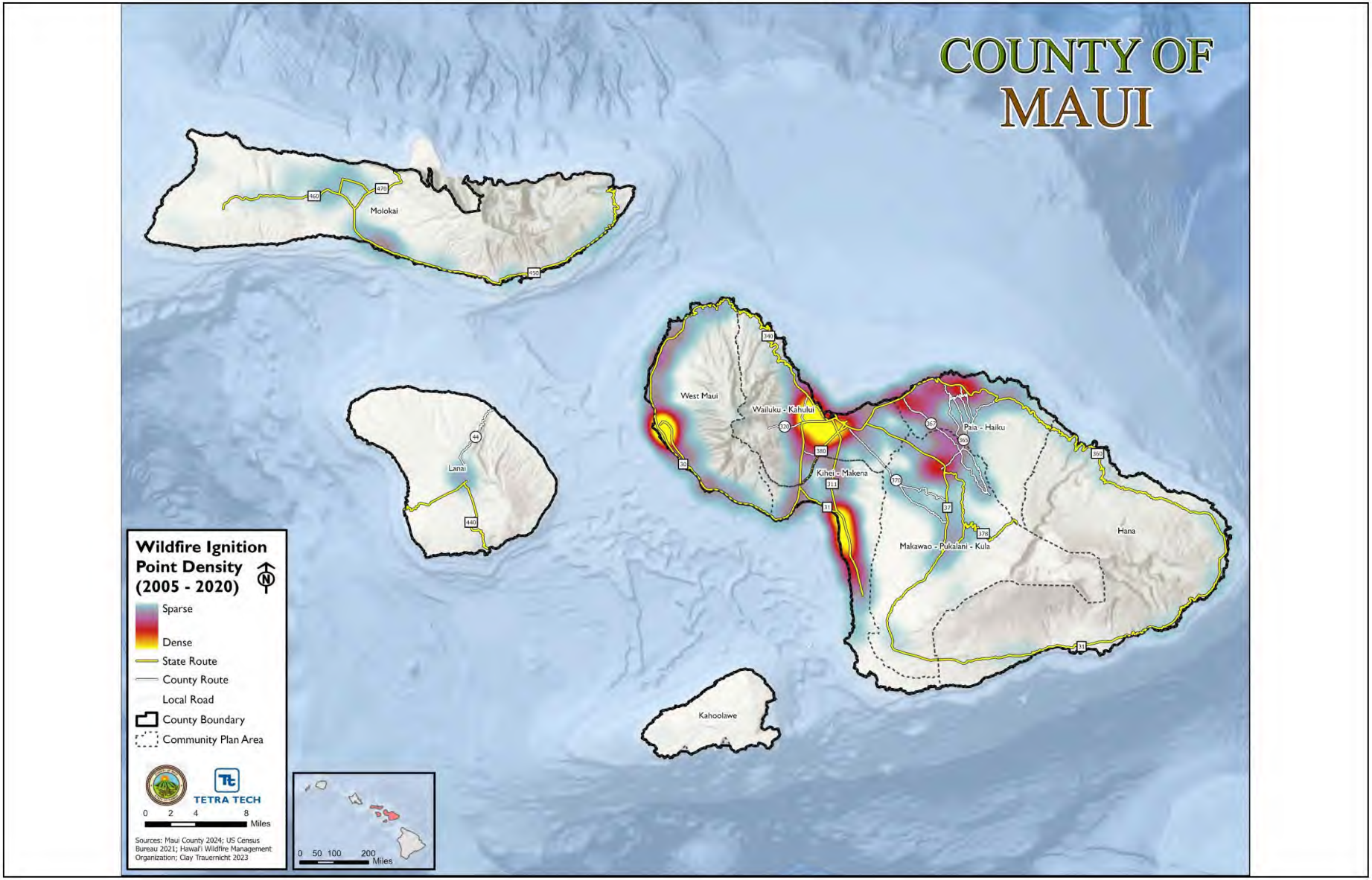


Figure 16-4. Wildfire Ignition Point Density (2005 to 2020)



16.1.3 Extent

Area Burned

Figure 16-5 shows the wildfire ignition points with total acres burned between 2005 and 2020. This map identifies the largest wildfires as larger and darker dots. The largest fires during this time frame occurred in the former plantation lands between Kahului and Kīhei, Kaunakakai, and Kahoʻolawe. Three of the wildfires exceeded 6,000 acres in area burned.

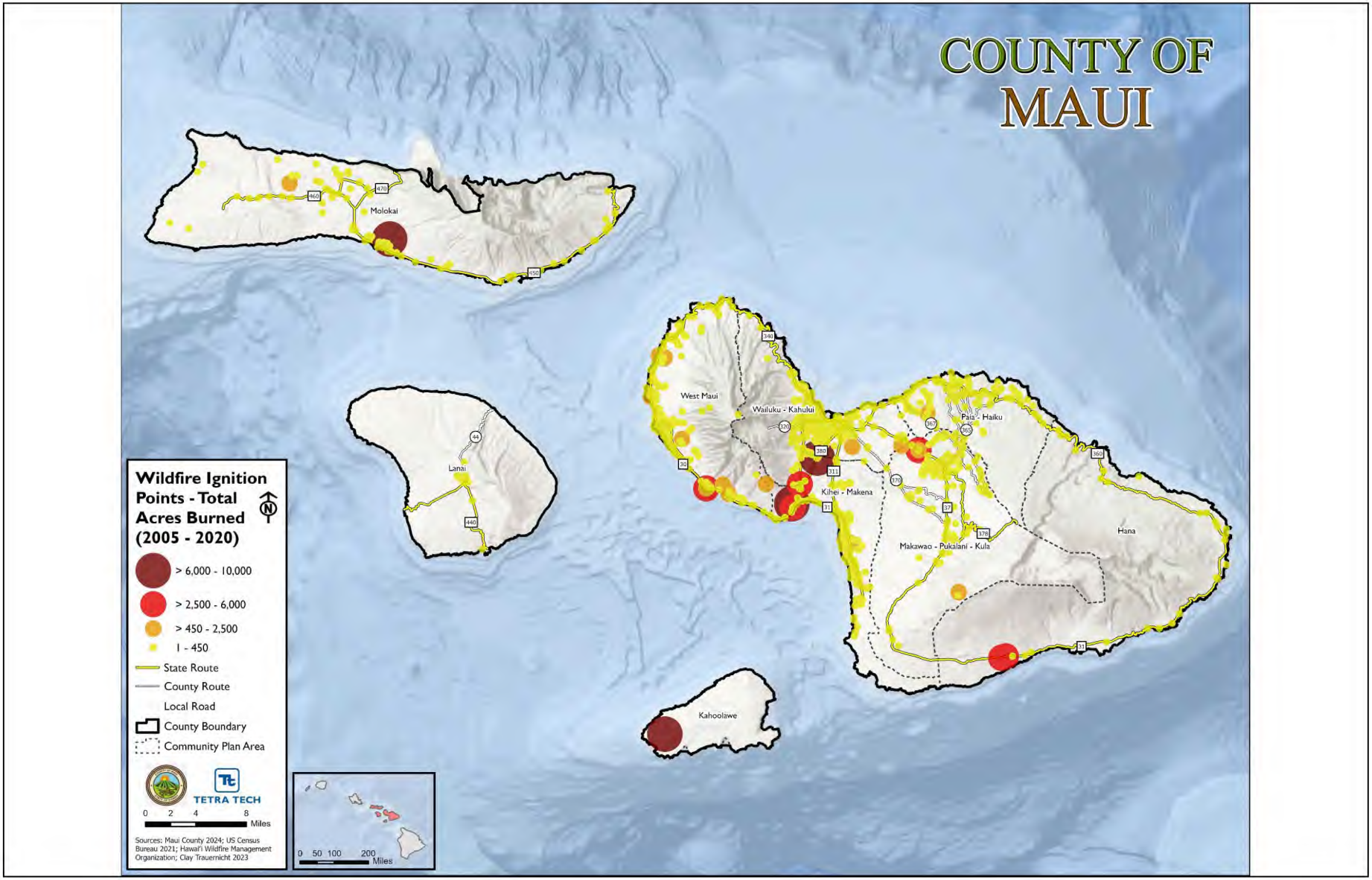
Warning Time

Fire Weather Watches and Red Flag Warnings are critical tools used to communicate the likelihood of severe fire weather conditions to wildland fire agencies. These alerts are designed to inform fire departments and residents about the onset or potential onset of critical weather and dry conditions that could lead to rapid or significant increases in wildfire activity. They include the following notifications (NWS n.d.):

- **Red Flag Warning—Take Action.** Be extremely careful with open flames. The National Weather Service (NWS) issues a Red Flag Warning, in conjunction with land management agencies, to alert land managers to an ongoing or imminent critical fire weather pattern. The criteria for Red Flag events is a Keetch-Byram Drought Index (KBDI) greater than or equal to 600, relative humidity less than or equal to 45 percent, and winds greater than or equal to 20 mph. Red Flag Warnings alert of the potential for widespread ignitions or control problems with new or existing fires.
- **Fire Weather Watch—Be Prepared.** A Watch alerts land managers and the public that upcoming weather conditions could result in extensive wildland fire occurrence or extreme fire behavior. A Fire Weather Watch is issued when there is a high potential for the development of a Red Flag event. Fire Weather Watches may be issued 12 to 72 hours prior to the expected onset of criteria.
- **Extreme Fire Behavior**—This alert implies a wildfire likely to rage out of control. It is often hard to predict these fires because such they behave erratically, sometimes dangerously. One or more of the following criteria must be met:
  - Moving fast: High rate of spread
  - Prolific crowning and/or spotting
  - Presence of fire whirls
  - Strong convection column

NWS plays a pivotal role in issuing these alerts. Fire weather forecasts accessible on the NWS website at weather.gov/fire include hazard/overview maps, the NWS Fire Weather Forecast Map, Today's SPC Outlook, the Latest Wildland Fire Outlook, and information on current large incidents.

Figure 16-5. Wildfire Ignition Points - Total Acres Burned (2005 to 2020)



16.1.4 Community Wildfire Protection Plans

Between 2016 and 2020, the HWMO developed Community Wildfire Protection Plans (CWPPs) for five communities in Maui County: Upcountry Maui; Leeward Haleakalā; South Maui; Western Maui; and Molokaʻi. All plans were updated in 2024 to include detailed lists of priority projects to mitigate wildfire risk. These plans identify and prioritize areas for hazardous fuel reduction treatments, recommend protection methods for at-risk communities and infrastructure, and suggest measures to reduce structural ignitability. The intended outcomes of the CWPPs are as follows:

- Improve community safety through coordination and collaboration, public awareness and education, increased wildfire prevention and preparedness, widespread hazard reduction efforts, improved wildfire response capacity, development of long-term strategies, and ongoing risk reduction communications.
- Catalyze efforts to guide planning and sustained implementation of actions toward fire-adapted communities, resilient landscapes, and safe and effective wildfire response.

Upcountry Maui

Originally developed in 2016 and updated in 2024, the Upcountry Maui CWPP covers the middle area of the island from the North Shore near Pāʻia up the slope of Haleakalā. The area is bordered by South Maui, Kahului, and East Maui. Steep slopes, rough terrain, strong winds, and a large percentage of highly ignitable invasive grasses characterize the Upcountry Maui landscape. This, coupled with warm weather, recurring drought conditions, and a history of human-caused fires, puts the area at increased risk of wildfire. The proximity of development to fire-prone wildlands presents hazardous conditions that threaten Upcountry Maui 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 pose increasing threats to commercial, community, environmental, and residential resources. Together, these factors create an environment that puts Upcountry Maui at risk of wildfire.

Wildfire occurrence in Upcountry Maui is tied to broad climate patterns. Rainfall in Upcountry Maui is highly variable over space and time and can greatly influence fire risk. There is a greater likelihood of large wildfires during drought. Additionally, wet periods may increase the quantity of available vegetative fuels, which can increase both fire risk and the frequency with which mitigation measures such as firebreaks and fuels reduction need to be carried out.

The Action Plan to reduce the risk of wildfire in the Upcountry community includes education and awareness programs and natural systems protection. Education and awareness programs and projects include assistance to communities with becoming Firewise certified, community outreach programs, wildfire and drought awareness campaigns, and training programs. Natural systems protection projects include fuels reduction, installing firebreaks, green waste removal programs, vegetation thinning, and installing water tanks for firefighting.

Leeward Haleakalā

Originally developed in 2020 and updated in 2024, the Leeward Haleakalā CWPP covers the Southern slope of Haleakalā. There are small population clusters in Kanaio, Kahikinui, Kaupo, and Kipahulu. The area is less developed and less accessible than many other parts of Maui and is considered at high risk of wildfire due to its arid landscape, steep slopes, frequent human-caused ignitions, long distances and emergency response times, lack of water for firefighting, copious amounts of overgrown and unmanaged fire-prone vegetation, and challenging ingress and egress.

Due to their location on the southern flank of Haleakalā, a 10,023-foot shield volcano, the residential communities across the CWPP region are mostly built on gentle to steep slopes. Homes in the region are built at a wide range of elevations, from 1,500 to 4,500 feet above sea level. Upslope fires can be highly dangerous, especially when combined with dense, unmanaged, flammable vegetation.

A large amount of land is covered by mixed grass-shrublands dominated by introduced, fire-prone species. These fuels encroach the residential areas less than 40 feet around homes and are especially prolific on unmanaged, vegetated corridors, vacant lots, and in wildland areas. The flammable herbaceous plants and shrubs create a continuous fuel bed on unmanaged lots and bordering lands that, when dry, could carry fires to the edge of homes or into the canopies of trees.

The Action Plan identifies three primary strategies for reducing wildfire risk: resilient landscapes; fire-adapted communities; and safe, effective wildfire response. The projects listed to achieve these strategies include local plans and regulations, structure and infrastructure projects, natural systems protection, and education and awareness programs. Local plans and regulations include collaborative planning and mapping, developing a fire management plan, and whole community integration into the planning process. Structure and infrastructure projects include improving infrastructure to increase access for firefighting and evacuation, installing fuel stations, developing water infrastructure for fire fighting, and establishing additional water resources. Natural systems protection projects include fuels reduction, installing fuel breaks, vegetation thinning, and developing green breaks. Education and awareness programs and projects include assistance to communities with becoming Firewise certified, community outreach programs, wildfire awareness campaigns, home mitigation education programs, and community and volunteer firefighter training programs.

South Maui

Originally developed in 2016 and updated in 2024, the South Maui CWPP covers the central-southwestern coastal area of Maui from Mā‘alaea to Ahihi-Kinau. 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. Overgrown vegetation close to homes, pockets of open space within subdivisions, and an increase of non-native high-fire-intensity plants around developed areas pose increasing threats to commercial, community, environmental, and residential resources. Unmanaged fire-prone vegetation, periods of high winds, warm weather, recurring drought conditions, and a history of human-caused fires create an environment that puts South Maui at risk of wildfire.

The Action Plan to reduce the risk of wildfire in the South Maui community includes local plans and regulations, structure and infrastructure projects, natural systems protection, and education and

awareness programs. Local plans and regulations include improving wildfire reporting. Structure and infrastructure projects include fuels treatment along roadways and fire suppression water tanks. Natural systems protection projects include vegetation management around powerline infrastructure, green waste programs, and fuels management. Education and awareness programs and projects include assistance to communities with becoming Firewise certified, community outreach programs, and wildfire and drought awareness campaigns.

Western Maui

Originally developed in 2014 and updated in 2024, the Western Maui CWPP encompasses the entire western head of the Island of Maui. This includes the West Maui Mountains and Mauna Kahalewai watershed areas, from Wailuku south to Māʻalaea, north and west through Lāhainā and Honokōhau, and south and east through Waiheʻe and Waiehu.

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 presents hazardous conditions that now threaten every Western Maui suburban and rural community.

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.

The Action Plan to reduce the risk of wildfire in the Western Maui community includes local plans and regulations, structure and infrastructure projects, natural systems protection, and education and awareness programs. Local plans and regulations include a firebreak assessment, post-fire restoration methods, case studies, fire planning, fire mapping and data maintenance, and cost-benefit analyses. Structure and infrastructure projects include installing roads and fire suppression water tanks. Natural systems protection projects include replanting the Puu Kukui Watershed Preserve, fire breaks, fuel breaks, wood chipping, and green waste programs. Education and awareness programs and projects include educating volunteers, collaborating with media outlets, community outreach programs, and wildfire and drought awareness campaigns.

Molokaʻi

Originally developed in 2016 and updated in 2024, the Molokaʻi CWPP encompasses the entire western Island of Molokaʻi. Steep slopes, rough terrain, strong winds, and a large percentage of highly ignitable invasive grasses characterize the Molokaʻi landscape. This, coupled with warm weather, recurring drought conditions, changes in land use and maintenance, and a history of human-caused fires, puts the area at increased risk of wildfire. The proximity of development to high-hazard fire-prone wildlands presents hazardous conditions that threaten Molokaʻi 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 pose increasing threats to commercial, community, environmental, and residential resources.

The Action Plan to reduce the risk of wildfire in the Molokaʻi community includes local plans and regulations, structure and infrastructure projects, natural systems protection, and education and awareness programs. Local plans and regulations include wildfire information, decision-making tools, and wildfire reporting. Structure and infrastructure projects include fuels treatment along roadways and fire suppression water tanks. Natural systems protection projects include green waste programs and fuels management. Education and awareness programs and projects include assistance to communities with becoming Firewise certified, community outreach programs, and wildfire and drought awareness campaigns.

16.1.5 Previous Occurrences

FEMA Disaster Declarations

Maui County has been included in 13 major disaster (DR) or emergency (EM) declarations for wildfire-related events (FEMA 2024), as shown in Table 16-2.

Table 16-2. FEMA Disaster Declarations for Wildfire Events in Maui County

Event Date	Declaration Date	Declaration Number	Description
March 4, 1983	March 4, 1983	FM-2044	Kilauea Fire
February 16, 1998	February 18, 1998	FM-2195	Hawaiian Beaches Subdivision Fire
March 14, 1998	March 16, 1998	FM-2196	Leilani Estates Subdivision Fire
August 25, 1998	August 25, 1998	FM-2236	Molokaʻi Fire 98
September 1, 2006 to September 6, 2006	September 2, 2006	FM-2673	Ma'alaea Fire
June 27, 2007 to July 4, 2007	June 28, 2007	FM-2701	Olowalu Fire
August 29, 2009 to September 7, 2009	August 31, 2009	FM-2834	Kaunakakai Fire
June 8, 2010 to June 13, 2010	June 9, 2010	FM-2844	Maalaea Fire
October 22, 2019	October 23, 2019	FM-5294	Kahana Ridge Fire
August 9, 2023	August 9, 2023	FM-5477	Pulehu Fire
August 9, 2023	August 9, 2023	FM-5476	Upcountry Fire
August 9, 2023	August 9, 2023	FM-5475	Lahaina Fire
August 8, 2023 to September 30, 2023	August 10, 2023	DR-4724	Wildfires and High Winds

Source: (FEMA 2024)

State Emergency Proclamations

The Governor of Hawaiʻi may declare a state of emergency by proclamation if an emergency or disaster has occurred or there is imminent danger or threat of an emergency or disaster in any portion of the state (Hawaiʻi State Legislature 2020). Table 16-3 lists all wildfire-related state emergency proclamations that have included Maui County.

Table 16-3. State Emergency Proclamations for Wildfire Events in Maui County, 2020 to 2024

Declaration Date	State Proclamation Number	Description
August 8, 2023	N/A	Proclamation Relating to Wildfires
November 14, 2024	2024-081	Proclamation Relating to November 2024 Red Flag Fire Conditions
December 11, 2024	2024-086	Proclamation Relating to December 2024 Red Flag Fire Conditions

Source: (HI-EMA 2024)

USDA Declarations

The U.S. Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties contiguous to them. Between 2020 and 2024, Maui County was not included in any USDA wildfire-related agricultural disaster declarations (USDA 2024).

2023 Wildfires

The wildfires in 2023 were among the most devastating in Maui County's history. Beginning on August 8, these fires had a catastrophic impact, particularly in the historic resort town of Lahaina. The fires resulted in the deaths of 102 people and caused extensive property damage, with approximately 1,550 parcels and 2,200 structures either damaged or destroyed (EPA 2025). The fires prompted several mandatory evacuations and emergency proclamations. Specific damage reports included the following:

- The fire burned 2,170 acres and destroyed most of the town of Lahaina, including over 2,200 structures burned mostly or completely to the ground. There were 99 confirmed fatalities and at least 32 injuries.
- The wildfire near Lahaina prompted evacuation orders, but power lines downed by the damaging winds closed roads and restricted evacuation routes. The Coast Guard rescued 17 people entering the Pacific Ocean who were escaping the fire and assisted 40 survivors on shore. The Hawai‘i National Guard was deployed on Maui as wildfires continued to burn out of control.
- On August 9, more than 14,000 people were transported off Maui with another 14,500 waiting to be moved.
- On August 9, over 14,000 customers were without power, and 2,100 people were seeking refuge in Maui shelters, a number that would increase throughout the month, reaching a peak of 8,000 in September.
- The fire destroyed about 4,000 cars.
- As of late October, the Coast Guard had recovered and removed 86 vessels from Lahaina Small Boat Harbor, in addition to 9,400 gallons of petroleum products and 3,300 pounds of hazardous materials.

The severity of these fires was exacerbated by dry, gusty conditions and the presence of El Niño, which brought drought conditions to the Hawaiian Islands. This event highlighted the increasing severity and frequency of wildfires due to climate change and other environmental factors.

All Events Since Previous HMP

Table 16-4 lists major recorded wildfire-related events that impacted Maui County since the previous HMP was developed. For earlier events, refer to the previous HMP.

Table 16-4. Wildfire Events in Maui County, 2020 to 2024

Event Date	FEMA Declaration or State Proclamation Number	Event Description
July 8, 2020	—	A brush fire was reported in Haliimaile. Total acreage burned was 4300 acres.
August 30, 2020	—	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. 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	—	A blaze charred about 550 acres of mainly brush on the slope above Kapalua Airport in West Maui. Personnel from a nearby water treatment plant were evacuated 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 October 2.
December 26, 2020	—	A wind-whipped fire in West Maui near Olowalu destroyed the Olowalu Community Center and several vehicles and storage units and partially damaged a residence on Luawau Street. No serious injuries were reported.
July 4, 2023	—	Portions of Piilani Highway were closed due to a brushfire.
August 8, 2023	FEMA: DR-4724 State: Proclamation Relating to Wildfires	Several wildfires ignited over Maui and the Big Island. Very strong trade winds, low relative humidity, and ongoing drought conditions across leeward sections led to rapid fire growth and spread. The fires prompted several mandatory evacuations and emergency proclamations. One wildfire destroyed the town of Lahaina, killing 99 people and injuring at least 32. The fire burned 2,170 acres and destroyed most of the historic town, including over 2,200 structures burned mostly or completely to the ground. The fire also destroyed about 4,000 cars, of which 1,000 had been abandoned on public roadways. As of late October, the Coast Guard had recovered and removed 86 vessels from Lahaina Small Boat Harbor. A brushfire in Kula burned 200 acres, prompted evacuations, and destroyed 19 homes. There were no known injuries or fatalities.
November 13, 2023	-	A brush fire led to the closure of Maui Veterans Highway from North Kīhei Road to Hansen Road. The fire burned about 35 acres.
July 22, 2024	-	Multiple fires were reported in the Piihana Farms area. Homes were evacuated and at least 4 acres of land was scorched.
November 16, 2024	-	A brush fire near Kahili Golf Course closed Honoapi`ilani and Kuihelani Highways due to smoke and reduced visibility.

Source: (NOAA 2024)

Wildfire Perimeter Mapping, 1999 to 2022

The wildfire perimeters map for Maui County from 1999 to 2022 illustrates the extent of wildfire activity across the region (see Figure 16-6). This map highlights the boundaries of areas affected by wildfires, showcasing the significant land coverage impacted by these events. It provides a clear understanding of the geographical extent and severity of wildfire incidents, emphasizing the need for robust mitigation and preparedness strategies to protect vulnerable areas. The largest wildfire during this period, the Kaunakakai Fire in 2009, burned over 8,358 acres on the Island of Molokaʻi, highlighting the potential for large-scale fires. The map shows that wildfires have touched various Community Plan Areas, including Hāna, Kīhei-Mākena, Makawao-Pukalani-Kula, Molokaʻi, Wailuku-Kahului, and West Maui.

16.1.6 Probability of Future Occurrences

Probability Based on Previous Occurrences

Information on previous wildfire occurrences in the County was used to calculate the probability of future occurrence of such events. Table 16-5 lists the number of events from various sources from 1998 to 2024, which is the most complete period of record for all sources reviewed. Based on these records and input from the HMWG, the probability of occurrence for wildfires in the County is considered “frequent.”

Table 16-5. Probability of Future Wildfire Events in Maui County

Hazard Type	Number of Occurrences Between 1998 and 2024	Percent Chance of Occurring in Any Given Year
Wildfires	71	100%

Source: (NOAA NCEI 2024) (FEMA 2024)

Note: The time period presented in this table is the most complete period of record for the various data sources reviewed; 100% probability indicates that it is statistically likely for an event to occur every year. It does not indicate that the occurrence of an event is a certainty in any given year.

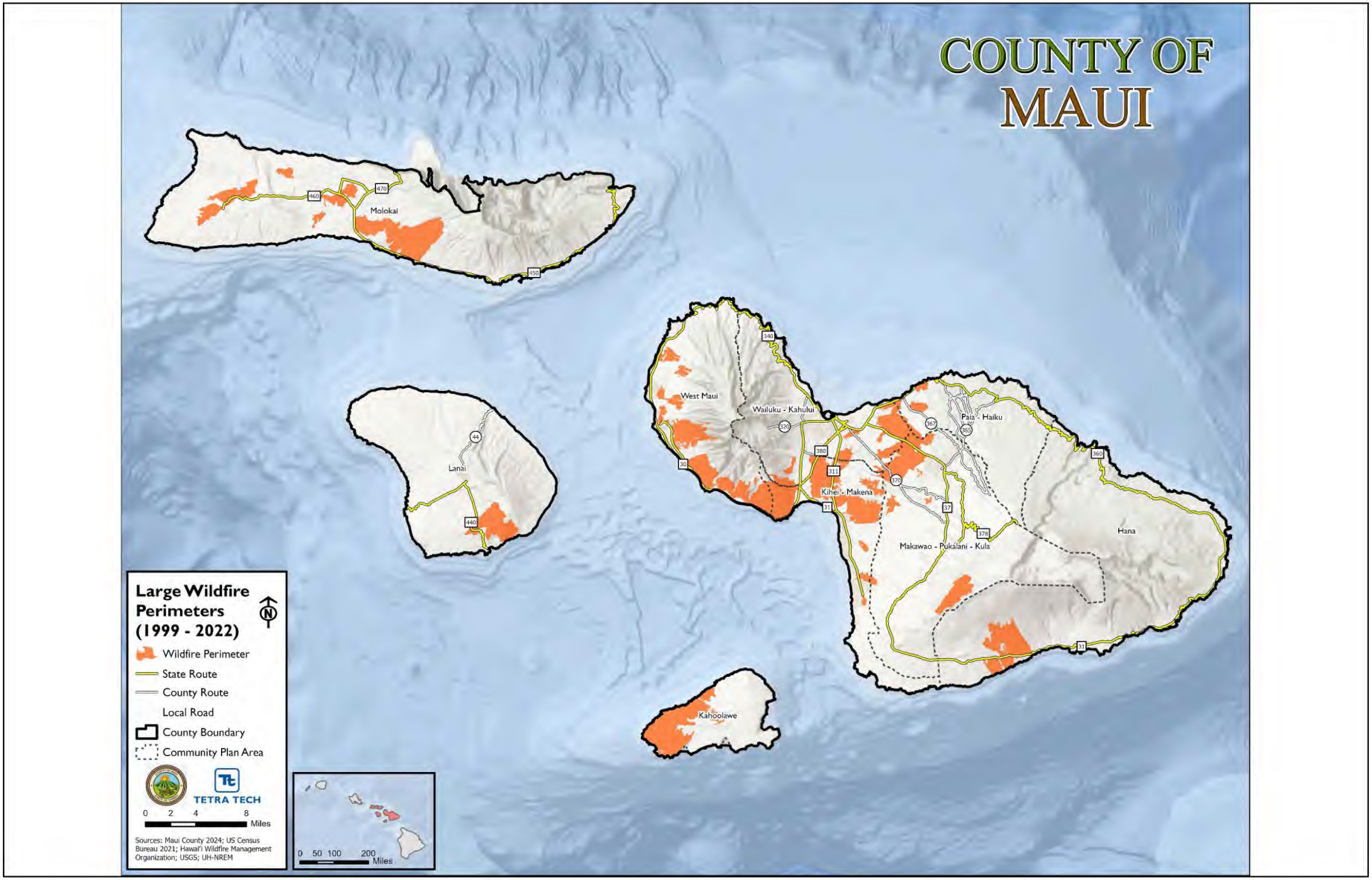
Effect of Climate Change on Future Probability

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. Climate change has the potential to affect multiple elements of the wildfire system, including 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 percent increase in days with high fire danger across the world.

Increased temperatures may intensify wildfire danger by warming and drying out vegetation. In Hawaiʻi, 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 °F to 7.5 °F by the end of the century.

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 (HI-EMA 2023).

Figure 16-6. Large Wildfire Perimeters (1999 to 2022)



16.1.7 Cascading Impacts on Other Hazards

Following wildfires, cascading hazards such as debris flow, landslides, and flooding may occur due to the loss of stabilizing vegetation, resulting in potentially catastrophic sequences. When wildfire hits drought-stricken areas, watersheds and reservoirs can be further impacted by ash and debris flows, water treatment facilities may shut down with damage or loss of power, crops can be destroyed, and smoke can affect animal and human health (NIDIS 2023).

Flooding after a wildfire is often more severe, as debris and ash left from the fire can form mudflows. During and after a rain event, as water moves across charred and denuded ground, it can also pick up soil and sediment and carry it in a stream of floodwaters. These mudflows have the potential to cause significant damage to impacted areas. Areas directly affected by fires and those located below or downstream of burn areas are most at risk for flooding (FEMA 2020).

16.2 VULNERABILITY AND IMPACT ASSESSMENT

To assess Maui County's risk to the wildfire hazard, a spatial analysis was conducted using 2013 Communities at Risk from Wildfire data sourced from HWMO. The asset inventories prepared for this HMP (population, buildings, critical facilities) were overlaid with the low, moderate, and high-risk hazard areas. Assets with their centroid located in the hazard areas were totaled to estimate the numbers and values at risk from the impacts of wildfire.

16.2.1 Life, Health, and Safety

Wildfires have the potential to impact human health and life. The most vulnerable populations are emergency responders and those living within a short distance of the WUI. Public health and safety impacts associated with wildfire include difficulty in breathing and reductions in visibility. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke.

Smoke generated by wildfire consists of visible and invisible emissions that contain particulate matter (soot, tar, water vapor, and minerals), gases (carbon monoxide, carbon dioxide, nitrogen oxides), and toxins (formaldehyde, benzene). Emissions from wildfires depend on the type of fuel, the moisture content of the fuel, the efficiency (or temperature) of combustion, and the weather.

Evacuation presents a challenge for those living in crowded or high-density housing situations, especially in multi-story buildings. Those living in areas with low road density may have fewer options for evacuation.

Overall Population

Table 16-6 summarizes the estimated population exposed to wildfire hazards by Community Plan Area. An estimated 18,026 residents, or 10.9 percent of the County's population, are in the low wildfire risk hazard area; 45,863 residents, or 27.9 percent of the population, are in the moderate risk area; and 96,102 residents, or 58.4 percent of the population, str in the high risk area. The Community Plan Areas with the greatest number of individuals in each risk area are Pāʻia-Haʻikū for the low wildfire risk area (13,674 persons) and Wailuku-Kahului for the moderate wildfire risk hazard area (16,081 persons) and high wildfire risk hazard area (39,360 persons).

Socially Vulnerable Population

Smoke and increased particulate matter in the air can cause lung irritation and severe respiratory problems in vulnerable populations, such as young children, the elderly, and individuals with asthma, emphysema, or other underlying respiratory issues. The U.S. Fire Administration estimates that older adults are more than twice as likely as the general population to die in fires.

Wildfires present significant challenges to vulnerable populations who have difficulty evacuating due to disability, age, or mobility challenges. Populations with limited access to information may not receive time-critical warnings to enable them to reach places of safety. Additionally, those already experiencing socioeconomic constraints may struggle to recover homes and property damaged or destroyed as a result of wildfire.

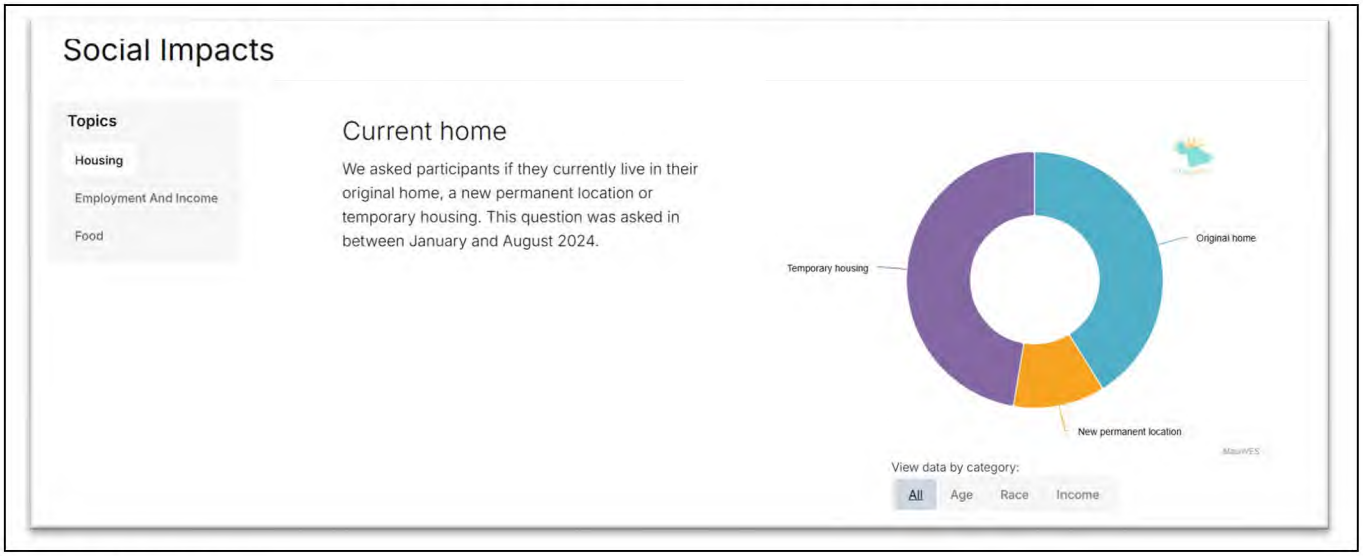
Table 16-7 presents the estimated socially vulnerable populations living in the low, moderate, and high wildfire risk hazard areas:

- In the low-risk hazard area, there are 3,273 persons over 65, 1,107 persons under 5, 210 non-English speakers, 1,743 persons with a disability, and 2,256 individuals living in poverty.
- In the moderate-risk hazard area, there are 9,307 persons over 65, 2,638 persons under 5, 1,927 non-English speakers, 4,872 persons with a disability, and 4,219 individuals living in poverty.
- In the high-risk hazard area, there are 19,484 persons over 65, 4,941 persons under 5, 3,752 non-English speakers, 10,556 persons with a disability, and 9,053 individuals living in poverty.

Impacts of the 2023 Wildfires

After the August 2023 wildfires, Maui's populations continue to face significant economic and housing instability. The Maui Recovery Survey: Housing & Jobs, conducted by the University of Hawai'i Economic Research Organization and the Hawai'i Community Foundation, highlights ongoing challenges for fire-affected households in West Maui and Kula. Many households still struggle with increased rent costs, displacement, and instability. Nearly half of all respondents remained in temporary housing, as displayed in Figure 16-7. In addition, over a third of the survivors were living with friends and family, in temporary units without assistance, or were unhoused.

Figure 16-7. Maui Wildfire Study, Housing Results



Source: (UHERO 2025)

Exacerbating the housing crisis, rents are 50 to 60 percent higher than pre-fire levels, with larger units costing nearly 90 percent more (UHERO 2025). This burden is especially severe for those whose incomes have declined post-fire, which included almost 70 percent of survey respondents, as displayed in Figure 16-8. In addition, more than half of the survey respondents did not receive assistance for employment disruption after the fire.

Figure 16-8. Maui Wildfire Study, Income Results

Source: (UHERO 2025)

Table 16-6. Population in the Wildfire Risk Hazard Areas

Community Plan Area	Total Population (2023 ACS)	Population in the Low Wildfire Risk Hazard Area		Population in the Moderate Wildfire Risk Hazard Area		Population in the High Wildfire Risk Hazard Area	
		Number of Persons	% of Plan Area Total	Number of Persons	% of Plan Area Total	Number of Persons	% of Plan Area Total
Hāna	2,135	1,659	77.7%	74	3.5%	222	10.4%
Kīhei-Mākena	29,174	0	0.0%	0	0.0%	29,165	99.9%
Lānaʻi	3,333	0	0.0%	3,298	98.9%	0	0.0%
Makawao-Pukalani-Kula	24,505	0	0.0%	15,373	62.7%	8,862	36.2%
Molokaʻi	8,092	2,063	25.5%	34	0.4%	5,724	70.7%
Pāʻia-Haʻikū	17,037	13,674	80.3%	2,812	16.5%	0	0.0%
Wailuku-Kahului	58,606	630	1.1%	16,081	27.4%	39,360	67.2%
West Maui	21,749	0	0.0%	8,191	37.7%	12,769	58.7%
Maui County (Total)	164,632	18,026	10.9%	45,863	27.9%	96,102	58.4%

Source: U.S. Census Bureau 2023 ACS; Hawai'i Wildfire Management Organization 2013

Table 16-7. Socially Vulnerable Persons Living in the Wildfire Risk Hazard Areas

Community Plan Area	Estimated Number of Socially Vulnerable Persons									
	Persons Over 65	% of Total	Persons Under 5	% of Total	Non-English Speaking Persons	% of Total	Persons with a Disability	% of Total	Persons in Poverty	% of Total
Low Wildfire Risk Hazard Area										
Hāna	439	77.8%	79	77.3%	31	78.4%	180	77.5%	260	77.7%
Kīhei-Mākena	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Lānaʻi	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Makawao-Pukalani-Kula	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Molokaʻi	439	25.5%	90	25.4%	14	24.0%	355	25.5%	380	25.5%
Pāʻia-Haʻikū	2,272	80.2%	907	80.2%	131	80.1%	1,139	80.2%	1,570	80.2%
Wailuku-Kahului	123	1.1%	31	1.0%	34	1.1%	69	1.1%	46	1.1%
West Maui	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Maui County (Total)	3,273	9.9%	1,107	12.4%	210	3.5%	1,743	9.9%	2,256	14.1%
Moderate Wildfire Risk Hazard Area										
Hāna	19	3.4%	3	2.9%	1	2.5%	8	3.4%	11	3.3%
Kīhei-Mākena	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Lānaʻi	705	98.9%	219	98.6%	373	99.0%	571	98.8%	245	98.8%
Makawao-Pukalani-Kula	3,419	62.7%	861	62.7%	303	62.7%	1,522	62.7%	1,675	62.7%
Molokaʻi	7	0.4%	1	0.3%	0	0.0%	5	0.4%	6	0.4%
Pāʻia-Haʻikū	467	16.5%	186	16.5%	27	16.5%	234	16.5%	323	16.5%
Wailuku-Kahului	3,162	27.4%	811	27.4%	873	27.4%	1,771	27.4%	1,176	27.4%
West Maui	1,528	37.7%	557	37.7%	350	37.6%	761	37.7%	783	37.6%
Maui County (Total)	9,307	28.2%	2,638	29.5%	1,927	31.7%	4,872	27.6%	4,219	26.4%
High Wildfire Risk Hazard Area										
Hāna	58	10.3%	10	9.8%	4	10.1%	24	10.3%	34	10.2%
Kīhei-Mākena	6,113	99.9%	1,330	99.9%	850	99.9%	3,148	99.9%	2,899	99.9%
Lānaʻi	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%

Community Plan Area	Estimated Number of Socially Vulnerable Persons									
	Persons Over 65	% of Total	Persons Under 5	% of Total	Non-English Speaking Persons	% of Total	Persons with a Disability	% of Total	Persons in Poverty	% of Total
Makawao-Pukalani-Kula	1,971	36.2%	496	36.1%	174	36.0%	877	36.1%	965	36.1%
Molokaʻi	1,219	70.7%	251	70.7%	41	70.2%	986	70.7%	1,054	70.7%
Pāʻia-Haʻikū	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Wailuku-Kahului	7,741	67.2%	1,986	67.1%	2,137	67.1%	4,335	67.1%	2,880	67.2%
West Maui	2,382	58.7%	868	58.7%	546	58.7%	1,186	58.7%	1,221	58.7%
Maui County (Total)	19,484	59.1%	4,941	55.2%	3,752	61.7%	10,556	59.7%	9,053	56.7%

Source: U.S. Census Bureau 2023 ACS Vulnerable Population Totals; Hawaiʻi Wildfire Management Organization 2013
Note: Population

Approximately 90 percent of Lahaina burn area residents remain displaced, and many from other areas who worked or owned businesses in West Maui or Kula have been forced to relocate. Despite these hardships, most displaced residents intend to return to West Maui, though affordable housing remains a significant barrier. Overall, socially vulnerable populations in Maui County have been disproportionately affected by the wildfires, facing ongoing challenges in housing stability, affordability, and economic recovery (UHERO 2025).

16.2.2 General Building Stock

Fires can cause significant damage to buildings, ranging from smoke and water damage to total loss. Buildings that do not comply with the Hawai'i State Building Code may be more susceptible to wildfires than others. Building materials and landscaping around the buildings can also impact vulnerability. For example, wood shakes can ignite quickly due to embers, and pine needles may catch roofs on fire if there are blowing embers in the area. Maintaining a buffer area (defensible space) between surrounding vegetation and the structure can decrease risk. Additionally, proactive landscaping schemes can be used in fire-prone areas, such as avoiding pine straw and mulch.

Table 16-8 summarizes the estimated building stock inventory located in the defined wildfire hazard areas by Community Plan Area. There are 5,011 buildings (11.0 percent of the total building stock) located in the low wildfire risk hazard area with an estimated $3.1 billion of replacement cost value (building and content replacement costs). There are 12,818 buildings (28.1 percent of the total building stock) located in moderate wildfire risk hazard area with an estimated $9.4 billion of replacement cost value. In the high wildfire risk hazard area, there are 26,283 buildings (57.7 percent of the total building stock) with an estimated $36.3 billion of replacement cost value. Table 16-9 provides a summary of buildings in the wildfire risk hazard areas by occupancy class. Most of the buildings in all three hazard areas are residential.

Table 16-8. Building Stock and Replacement Cost Value in the Wildfire Risk Hazard Areas

Community Plan Area	Community Plan Area Total Buildings		Number of Buildings in Hazard Area		Replacement Cost Value in Hazard Area	
	Number of Buildings	Replacement Cost Value	Count	% of Plan Area Total	Value	% of Plan Area Total
Low Wildfire Risk Hazard Area						
Hāna	930	$741,266,476	720	77.4%	$603,217,466	81.4%
Kīhei-Mākena	7,613	$11,692,760,990	0	0.0%	$0	0.0%
Lānaʻi	1,258	$1,012,846,136	0	0.0%	$0	0.0%
Makawao-Pukalani-Kula	8,868	$6,037,317,698	0	0.0%	$0	0.0%
Molokaʻi	3,056	$2,384,451,998	754	24.7%	$333,594,071	14.0%
Pāʻia-Haʻikū	4,316	$2,686,054,376	3,385	78.4%	$1,990,693,545	74.1%
Wailuku-Kahului	15,444	$18,302,375,352	152	1.0%	$135,677,339	0.7%
West Maui	4,063	$8,896,487,618	0	0.0%	$0	0.0%
Maui County (Total)	45,548	$51,753,560,644	5,011	11.0%	$3,063,182,421	5.9%
Moderate Wildfire Risk Hazard Area						
Hāna	930	$741,266,476	29	3.1%	$11,852,600	1.6%
Kīhei-Mākena	7,613	$11,692,760,990	0	0.0%	$0	0.0%
Lānaʻi	1,258	$1,012,846,136	1,218	96.8%	$898,712,745	88.7%
Makawao-Pukalani-Kula	8,868	$6,037,317,698	5,585	63.0%	$3,608,433,886	59.8%
Molokaʻi	3,056	$2,384,451,998	12	0.4%	$2,860,707	0.1%
Pāʻia-Haʻikū	4,316	$2,686,054,376	768	17.8%	$493,792,589	18.4%
Wailuku-Kahului	15,444	$18,302,375,352	3,699	24.0%	$1,791,306,920	9.8%
West Maui	4,063	$8,896,487,618	1,507	37.1%	$2,603,166,711	29.3%
Maui County (Total)	45,548	$51,753,560,644	12,818	28.1%	$9,410,126,158	18.2%
High Wildfire Risk Hazard Area						
Hāna	930	$741,266,476	92	9.9%	$39,346,255	5.3%
Kīhei-Mākena	7,613	$11,692,760,990	7,536	99.0%	$11,269,750,609	96.4%
Lānaʻi	1,258	$1,012,846,136	0	0.0%	$0	0.0%

Community Plan Area	Community Plan Area Total Buildings		Number of Buildings in Hazard Area		Replacement Cost Value in Hazard Area	
	Number of Buildings	Replacement Cost Value	Count	% of Plan Area Total	Value	% of Plan Area Total
Makawao-Pukalani-Kula	8,868	$6,037,317,698	3,176	35.8%	$2,167,123,838	35.9%
Molokaʻi	3,056	$2,384,451,998	2,173	71.1%	$1,803,659,419	75.6%
Pāʻia-Haʻikū	4,316	$2,686,054,376	0	0.0%	$0	0.0%
Wailuku-Kahului	15,444	$18,302,375,352	10,897	70.6%	$15,319,674,802	83.7%
West Maui	4,063	$8,896,487,618	2,409	59.3%	$5,707,265,916	64.2%
Maui County (Total)	45,548	$51,753,560,644	26,283	57.7%	$36,306,820,839	70.2%

Source: USACE NSI 2022; Hawaiʻi Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; RSMeans 2024; Hawaiʻi Wildfire Management Organization 2013

Table 16-9 Buildings in the Wildfire Risk Hazard Areas by Occupancy Class

Community Plan Area	Number of Buildings in Hazard Area			
	Residential	Commercial	Industrial	Other[a]
Low Wildfire Risk Hazard Area				
Hāna	649	55	8	8
Kīhei-Mākena	0	0	0	0
Lānaʻi	0	0	0	0
Makawao-Pukalani-Kula	0	0	0	0
Molokaʻi	721	22	10	1
Pāʻia-Haʻikū	3,156	152	55	22
Wailuku-Kahului	142	4	4	2
West Maui	0	0	0	0
Maui County (Total)	4,668	233	77	33
Moderate Wildfire Risk Hazard Area				
Hāna	29	0	0	0
Kīhei-Mākena	0	0	0	0
Lānaʻi	1,140	65	10	3
Makawao-Pukalani-Kula	5,202	286	44	53
Molokaʻi	12	0	0	0
Pāʻia-Haʻikū	649	102	10	7
Wailuku-Kahului	3,624	56	13	6
West Maui	1,331	141	14	21
Maui County (Total)	11,987	650	91	90
High Wildfire Risk Hazard Area				
Hāna	87	4	0	1
Kīhei-Mākena	6,630	738	104	64
Lānaʻi	0	0	0	0
Makawao-Pukalani-Kula	2,999	120	32	25
Molokaʻi	2,000	111	46	16
Pāʻia-Haʻikū	0	0	0	0
Wailuku-Kahului	8,870	1,518	319	190
West Maui	2,075	268	38	28
Maui County (Total)	22,661	2,759	539	324

Source: USACE NSI 2022; Hawai'i Emergency Management Agency 2022; Niyam IT 2022; County of Maui 2024; Hawai'i Wildfire Management Organization 2013

a. Other = Government, Religion, Agricultural, and Education

16.2.3 Community Lifelines and Other Critical Facilities

Wildfires can significantly impact Maui County's infrastructure and public services. Residual pollutants like char and debris can contaminate water supplies, clogging wastewater pipes and culverts. Excessive heat can cause hazardous materials and fuel storage to rupture, fueling the fire and causing rapid spreading. Communication facilities may become inoperable. Damage to fire stations can hinder fire suppression and support services.

Due to their geographic extent, roads and utility lines have a higher chance of being impacted by wildfires. Damage to utility lines can compromise the functionality of water, sewer, gas, and electricity systems. Transportation routes may be closed due to debris, poor air quality, or flames near roadways, preventing residents and commuters from entering or leaving hazard areas during wildfire events. If any section of a road or utility line is damaged, the entire system may be affected. For instance, a wildfire that makes one area of a road or bridge impassable can block access to other roads or locations.

Table 16-10 summarizes the number of critical facilities exposed to the wildfire risk hazard areas by lifeline category:

- There are 25 critical facilities located in the low-risk hazard area, with the Safety and Security sector making up the largest portion (eight facilities). The Hāna Community Plan Area contains the highest number of critical facilities in this hazard area, totaling 13.
- In the moderate risk hazard area, Maui County has 48 critical facilities, with the Water Systems sector having the most (12 facilities). The Lānaʻi Community Plan Area leads all Plan Areas with 15 facilities.
- For the high-risk hazard area, Maui County has a total of 182 critical facilities, with the Health and Medical sector accounting for 38 of these. The Wailuku-Kahului Community Plan Area has the highest number of critical facilities in this hazard area, totaling 90.

16.2.4 Economy

Wildfires can result in significant economic losses, particularly for businesses dependent on timber, such as paper mills and lumber companies. These losses can be passed along to consumers through higher prices, and in some cases, jobs may be lost. The costs associated with wildfire response and recovery can also be substantial, depleting fiscal resources and potentially increasing insurance rates. The tourism industry can be severely impacted if roads and tourist attractions are closed due to health and safety concerns, leading to a decline in visitor numbers and revenue.

A month after the Lahaina Wildfire, the Hawaiʻi Department of Business, Economic Development and Tourism (DBEDT) estimated that the daily total business revenue of destroyed Lahaina businesses was $2.7 million (DBEDT 2023). The economic costs of the wildfires are estimated to be in the billions of dollars, primarily due to property damage, lost output, and decreased tourism. Tourism, which accounts for approximately 40 percent of Maui's gross domestic product and 51 percent of jobs, has been severely affected, leading to significant economic repercussions. Additionally, the high cost of living in Hawaiʻi, coupled with wages far below the national average, means these losses are likely to impact residents for years to come (NCBI PMC 2024).

Table 16-10. Number of Facilities in the Wildfire Risk Hazard Areas, by Lifeline Category

Community Plan Area	Communications	Energy	Food, Hydration, Shelter	Hazardous Materials	Health & Medical	Safety & Security	Transportation	Water Systems	Other Critical Facilities	Count	% of Plan Area Total
Number of Facilities in the Low Wildfire Risk Hazard Area											
Hāna	2	1	1	0	1	3	1	2	2	13	100.0%
Kīhei-Mākena	0	0	0	0	0	0	0	0	0	0	0.0%
Lānaʻi	0	0	0	0	0	0	0	0	0	0	0.0%
Makawao-Pukalani-Kula	0	0	0	0	0	0	0	0	0	0	0.0%
Molokaʻi	0	0	0	0	0	3	0	0	2	5	16.7%
Pāʻia-Haʻikū	1	0	0	0	2	2	0	0	1	6	42.9%
Wailuku-Kahului	0	0	0	0	0	0	0	1	0	1	1.0%
West Maui	0	0	0	0	0	0	0	0	0	0	0.0%
Maui County (Total)	3	1	1	0	3	8	1	3	5	25	9.1%
Number of Facilities in the Moderate Wildfire Risk Hazard Area											
Hāna	0	0	0	0	0	0	0	0	0	0	0.0%
Kīhei-Mākena	0	0	0	0	0	0	0	0	0	0	0.0%
Lānaʻi	2	0	2	0	5	4	0	0	2	15	83.3%
Makawao-Pukalani-Kula	0	0	0	0	1	4	0	1	3	9	37.5%
Molokaʻi	0	0	0	0	0	0	0	0	0	0	0.0%
Pāʻia-Haʻikū	0	1	0	0	0	2	0	1	2	6	42.9%
Wailuku-Kahului	1	1	0	0	0	0	0	5	0	7	6.9%
West Maui	1	0	1	0	0	1	3	5	0	11	27.5%
Maui County (Total)	4	2	3	0	6	11	3	12	7	48	17.5%
Number of Facilities in the High Wildfire Risk Hazard Area											
Hāna	0	0	0	0	0	0	0	0	0	0	0.0%
Kīhei-Mākena	3	0	2	0	3	5	1	13	3	30	88.2%
Lānaʻi	0	0	0	0	0	0	0	0	0	0	0.0%

Community Plan Area	Communications	Energy	Food, Hydration, Shelter	Hazardous Materials	Health & Medical	Safety & Security	Transportation	Water Systems	Other Critical Facilities	Count	% of Plan Area Total
Makawao-Pukalani-Kula	2	0	0	0	2	2	0	4	3	13	54.2%
Molokaʻi	2	0	3	0	3	7	2	2	2	21	70.0%
Pāʻia-Haʻikū	0	0	0	0	0	0	0	0	0	0	0.0%
Wailuku-Kahului	4	1	1	0	25	27	12	7	13	90	88.2%
West Maui	1	0	4	0	5	6	0	11	1	28	70.0%
Maui County (Total)	12	1	10	0	38	47	15	37	22	182	66.2%

Source: Hawaiʻi Emergency Management Agency 2017; Hawaiʻi Wildfire Management Organization 2013

16.2.5 Natural, Historic and Cultural Resources

Natural

Intense wildfires can result in severe environmental damage, including the burning and killing of plant and animal life. Intense fires can also heat narrow and shallow waterways, resulting in damage to aquatic systems. Post-fire runoff polluted with debris and contaminants can be extremely harmful to terrestrial ecosystems and aquatic life.

The age and density of infrastructure in Maui County can exacerbate the environmental consequences of fires due to the increased amount of chemicals and contaminants released if that infrastructure burns. These chemicals, such as iron, lead, and zinc, may leach into stormwater, contaminate nearby streams, and impair aquatic life. Intense wildfire events that destroy existing ecosystems can result in an increase in invasive species that may be able to move into an area with a lack of natural competitors.

Historic and Cultural

Wildfires pose a significant threat to historic and cultural resources in Maui County, with the potential to cause extensive damage or even complete destruction. The impact on historic infrastructure from wildfires is largely dependent on the construction materials used. Many historic structures are constructed from wood, a highly flammable material. Furthermore, these structures were often built before the implementation of strict building codes and before there was a comprehensive understanding of wildfire risks. In many instances, historic structures house cultural resources and artifacts

16.2.6 Identified Vulnerability Issues

The County has identified the following vulnerabilities related to this hazard:

- Steep slopes, rough terrain, strong winds, and a large percentage of highly ignitable invasive grasses characterize much of the County's landscape.
- More than half of the County's population lives in a wildfire hazard area.
- More than 25,000 building are located in a wildfire hazard area.

16.3 FUTURE CHANGES THAT MAY AFFECT RISK

16.3.1 Potential or Planned Development

As discussed in Chapter 3 (County Profile), areas targeted for future growth and development have been identified across Maui County. New development with a mix of additional structures, ornamental vegetation, and wildland fuels will require continued assessment of the hazard and mitigation risk

Any changes in development can impact the County's risk to wildfire hazards. Therefore, the County should integrate comprehensive wildfire management strategies into existing building codes. These

strategies should aim to protect structures from residual impacts such as heat, debris, and char. Given that residential developments are generally more vulnerable to wildfire damage than structures like warehouses, commercial buildings, and industrial facilities, it is crucial to prioritize these areas. Additionally, all new developments should be designed with accessible transit routes to facilitate efficient evacuation during wildfire events.

In Maui County, 388 new developments are located within the low wildfire risk hazard area, representing 11.9 percent of all new developments. The majority are in Paia-Haiku with 331 developments (92.5 percent), followed by Hana with 22 (56.4 percent) and Molokai with 13 (11.4 percent). Wailuku-Kahului also has 22 developments (2.9 percent), while all other community planning areas report no new development in this low-risk hazard area.

Additionally, in the moderate wildfire risk hazard area, there are 635 new developments, accounting for 19.6 percent of all new development in Maui County. The highest concentration is in Lanai with 255 developments (93.8 percent), followed by Makawao-Pukalani-Kula with 239 (38.3 percent). Other areas with notable development include West Maui with 60 (10.5 percent) and Wailuku-Kahului with 68 (9.0 percent). Smaller counts are seen in Paia-Haiku with 13 new developments (3.6 percent), while the remaining planning areas report no development in this hazard area.

In the high wildfire risk hazard area, 1,551 new developments are located within Maui County, representing 47.8 percent of all new developments. The largest share is in Kihei-Makena with 475 developments (92.1 percent), followed by Wailuku-Kahului with 357 (47.5 percent), West Maui with 355 (62.0 percent), and Makawao-Pukalani-Kula with 260 (41.7 percent). Molokai also has a significant share with 98 developments (86.0 percent), while Hana has six (15.4 percent). The remaining planning areas report no new development in this high-risk hazard area.

Table 16-11 through Table 16-13 display the number of new developments by community planning area for each wildfire risk hazard area.

Table 16-11. Number of New Development in the Low Wildfire Risk Hazard Area

Community Plan Area	Number of New Development in the Low Wildfire Risk Hazard Area	
	[illegible]	[illegible]
Hana	22	56.4%
Kahoolawe	0	0.0%
Kihei - Makena	0	0.0%
Lanai	0	0.0%
Makawao - Pukalani - Kula	0	0.0%
Molokai	13	11.4%
Paia - Haiku	331	92.5%

Wailuku - Kahului	22	2.9%
West Maui	0	0.0%
Maui County (Total)	**388**	**11.9%**

Source: *County of Maui 2025; Hawai'i Wildfire Management Organization 2013*

Table 16-12. Number of New Development in the Moderate Wildfire Risk Hazard Area

Community Plan Area	Number of New Development in the Moderate Wildfire Risk Hazard Area	
	Count	% of Jurisdiction Total
Hana	0	0.0%
Kahoolawe	0	0.0%
Kihei - Makena	0	0.0%
Lanai	255	93.8%
Makawao - Pukalani - Kula	239	38.3%
Molokai	0	0.0%
Paia - Haiku	13	3.6%
Wailuku - Kahului	68	9.0%
West Maui	60	10.5%
Maui County (Total)	**635**	**19.6%**

Source: *County of Maui 2025; Hawai'i Wildfire Management Organization 2013*

Table 16-13. Number of New Development in the High Wildfire Risk Hazard Area

Community Plan Area	Number of New Development in the High Wildfire Risk Hazard Area	
	Count	% of Jurisdiction Total
Hana	6	15.4%
Kahoolawe	0	0.0%
Kihei - Makena	475	92.1%
Lanai	0	0.0%
Makawao - Pukalani - Kula	260	41.7%
Molokai	98	86.0%
Paia - Haiku	0	0.0%

Wailuku - Kahului	357	47.5%
West Maui	355	62.0%
Maui County (Total)	**1,551**	**47.8%**

Source: *County of Maui 2025; Hawai'i Wildfire Management Organization 2013*

16.3.2 Projected Changes in Population

Any changes in the density of population can impact the number of persons exposed to the wildfire hazard. The Department of Business, Economic Development and Tourism (DBEDT) produced population projections for the County from 2030 to 2050. According to these projections, Maui County's population is projected to grow to 173,520 by 2030, 181,000 by 2040, and 184,870 by 2050.

16.3.3 Climate Change

Climate change is expected to significantly impact wildfire, increasing ignition frequency, fire spread, and vegetation fuels. By mid-century, there could be a 35 percent increase in high fire danger days globally. In the State of Hawai'i, temperatures are rising by 0.3 °F per decade, with predictions of a 5 °F to 7.5 °F increase by the century's end, intensifying wildfire risks by drying vegetation.

Wildfires are tied to rainfall patterns, with more frequent fires in dry leeward areas and larger fires during droughts. Further, changing climate conditions make native species more vulnerable to competition from non-native species, potentially increasing wildfire frequency and intensity due to fire-prone non-native species.

16.3.4 Other Identified Conditions

Vegetation and fuel load, land use and management practices, and technological advancements are crucial factors affecting future wildfire risk. Dense, dry vegetation and invasive species increase fire intensity, while poor land management can lead to severe wildfires. Implementing controlled burns and forest thinning can mitigate these risks. Advanced technologies like artificial intelligence and drones enhance early detection and response, improving wildfire management and reducing overall impact.

17. HAZARD RANKING

17.1 HAZARD RANKING METHODOLOGY

Maui County recognizes that some hazards pose a greater risk to the community and will direct its attention and resources accordingly to manage risk and reduce losses. To achieve this, the hazards of concern were ranked using the methods described below.

17.1.1 Categories Used in Ranking

The ranking methodology is based on four risk assessment categories (probability of occurrence, consequence, adaptive capacity, and climate change), with the following scoring parameters defined for each category:

- **Level**—The level is a qualitative description of how each hazard rates in each category (such as low to high, or unlikely to frequent)
- **Benchmark value**—The benchmark values are clearly determinable quantities or descriptions that define which level should apply to each hazard
- **Numeric value**—The numeric value is the hazard's score in each category, based on the assigned level
- **Weighting**—The weighting is a multiplier applied to each hazard's numeric value in each category, to represent the relative importance of the category (the higher the weighting, the more important the category)

The following sections describe the categories and their associated scoring parameters.

Probability of Occurrence

For some hazards, the probability of occurrence was based on the likelihood that an event scenario of a specified magnitude (such as a 1 percent annual chance flood or a M7.2 earthquake) would occur in any given year. When no scenario was assessed, an examination of the historical record and judgment were used to estimate the probability of occurrence of an event that will impact the County. Table 17-1. summarizes the scoring parameters for the probability of occurrence.

Table 17-1. Values and Weights for Probability of Occurrence

Level	Benchmark Value	Numeric Value	Weighting
Unlikely	Hazard event has less than a 1 percent annual probability of occurring.	0	30%
Rare	Hazard event has between 1 and 10 percent annual probability of occurring.	1	
Occasional	Hazard event has between 10 and 100 percent annual probability of occurring.	2	
Frequent	100 percent annual probability; hazard event is likely to occur multiple times per year.	3	

Consequence

Consequence represents the expected vulnerability and impact associated with the hazard. This is rated for three subcategories: vulnerability of people; vulnerability of property; and economic impacts on the community. A numeric value based on defined benchmarks is assigned for each subcategory, and a factor is applied to those values representing the relative importance of each subcategory. The total numeric value for consequence is the sum of the factored numeric values for each subcategory. For drought and high windstorms, the County chose to use 100 percent impact on the population and zero impact on buildings and replacement cost values; since these hazards do not have a defined hazard area, it is difficult to estimate the impact to population, property, and the economy. Table 17-2 summarizes the scoring parameters for consequence.

Table 17-2. Values and Weights for Consequence

Level	Benchmark Value	Numeric Value	Factor	Weighting
Population (Numeric Value x 3)				
None	No population vulnerable to the hazard	0	3	
Low	14 percent or less of population is exposed to a hazard with potential for measurable life-safety impact due to its extent and location.	1		
Medium	15 to 29 percent of population is exposed to a hazard with potential for measurable life-safety impact due to its extent and location.	2		
High	30 percent or more of population is exposed to a hazard with potential for measurable life-safety impact, due to its extent and location.	3		
Property (Numeric Value x 2)				
None	No property vulnerable to the hazard	0	2	
Low	Property vulnerability is 14 percent or less of the total number of structures for your community.	1		
Medium	Property vulnerability is 15 to 29 percent of the total number of structures for the community.	2		
High	Property vulnerability is 30 percent or more of the total number of structures for the community.	3		
Economy (Numeric Value x 1)				
None	No estimated loss due to the hazard	0	1	
Low	Loss estimate is 9 percent or less of the total replacement cost for the community.	1		
Medium	Loss estimate is 10 to 19 percent of the total replacement cost for the community.	2		
High	Loss estimate is 20 percent or more of the total replacement cost for the community.	3		

30%

Adaptive Capacity

Adaptive capacity describes a community's administrative, technical, planning/regulatory, and financial ability to protect against or withstand a hazard event. Mitigation measures that can increase a community's capacity to withstand and rebound from events include codes or ordinances with higher

standards to withstand hazards due to design or location; deployable resources; or plans and procedures for responding to an event.

A rating of "weak" for adaptive capacity means a community does not have the capability to effectively respond, which increases vulnerability. A "strong" adaptive capacity means the community does have the capability to effectively respond, which decreases vulnerability. These ratings were assigned using the results of the capability assessment. Table 17-3 summarizes the scoring parameters for adaptive capacity.

Table 17-3. Values and Weights for Adaptive Capacity

Level	Benchmark Value	Numeric Value	Weighting
Weak	Weak, outdated, or inconsistent plans, policies, codes, or ordinances in place; no redundancies; limited to no deployable resources; limited capabilities to respond; long recovery.	1	30%
Moderate	Plans, policies, codes/ordinances in place and meet minimum requirements; mitigation actions identified but not implemented on a widespread scale; county can recover but needs outside resources; moderate county capabilities.	0	
Strong	Plans, policies, codes/ordinances in place that exceed minimum requirements; mitigation/protective measures in place; county has the ability to recover quickly because resources are readily available, and capabilities are high.	-1	

Climate Change

The hazard ranking addresses climate change in order to help guide and prioritize the mitigation strategy as a long-term future vision for mitigating the hazards of concern. Current climate change projections were evaluated as part of the hazard ranking to account for potential increases in the severity or frequency of the hazard. The potential impacts that climate change may have on each hazard of concern are discussed in the risk assessment chapters for each hazard. Table 17-4 summarizes the scoring parameters for climate change.

Table 17-4. Values and Weights for Climate Change

Level	Benchmark Value	Numeric Value	Weighting
Low	No local data are available; modeling projects are uncertain on whether there is increased future risk; confidence level is low (inconclusive evidence).	1	10%
Medium	Studies and modeling projections indicate a potential for exacerbated conditions due to climate change; confidence level is medium to high (moderate evidence).	2	
High	Studies and modeling projections indicate exacerbated conditions and increased future risk due to climate change; very high confidence level (strong evidence, well documented, and acceptable methods).	3	

17.1.2 Total Ranking Score

The total ranking score based on the categories described above is calculated using the following equation:

Risk Ranking Score Equation

Ranking Score= [(Consequence on Population x 3) + (Consequence on Property x 2) + (Consequence on Economy x 1) x 0.3] + [Adaptive Capacity x 0.3] + [Climate Change x 0.1] + [Probability of Occurrence x 0.3]

Using this equation, the highest possible ranking score is 6.9. The higher the number, the greater the relative risk. Based on the score for each hazard, a hazard ranking is assigned to each hazard of concern as follows:

- Low = Values less than 3.9
- Medium = Values between 3.9 and 4.9
- High = Values greater than 4.9

The County applied the same methodology to develop the hazard rankings for each Community Plan Area to ensure consistency in the overall ranking of risk. However, the County had the ability to alter rankings based on local knowledge and experience in handling each hazard.

17.2 HAZARD RANKING RESULTS

Using the methodology described above, the hazard ranking for the identified hazards of concern was determined for the County overall and each Community Plan Area. The hazard ranking for Maui County is detailed in the following tables that present the process for the ranking:

- Table 17-5 shows the final hazard ranking for each hazard of concern.
- Table 17-6 shows the weighted numeric values assigned for each hazard of concern.
- Table 17-7 shows the unweighted numeric values assigned for probability, adaptive capacity, and climate change for each hazard.
- Table 17-8 to Table 17-18 show the numeric values assigned for each subcategory of consequence for each hazard. Results are shown for applying the subcategory factors, but not the category-wide weighting.

Table 17-5. Hazard Ranking

Community Planning Area	Coastal Erosion	Dam/ Reservoir Failure	Drought	Earthquake	Flood	High Windstorms	Hurricane	Landslide	Tsunami	Volcanic Hazards	Wildfire
Hāna	Medium	Low	Medium	Low	Low	Medium	Low	Low	Low	High	Low
Kīhei-Mākena	Medium	Low	Medium	High	Low	Medium	Low	Low	Low	High	High
Lānaʻi	Medium	Low	Medium	Medium	Low	Medium	Low	Low	Low	Low	Low
Makawao-Pukalani-Kula	Medium	Low	Medium	Low	Low	Medium	Low	Low	Low	Low	High
Molokaʻi	Medium	Low	Medium	High	Medium	Medium	Low	Low	Low	Low	High
Pāʻia-Haʻikū	Medium	Low	Medium	Low	Low	Medium	Low	Low	Low	Low	Low
Wailuku-Kahului	Medium	High	Medium	High	Low	Medium	Low	Low	Low	Low	High
West Maui	Medium	Low	Medium	Medium	Low	Medium	Low	Low	Medium	Low	High

Note: Low (yellow) = Values less than 3.9; Medium (orange) = Values between 3.9 and 4.9; High (red) = Values greater than 4.9

Note: Coastal erosion risk was adjusted to medium based on input from the Hazard Mitigation Working Group and the fact that the hazard is ranked as High in the 2023 State Hazard Mitigation Plan.

Table 17-6. Numerical Hazard Ranking

Community Planning Area	Coastal Erosion	Dam/ Reservoir Failure	Drought	Earthquake	Flood	High Windstorms	Hurricane	Landslide	Tsunami	Volcanic Hazards	Wildfire
Hāna	3.0	2.3	4.8	2.5	3.0	4.3	3.3	2.7	2.5	5.8	3.0
Kīhei-Mākena	3.0	2.3	4.8	6.1	3.3	4.3	3.3	2.7	3.4	5.8	6.6
Lānaʻi	3.0	2.3	4.8	4.6	3.0	4.3	3.3	2.7	2.5	2.2	3.0
Makawao-Pukalani-Kula	3.0	2.3	4.8	2.5	3.0	4.3	3.3	2.7	2.5	2.2	6.6
Molokaʻi	3.0	2.3	4.8	6.1	4.8	4.3	3.3	2.7	2.5	2.2	6.6
Pāʻia-Haʻikū	3.0	2.6	4.8	2.5	3.0	4.3	3.3	2.7	2.5	2.2	3.0
Wailuku-Kahului	3.0	5.9	4.8	6.1	3.0	4.3	3.3	2.7	2.8	2.2	6.6
West Maui	3.0	2.6	4.8	4.3	3.3	4.3	3.3	2.7	4.6	2.2	6.6

Note: Low (yellow) = Values less than 3.9; Medium (orange) = Values between 3.9 and 4.9; High (red) = Values greater than 4.9

Table 17-7. Probability, Adaptive Capacity, and Climate Change

Hazard	Probability Level	Probability Numeric Value	Adaptive Capacity Level	Adaptive Capacity Numeric Value	Climate Change Level	Climate Change Numeric Value
Coastal Erosion	Frequent	3	Medium	0	High	3
Dam/Reservoir Failure	Rare	1	Medium	0	Medium	2
Drought	Frequent	3	Medium	0	High	3
Earthquake	Occasional	2	Medium	0	Low	1
Flood	Frequent	3	Medium	0	High	3
High Windstorm	Occasional	2	Medium	0	Low	1
Hurricane	Occasional	2	Medium	0	High	3
Landslide	Occasional	2	Medium	0	High	3
Tsunami	Rare	1	Low	-1	Low	1
Volcanic Hazards	Unlikely	0	Low	-1	Low	1
Wildfire	Frequent	3	Medium	0	High	3

Table 17-8. Consequence Rating for Coastal Erosion

	Population			Property			Economy			Total Rating (Population + Property + Economy)
Community Planning Area	Consequence	Numeric Value	Multiplied by Factor (3)	Consequence	Numeric Value	Multiplied by Factor (2)	Consequence	Numeric Value	Multiplied by Factor (1)	
Hāna	Low	1	3	Low	1	2	Low	1	1	6
Kīhei-Mākena	Low	1	3	Low	1	2	Low	1	1	6
Lānaʻi	Low	1	3	Low	1	2	Low	1	1	6
Makawao-Pukalani-Kula	Low	1	3	Low	1	2	Low	1	1	6
Molokaʻi	Low	1	3	Low	1	2	Low	1	1	6
Pāʻia-Haʻikū	Low	1	3	Low	1	2	Low	1	1	6
Wailuku-Kahului	Low	1	3	Low	1	2	Low	1	1	6
West Maui	Low	1	3	Low	1	2	Low	1	1	6

Table 17-9. Consequence Rating for Dam and Reservoir Failure

Community Planning Area	Population			Property			Economy			Total Rating (Population + Property + Economy)
	Consequence	Numeric Value	Multiplied by Factor (3)	Consequence	Numeric Value	Multiplied by Factor (2)	Consequence	Numeric Value	Multiplied by Factor (1)	
Hāna	Low	1	3	Low	1	2	Low	1	1	6
Kīhei-Mākena	Low	1	3	Low	1	2	Low	1	1	6
Lānaʻi	Low	1	3	Low	1	2	Low	1	1	6
Makawao-Pukalani-Kula	Low	1	3	Low	1	2	Low	1	1	6
Molokaʻi	Low	1	3	Low	1	2	Low	1	1	6
Pāʻia-Haʻikū	Low	1	3	Low	1	2	Medium	2	2	7
Wailuku-Kahului	High	3	9	High	3	6	High	3	3	18
West Maui	Low	1	3	Low	1	2	Medium	2	2	7

Table 17-10. Consequence Rating for Drought

Community Planning Area	Population			Property			Economy			Total Rating (Population + Property + Economy)
	Consequence	Numeric Value	Multiplied by Factor (3)	Consequence	Numeric Value	Multiplied by Factor (2)	Consequence	Numeric Value	Multiplied by Factor (1)	
Hāna	High	3	9	Low	1	2	Low	1	1	12
Kīhei-Mākena	High	3	9	Low	1	2	Low	1	1	12
Lānaʻi	High	3	9	Low	1	2	Low	1	1	12
Makawao-Pukalani-Kula	High	3	9	Low	1	2	Low	1	1	12
Molokaʻi	High	3	9	Low	1	2	Low	1	1	12
Pāʻia-Haʻikū	High	3	9	Low	1	2	Low	1	1	12
Wailuku-Kahului	High	3	9	Low	1	2	Low	1	1	12
West Maui	High	3	9	Low	1	2	Low	1	1	12

Table 17-11. Consequence Rating for Earthquake

Community Planning Area	Population			Property			Economy			Total Rating (Population + Property + Economy)
	Consequence	Numeric Value	Multiplied by Factor (3)	Consequence	Numeric Value	Multiplied by Factor (2)	Consequence	Numeric Value	Multiplied by Factor (1)	
Hāna	Low	1	3	Low	1	2	Low	1	1	6
Kīhei-Mākena	Medium	2	6	Medium	2	4	High	3	3	13
Lānaʻi	Low	1	3	Low	1	2	Low	1	1	6
Makawao-Pukalani-Kula	High	3	9	High	3	6	High	3	3	18
Molokaʻi	Low	1	3	Low	1	2	Low	1	1	6
Pāʻia-Haʻikū	High	3	9	High	3	6	High	3	3	18
Wailuku-Kahului	Low	1	3	High	3	6	High	3	3	12
West Maui										

Table 17-12. Consequence Rating for Flood

Community Planning Area	Population			Property			Economy			Total Rating (Population + Property + Economy)
	Consequence	Numeric Value	Multiplied by Factor (3)	Consequence	Numeric Value	Multiplied by Factor (2)	Consequence	Numeric Value	Multiplied by Factor (1)	
Hāna	Low	1	3	Low	1	2	Low	1	1	6
Kīhei-Mākena	Low	1	3	Low	1	2	Medium	2	2	7
Lānaʻi	Low	1	3	Low	1	2	Low	1	1	6
Makawao-Pukalani-Kula	Low	1	3	Low	1	2	Low	1	1	6
Molokaʻi	Medium	2	6	Medium	2	4	Medium	2	2	12
Pāʻia-Haʻikū	Low	1	3	Low	1	2	Low	1	1	6
Wailuku-Kahului	Low	1	3	Low	1	2	Low	1	1	6
West Maui	Low	1	3	Low	1	2	Medium	2	2	7

Table 17-13. Consequence Rating for High Windstorm

Community Planning Area	Population			Property			Economy			Total Rating (Population + Property + Economy)
	Consequence	Numeric Value	Multiplied by Factor (3)	Consequence	Numeric Value	Multiplied by Factor (2)	Consequence	Numeric Value	Multiplied by Factor (1)	
Hāna	High	3	9	Low	1	2	Low	1	1	12
Kīhei-Mākena	High	3	9	Low	1	2	Low	1	1	12
Lānaʻi	High	3	9	Low	1	2	Low	1	1	12
Makawao-Pukalani-Kula	High	3	9	Low	1	2	Low	1	1	12
Molokaʻi	High	3	9	Low	1	2	Low	1	1	12
Pāʻia-Haʻikū	High	3	9	Low	1	2	Low	1	1	12
Wailuku-Kahului	High	3	9	Low	1	2	Low	1	1	12
West Maui	0	1	3	Low	1	2	Low	1	1	6

Table 17-14. Consequence Rating for Hurricane

Community Planning Area	Population			Property			Economy			Total Rating (Population + Property + Economy)
	Consequence	Numeric Value	Multiplied by Factor (3)	Consequence	Numeric Value	Multiplied by Factor (2)	Consequence	Numeric Value	Multiplied by Factor (1)	
Hāna	Low	1	3	Medium	2	4	Low	1	1	8
Kīhei-Mākena	Low	1	3	Medium	2	4	Low	1	1	8
Lānaʻi	Low	1	3	Medium	2	4	Low	1	1	8
Makawao-Pukalani-Kula	Low	1	3	Medium	2	4	Low	1	1	8
Molokaʻi	Low	1	3	Medium	2	4	Low	1	1	8
Pāʻia-Haʻikū	Low	1	3	Medium	2	4	Low	1	1	8
Wailuku-Kahului	Low	1	3	Medium	2	4	Low	1	1	8
West Maui	Low	1	3	Medium	2	4	Low	1	1	8

Table 17-15. Consequence Rating for Landslide

Community Planning Area	Population			Property			Economy			Total Rating (Population + Property + Economy)
	Consequence	Numeric Value	Multiplied by Factor (3)	Consequence	Numeric Value	Multiplied by Factor (2)	Consequence	Numeric Value	Multiplied by Factor (1)	
Hāna	Low	1	3	Low	1	2	Low	1	1	6
Kīhei-Mākena	Low	1	3	Low	1	2	Low	1	1	6
Lānaʻi	Low	1	3	Low	1	2	Low	1	1	6
Makawao-Pukalani-Kula	Low	1	3	Low	1	2	Low	1	1	6
Molokaʻi	Low	1	3	Low	1	2	Low	1	1	6
Pāʻia-Haʻikū	Low	1	3	Low	1	2	Low	1	1	6
Wailuku-Kahului	Low	1	3	Low	1	2	Low	1	1	6
West Maui	Low	1	3	Low	1	2	Low	1	1	6

Table 17-16. Consequence Rating for Tsunami

Community Planning Area	Population			Property			Economy			Total Rating (Population + Property + Economy)
	Consequence	Numeric Value	Multiplied by Factor (3)	Consequence	Numeric Value	Multiplied by Factor (2)	Consequence	Numeric Value	Multiplied by Factor (1)	
Hāna	Low	1	3	Low	1	2	Low	1	1	6
Kīhei-Mākena	Low	1	3	Medium	2	4	Medium	2	2	9
Lānaʻi	Low	1	3	Low	1	2	Low	1	1	6
Makawao-Pukalani-Kula	Low	1	3	Low	1	2	Low	1	1	6
Molokaʻi	Low	1	3	Low	1	2	Low	1	1	6
Pāʻia-Haʻikū	Low	1	3	Low	1	2	Low	1	1	6
Wailuku-Kahului	Low	1	3	Low	1	2	Medium	2	2	7
West Maui	Medium	2	6	Medium	2	4	High	3	3	13

Table 17-17. Consequence Rating for Volcanic Hazards

Community Planning Area	Population			Property			Economy			Total Rating (Population + Property + Economy)
	Consequence	Numeric Value	Multiplied by Factor (3)	Consequence	Numeric Value	Multiplied by Factor (2)	Consequence	Numeric Value	Multiplied by Factor (1)	
Hāna	High	3	9	High	3	6	High	3	3	18
Kīhei-Mākena	High	3	9	High	3	6	High	3	3	18
Lānaʻi	Low	1	3	Low	1	2	Low	1	1	6
Makawao-Pukalani-Kula	Low	1	3	Low	1	2	Low	1	1	6
Molokaʻi	Low	1	3	Low	1	2	Low	1	1	6
Pāʻia-Haʻikū	Low	1	3	Low	1	2	Low	1	1	6
Wailuku-Kahului	Low	1	3	Low	1	2	Low	1	1	6
West Maui	Low	1	3	Low	1	2	Low	1	1	6

Table 17-18. Consequence Rating for Wildfire

Community Planning Area	Population			Property			Economy			Total Rating (Population + Property + Economy)
	Consequence	Numeric Value	Multiplied by Factor (3)	Consequence	Numeric Value	Multiplied by Factor (2)	Consequence	Numeric Value	Multiplied by Factor (1)	
Hāna	Low	1	3	Low	1	2	Low	1	1	6
Kīhei-Mākena	High	3	9	High	3	6	High	3	3	18
Lānaʻi	Low	1	3	Low	1	2	Low	1	1	6
Makawao-Pukalani-Kula	High	3	9	High	3	6	High	3	3	18
Molokaʻi	High	3	9	High	3	6	High	3	3	18
Pāʻia-Haʻikū	Low	1	3	Low	1	2	Low	1	1	6
Wailuku-Kahului	High	3	9	High	3	6	High	3	3	18
West Maui	High	3	9	High	3	6	High	3	3	18

PART 3: CAPABILITY ASSESSMENT

18. CAPABILITY ASSESSMENT

A capability assessment is an inventory of a community's missions, programs, and policies and an analysis of its capacity to carry them out (FEMA 2003). This integral part of the planning process analyzes current governmental programs, policies, regulations, and funding that could either facilitate or hinder mitigation. Through assessing its capabilities, a community learns whether it can implement certain mitigation actions by determining the following:

- The range of local and/or state administrative, programmatic, regulatory, financial, and technical resources available to assist in implementing mitigation actions
- Types of mitigation actions that may be technically, legally, administratively, politically, or fiscally challenging or infeasible because they are outside of current capabilities
- Opportunities to enhance local capabilities to support long-term mitigation and risk reduction

This chapter summarizes existing capabilities at all levels of government (federal, state, county, and local) for supporting hazard mitigation within the planning area. These capabilities are presented in seven categories:

- Planning and regulatory capabilities
- Administrative and technical capabilities
- Fiscal capabilities
- Education and outreach
- Community classifications
- Adaptive capacity
- NFIP and CRS

Maui County evaluated the effectiveness of its capabilities for supporting hazard mitigation and identified opportunities to enhance those capabilities. The county identified how it has integrated hazard mitigation into its existing planning, regulatory, and operational/administrative framework and how it intends to promote ongoing integration.

18.1 PLANNING AND REGULATORY CAPABILITIES

Planning and regulatory capabilities are based on ordinances, policies, local laws, state statutes, plans, and programs that relate to managing growth and development. Planning and regulatory capabilities refer to current plans and regulations as well as the community's ability to change and improve those plans and regulations as needed. This section summarizes planning and regulatory capabilities for Maui County.

18.1.1 Federal

National Flood Insurance Program

The U.S. Congress established the National Flood Insurance Program (NFIP) with the passage of the National Flood Insurance Act of 1968. The NFIP is a Federal program enabling property owners in participating communities to purchase insurance as a protection against flood losses in exchange for State and community floodplain management regulations that reduce future flood damages.

There are three components to the NFIP: flood insurance; floodplain management; and flood hazard mapping. Communities participate in the NFIP by adopting and enforcing floodplain management ordinances to reduce future flood damage. In exchange, the NFIP makes federally backed flood insurance available to homeowners, renters, and business owners in these communities. Community participation in the NFIP is voluntary. Flood insurance is designed to provide an alternative to disaster assistance to reduce the escalating costs of repairing damage to buildings and their contents caused by floods. Flood damage in the U.S. is reduced by nearly $1 billion each year through communities implementing sound floodplain management requirements and property owners purchasing flood insurance. Additionally, buildings constructed in compliance with NFIP building standards suffer approximately 80 percent less damage annually than those not built in compliance (FEMA 2023).

Maui County actively participates in the NFIP. As of 2024, there were more than 10,000 NFIP policies in Maui County. There have been 574 claims made, totaling more than $10 million for damages to structures and contents. There are 35 NFIP Repetitive Loss (RL) properties in the County. Further details on the County's flood vulnerability and implementation of the NFIP may be found in the flood hazard profile in Chapter 10.

The state and local jurisdictions within it may adopt higher regulatory standards when implementing the provisions of the NFIP. Specifically identified are the following:

- **Freeboard**—The County adopted the 2018 International Building Code (IBC) and 2006 International Residential Code (IRC), as incorporated into the Maui Code of Ordinances Title 16. The 2018 IBC requires new construction to be designed with one and a half feet freeboard above current base flood elevation in hazardous flood zones.
- **Cumulative Substantial Improvements/Damages**—The NFIP allows improvements valued at up to 50 percent of the building's pre-improvement value to be permitted without meeting the flood protection requirements. Over the years, a community may issue a succession of permits for different repairs or improvements to the same structures. This can greatly increase the overall flood damage potential for structures within a community. The community may wish to deem "substantial improvement" cumulatively so that once a threshold of improvement within a certain length of time is reached, the structure is considered to be substantially improved and must meet flood protection requirements.

NFIP Community Rating System

The Community Rating System (CRS) is a voluntary incentive program under the NFIP that encourages community floodplain management activities that exceed the minimum NFIP requirements. In

participating communities, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from community actions that meet the three CRS goals: reduce flood losses; facilitate accurate insurance rating; and promote the awareness of flood insurance (FEMA 2021).

As of January 2025, Maui County is a Class 7 community in the CRS. The County will continue to develop technical expertise to maintain and enhance their participation in the program.

Robert T. Stafford Disaster Relief and Emergency Assistance Act

The Robert T. Stafford Disaster Relief and Emergency Assistance Act provides for federal government assistance to state and local governments in carrying out their responsibilities to alleviate the impacts of disasters. This act encourages the development of comprehensive disaster preparedness and assistance plans, programs, capabilities, and organizations by state and local governments. It also encourages hazard mitigation measures to reduce losses from disasters, including development of land-use and construction regulations. It provides federal assistance programs for public and private losses sustained in disasters.

Disaster Mitigation Act of 2000

The Disaster Mitigation Act (DMA) is amended the Robert T. Stafford Disaster Relief and Emergency Assistance Act with a new set of requirements for hazard mitigation plans. This new section emphasizes the need for state, tribal, and local entities to closely coordinate mitigation planning and implementation efforts. It emphasizes planning for disasters before they occur. It specifically addresses planning at the local level, requiring plans to be in place before Hazard Mitigation Assistance grant funds are available to communities. This plan is designed to meet the requirements of DMA, improving eligibility for hazard mitigation funds.

Code of Federal Regulations, Local Mitigation Plans

FEMA requires that communities have an approved local hazard mitigation plan that meets the requirements of 44 CFR Part 201.6 as a condition of receiving non-emergency assistance under the Robert T. Stafford Act or FEMA mitigation grants. The mitigation plan demonstrates the community's commitment to reducing risks from natural hazards and serves as a guide for local decision-makers as they commit resources to reduce the effects of natural hazards. Required plan elements are listed, including requirements related to the planning process, the risk assessment, the mitigation strategy, plan adoption, and plan maintenance.

U.S. Army Corps of Engineers

Under Section 404(e) of the Clean Water Act, the U.S. Army Corps of Engineers (USACE) can issue three types of general permits:

- A nationwide permit (NWP) is a general permit that authorizes activities across the country that have only minimal individual and cumulative adverse environmental effects, unless a district or division commander revokes the nationwide permit in a state or other geographic region. There are 59 nationwide permits, and they authorize a wide variety of activities, including

transportation projects, bank stabilization activities, residential development, commercial and industrial development, aids to navigation, and maintenance activities (USACE 2021).

- Standard permits are individual permits that involve a full public interest review of an individual permit application and include the issuance of a public notice for any project that does not meet the terms and conditions of an NWP or a Letter of Permission (USACE 2024).
- Regional general permits are for small, specialized projects (USACE 2024).

18.1.2 State

State of Hawai‘i Floodplain Management

The Department of Land and Natural Resources (DLNR) is the state coordinating agency for the NFIP. The DLNR is responsible for managing, administering, and exercising control over public lands, water resources, ocean waters, navigable streams, coastal areas (except commercial harbors), minerals, and all interests therein (State of Hawai‘i 2024). DLNR’s primary NFIP function is to act as a liaison between FEMA and Hawai‘i’s four participating counties and to provide the support needed to maintain NFIP eligibility through proper administration and enforcement of floodplain management regulations. Each county has a designated floodplain manager who should be consulted when developing in the SFHA and to understand building permit requirements (State of Hawai'i 2024). The DLNR Maui representative was engaged throughout the planning process for this HMP.

Act 16, Session Laws of Hawai‘i 2020

Under Hawai‘i’s Act 16, Special Management Area permits are required for residential developments along the shoreline. Counties may not reduce the shoreline setback to less than 40 feet from the ocean. Prohibitions have been incorporated to protect beaches and coastal dunes by restricting and/or prohibiting the construction of shoreline hardening structures at sites with beaches; seawalls, revetments, and other shoreline hardening structures are no longer allowed at the sites with beaches unless it is in the interest of the public.

Stormwater Management Planning

Managing stormwater runoff can reduce the amount of pollution entering streams and eventually the ocean. Stormwater can contribute large amounts of runoff within a watershed. In an effort to increase developers’ and state and county agencies’ awareness of the cumulative impacts of stormwater, the State of Hawai‘i Office of Planning and Sustainable Development developed the Stormwater Impact Assessment. The assessment connects primary, secondary and cumulative impacts to Hawai‘i’s Environmental Review Process, which is a framework for assessing and mitigating stormwater impacts during project development and design.

In addition, the Hawai‘i Department of Transportation (HDOT), Highways, Maui District continues to implement its comprehensive Storm Water Management Program. The program is designed to reduce, to the maximum extent practicable, the amount of stormwater containing pollutants discharging from HDOT Highways’ Maui District storm sewer system, which includes all of the storm drains along State-owned roadways within the urban area of Kahului.

18.1.3 County

Land Use Planning and Regulatory Authority

The Maui Department of Planning is responsible for land use and comprehensive planning and for offering technical advice to the Mayor, County Council, and commissions. The department proposes zoning legislation, drafts updates to the General Plan, Maui Island Plan, and nine community plans, and presents reports and recommendations on development proposals. It oversees programs on cultural resources, census and geographic information, floodplain permits, and other special projects and permits. The Department was actively involved in development of this HMP, attended all meetings for the HMP, participated in stakeholder coordination, and reviewed draft sections of the plan.

There are three Planning Commissions that advise the Mayor, County Council, and Planning Director in matters concerning planning: the Maui Planning Commission is concerned with the Island of Maui and adjacent waters; the Molokaʻi Planning Commission is concerned with the Island of Molokaʻi, except the area known as the Kalaupāpā Settlement; and the Lānaʻi Planning Commission is concerned with the Island of Lānaʻi. In addition, three Advisory Committees advise the Maui Planning Commission on matters related to East Maui, Pāʻia-Haʻikū, and South Maui.

Maui County Council

The nine-member Maui County Council is the legislative and policy-making body of the Maui County government. The Council's standing committees include the following:

- Agriculture, Diversification, Environment, and Public Transportation Committee
- Budget, Finance, and Economic Development Committee
- Disaster Recovery, International Affairs, and Planning Committee
- Government Relations, Ethics, and Transparency Committee
- Housing and Land Use Committee
- Kōmike Aloha ʻĀina
- Water and Infrastructure Committee
- Water Authority, Social Services, and Parks Committee

Emergency and Evacuation Plans

The Maui Emergency Management Agency coordinates all emergency management activities in the County, including planning, response, and management. MEMA maintains the Maui County Comprehensive Emergency Management Plan (CEMP), which is an all-hazards plan that outlines how the County will manage emergencies and disaster situations. Following the 2023 Lahaina Wildfire, MEMA underwent an extensive planning process update and is currently updating the following County plans:

- Continuity of operations
- Debris management
- Emergency operations center assessment
- Evacuation
- Feeding
- Flood response
- Mass care/sheltering
- Tsunami/hurricane response
- Alert and warning
- Commodities points of distribution
- Disabilities and access and functional needs/vulnerable communities
- Family reunification/assistance
- Mass casualty/mass fatality
- Public information and crisis communications
- Volunteer and donations management
- Search and rescue
- Cost recovery
- Critical infrastructure/key resources
- Logistics, facilities, and resource management
- Public health and medical
- Cyber security incident response and recovery plan

Maui Island Shoreline Rule Update

The Shoreline Rules for the Maui Planning Commission (Maui Island) were updated in 2024. The Shoreline Rules regulate uses and activities on land within the shoreline environment in order to protect the safety and welfare of the public by protecting against coastal natural hazards, in accordance with the Hawai‘i coastal zone management law (Hawai‘i Revised Statutes chapter 205A). The new erosion setback is based on future projected erosion with 3.2 feet of sea level rise, plus 40 feet. For areas that do not have a mapped erosion hazard line, the setback is 200 feet or an optional lot-depth-based setback.

18.1.4 Summary of Specific Capabilities

Table 18-1 summarizes specific County and state regulatory capabilities. The comments describe how each code, ordinance, or requirement reduces risk and will be integrated with this HMP. Table 18-2 summarizes state, County, and private-organization planning documents. The description includes hazards addressed by the plan, mitigation actions included in the plan, recommended improvements to the plan, and integration opportunities between the plan and this HMP.

Table 18-1. Regulatory Capability

Planning/ Regulatory Tool	Citation / Comments
County	
Building Code	• Enforcement of the following building codes began October 28, 2023: • Building Code Administrative and Supplemental Provisions Maui County Code, Chapter 16.26C Building Code County Ordinance 5508 • 2018 International Building Code (IBC) Maui County Code, Chapter 16.25 – County Ordinance 5507 • 2018 International Residential Code (IRC) Maui County Code, Chapter 16.08B Residential Code • 2018 International Existing Building Code (IEBC) Maui County Code, Chapter 16.10 Existing Building Code • 2018 International Energy Conservation Code (IECC) MCC Chapter 16.16C Energy Code County Ordinance 5455 • The building code includes development standards to mitigate wind, seismic, tsunami, and fire hazards. Flood provisions are regulated separately from the building code through enforcement of Chapter 16.29 (Flood Hazard Areas).
Zoning Code	• Maui County Code, Title 19 – Zoning, Article 1. Interim Zoning Provisions (Ord. No. 3661, § 2, 2009), Article II. Comprehensive Zoning Provisions (last updated Ord. No. 4933, § 1, 2018) • Within the Comprehensive Zoning Ordinance, Title 19, only Chapter 19.47 speaks to the wetlands overlay district and contains permitted uses with the wetlands overlay district. Section 19.47.050 lists permitted uses in the wetlands overlay district. Title 16.29, flood hazard areas, further regulates wetlands, floodways, and floodplains. • The County administers Title 16.29, flood hazard areas, and has other regulatory functions such as the Special Management Area Shoreline designations to discourage development or redevelopment within the special management area that often includes natural hazard areas. • The code does not encourage resilient development through density bonuses for projects outside of natural hazard areas.
Subdivisions	• Maui County Code Title 18 – Subdivisions (last updated Ord. No. 4053, § 1, 2013) • Comments: Regulations provide for conservation/cluster subdivisions but do not currently allow density transfers where hazard areas exist. • The Subdivision Ordinance (Title 18) does not restrict the subdivision of land within or next to natural hazard areas. The subdivision ordinance also does not allow cluster subdivisions or density transfers to conserve environmental resources. These types of provisions could be considered through zoning standards and provisions.
Stormwater Management	• Maui County Code, Title 18, Chapter 20.135 – Post-construction stormwater quality best management practices (Last updated Ord. No. 4053, § 34, 2013); Title 16, Chapter 26B.3900 – Post- construction Stormwater Quality Best Management Practices (last updated Ord. No. 3928, § 3, 2012) • The Stormwater code and HDOT Stormwater Management Plan for Maui County reduce the severity of floods from severe rainfall events.
Site Plan Review	• Maui County Code, Title 12 – Landscape Planting and Beautification (last updated Ord. 2268 § 2, 1993); Title 16 – Buildings and Construction, Chapter 16.26B Building Code (last updated Ord. No. 3928, § 3, 2012)
Environmental Protection	• Maui County Code, Title 20 – Environmental Protection (last updated Ord. No. 3752, § 2, 2010); Hawai'i Revised Statues Title 19 Health, Chapter 344 State Environmental Policy

Planning/ Regulatory Tool	Citation / Comments
Flood Prevention Ordinance	• Maui County Code, Title 16 – Buildings and Construction, Chapter 16.29 Flood Hazard Areas (last updated Ord. No. 5603, § 3, 2024)
Cultural Resources Ordinance	• Maui County Code, Title 19 Zoning, Article III Maui County Historic Districts establishes three historic districts and regulations on buildings and uses.
State	
Climate Change Ordinance	• 2023 Hawai'i Revised Statutes, Title 13 Planning and Economic Development, 225P Climate Adaptation; Section 226-109, Hawai'i Revised Statutes – amends the Hawai'i State Planning Act to require consideration of climate change in land use, capital improvement, and program decisions made by State agencies and all four counties
Emergency Management Ordinance	• Hawai'i Revised Statues Title 10 Public Safety and Internal Security, Chapter 127A Emergency Management • The MEMA staff includes hazard mitigation specialists who implement this HMP and monitor the progress of the Mitigation Strategy.
Post-Disaster Recovery	• Hawai'i Revised Statues Title 13 Planning and Economic Development, Chapter 209 Disaster Relief and Rehabilitation • This HMP's Mitigation Strategy includes an action to implement the projects identified in the Lahaina Long-Term Recovery Plan, a document that follows this code.
Real Estate Disclosure	• Hawai'i Revised Statues Title 28. Property, 508D Mandatory Seller Disclosures in Real Estate Transactions; Special Flood Hazard Area and Tsunami Inundation Area Disclosure • The Hawai'i Association of Realtors provides a standard form to members which includes disclosure of hazard-related risks and damages from past events.
Growth Management	• Hawai'i Revised Statutes, Title 13 Planning and Economic Development, 223 Quality Growth Policy; Hawai'i Revised Statutes, Title 13 Planning and Economic Development, Chapter 226 Hawai'i State Planning Act, 226-104 Population growth and land resources priority guidelines

Table 18-2. Planning Capability

Plan Type	Description	Plan Name and Year	Responsible Agency
County			
Agriculture Plan	The purpose of this plan is to support and accelerate Maui County's transition from mono-crop plantations of sugarcane and pineapple for export to diversified agriculture for local consumption. The plan outlines several action items that align with the mission and goals of this HMP by reducing the risk of wildfire on agricultural lands and increasing the resilience of the Food, Hydration & Shelter Community Lifeline. Implementing this plan is one of the mitigation actions listed in this HMP's Mitigation Strategy.	2024-2028 Strategic Plan	Maui County Department of Agriculture
Climate Adaptation / Resilience Plan	This plan provides a clear and actionable set of strategies and actions to reduce communities' contribution to climate change and to build community resilience and adaptation to current and future climate change impacts. The CARP is a two-pronged approach that addresses both mitigation by reducing greenhouse gas emissions and adaptation by increasing resiliency and preparedness. The CARP was shaped by guiding principles developed and vetted by the Climate Action and Resiliency Plan Advisory Committee and the County of Maui's Resiliency Hui. The plan's Resiliency Strategies and Actions are aligned with this HMP's goals and can be further integrated with the Maui HMP by identifying specific natural hazards for each resilience action. Implementing this plan is one of the mitigation actions listed in this HMP's Mitigation Strategy.	Climate Action and Resiliency Plan, 2022	Maui County Office of Climate Change, Resiliency, and Sustainability
Comprehensive Plan	The Maui County General Plan contains three parts: the Countywide Policy Plan; the Maui Island Plan; and nine community plans. The Countywide Policy Plan, adopted in 2010, provides broad goals, objectives, policies, and implementing actions that portray the desired direction of the County's future. The Maui Island Plan, adopted in 2012, provides direction for future growth, the economy, and social and environmental decisions on the island through 2030. The nine community plans, adopted from 1994 to 2024, provide the goals, objectives, policies, and land uses for each region in Maui County. The Maui Island Plan has an entire chapter dedicated to Natural Hazards and integration with the County HMP. Implementing this plan is one of the mitigation actions listed in this HMP's Mitigation Strategy.	General Plan 2030: Countywide Policy Plan, Maui Island Plan, Community Plans	Maui County Department of Planning

Plan Type	Description	Plan Name and Year	Responsible Agency
Capital Improvement Plan	The County of Maui's Capital Improvement Program is a six-year plan that outlines the public infrastructure needs of the community. The Capital Improvement Program addresses public infrastructure projects that include a permanent improvement or betterment as distinguished from ordinary repair or current maintenance. The fiscal year 2024 Capital Improvement Program included a budget of $181.4 million and did not address specific hazards. It can be used to develop mitigation actions and can be improved in the future by identifying which projects mitigate against specific natural hazards.	Capital Improvement Program, 2024	Maui Department of Public Works
County Disaster Preparedness Guide	The Disaster Preparedness Guide for Maui County was created to inform the public about how to prepare for a disaster and cope with the aftermath. The Guide does not address specific hazards and it focuses on three key public information messages: be informed; make a plan; and build a kit. This product could be improved to include information for visitors as well as residents. In addition, shorter products, such as flyers, brochures, and handouts may reach wider audiences with the key messages. This is a preparedness product that does not address mitigation goals or actions. However, it could be expanded to include home mitigation measures for natural hazards.	Disaster Preparedness Guide for Maui County, 2019	Maui Emergency Management Agency
Economic Development Plan	The Maui County Comprehensive Economic Development Strategy (CEDS) lays out a vision of shared economic vitality for the county. The plan names coastal erosion and climate change as threats in the economic assessment and addresses community lifelines in the transportation, utilities, and infrastructure sections. The CEDS lists the 2020 HMP in Appendix 1 Resiliency in Maui County: Plans and Actions. This plan can be used to develop and implement mitigation actions related to the economy; funding may be available from the U.S. Economic Development Administration for mitigation actions that align with the CEDS. Future iterations of the CEDS could include a discussion of natural hazard impacts on the economy and further alignment between the plans per the Economic Development Administration and FEMA Comprehensive Economic Development Strategy and Hazard Mitigation Plan Alignment Guide. In addition, both the CEDS and HMP would benefit from integrating lessons learned from the Lahaina Economic Recovery Commission.	Maui Comprehensive Economic Development Strategy, 2022	Maui Economic Development Board

Plan Type	Description	Plan Name and Year	Responsible Agency
Floodplain Management or Watershed Plan	Maui County's 2025 Multi-Hazard Mitigation Plan will continue to serve as a CRS-credited Floodplain Management Plan.	Maui County Hazard Mitigation Plan, 2025	Maui Emergency Management Agency
Post-Disaster Recovery Plan	Following the devastating wildfires in August 2023, the Lahaina Long-Term Recovery Plan (LTRP) was drafted to guide the rebuilding and recovery of Lahaina. This LTRP defines recovery as a series of interconnected activities that help the Lahaina community advance its shared post-fire goals. The plan identifies 40 priority projects that are deemed vital to long-term recovery and were elevated by the County, State, and community members. These projects range from immediate, short-term actions to long-term initiatives. The plan is a wildfire recovery plan that includes short- and long-term projects that will reduce the community risk of natural hazard impacts. Several projects listed in the LTRP identify FEMA Hazard Mitigation as a potential funding source; therefore, implementation of the LTRP is listed as a mitigation action in the Mitigation Strategy.	Lahaina Long-Term Recovery Plan, 2024	Maui Office of the Mayor
Transportation Plan	Hele Mai Maui 2045 identifies transportation projects and programs that improve mobility options for people of all ages and abilities. The plan specifically calls out coastal erosion, flood, and wildfire as hazards that could impact the County's transportation infrastructure. The plan contains a prioritized list of projects; therefore, implementation of Hele Mai Maui 2045 is listed as a mitigation action in the Mitigation Strategy.	Hele Mai Maui 2045: Long-Range Transportation Plan, 2025	Maui Metropolitan Planning Organization
Tourism Plan	The Tourism Industry Strategic Plan serves as a guide for developing policy and advocating for the allocation of resources to improve the visitor industry in Maui Nui. Goal 4, Ongoing Action D specifically calls out the need for the visitor industry to collaborate with emergency management to protect the safety of visitors. The plan could be further improved by including action items to develop a disaster response guide for hotels and disaster information handouts for visitors in a variety of foreign languages.	Maui County Tourism Industry Strategic Plan 2017-2026	Mayor's Office of Economic Development
Water Conservation Plan	The Water Shortage and Conservation Plan establishes a framework for timely and effective mitigation actions during water shortages. The plan aims to proactively improve the resilience of water supply systems, target sustainable and efficient use of groundwater and surface water resources, and protect public trust uses. The plan specifically addresses drought and the impact of wildfire on water delivery systems.	Water Shortage and Conservation Plan, 2024	Maui Department of Water Supply
Water Use Plan	The Plan provides an overview of existing water resources, demands, and strategies to extend the water supply on Maui Island. Drought and wildfire are considered throughout the plan and water strategies are presented for each aquifer.	Maui Island Water Use and Development Plan, 2019	Maui Department of Water Supply

Plan Type	Description	Plan Name and Year	Responsible Agency
Water Use Plan	The Plan provides an overview of existing water resources, demands, and strategies to extend the water supply on Lānaʻi Island. Drought and wildfire are identified as threats to the Lānaʻi watershed and mitigation measures are presented in the Plan.	Lānaʻi Island Water Use and Development Plan, 2011	Maui Department of Water Supply
Water Use Plan	The Moloka'i Water Use and Development Plan Update is currently in progress.	Molokaʻi Island Water Use and Development Plan, TBA	Maui Department of Water Supply
Watershed Plan	The Southwest Maui Watershed Management Plan focuses on the 49,688-acre area that includes the Hapapa, Wailea, and Mo'oloa watersheds. While a specific mitigation strategy is not outlined in the plan, it does reference wildfire and flood as threats to the watershed and recommends stakeholder collaboration to prevent natural hazards.	Southwest Maui Watershed Management Plan, 2019	Central Maui Soil and Water Conservation District
Vulnerability Assessment (Climate Change)	As of 2025, Maui County is developing a Countywide Climate Change Vulnerability Assessment, which will build off of existing County departmental vulnerability assessments, the County's multi-hazard mitigation plan, and other community plans and community vulnerability assessments that are complete or are currently underway. This planning effort aims to provide an integrated, high-level climate change vulnerability study that can help guide County policies, projects, and budget priorities to address climate change vulnerabilities.	TBA (In Progress)	Maui County Office of Climate Change, Resiliency, and Sustainability
Vulnerability Assessment (Coastal Threats to Parks)	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. As of 2025, Phase 1 of the project is complete, which assessed the vulnerability of parks to coastal hazards and sea level rise, determined the potential for each beach park to adapt to future conditions, and identified adaptation strategies for each beach park. Phase 2 is currently underway. This phase will develop Readiness Plans for the beach parks identified to have low adaptation potential and develop Adaptation Pathways for Kamaʻole I, II and III, Charley Young, Hoʻokipa, Ukumehame, and Pāpalaua Wayside Park.	TBA (In Progress)	Maui Department of Planning

Plan Type	Description	Plan Name and Year	Responsible Agency
State			
Catastrophic Hurricane Framework	The 2015 Hawai'i Catastrophic Hurricane Plan/FEMA Region 9 Hawai'i Catastrophic Annex is the result of two years of collaborative, whole community planning for a catastrophic hurricane by county and state governments, the Federal Government, nongovernmental organizations, and private sector partners and stakeholders. The Plan/Annex addresses the magnitude of physical effects and operational impacts from a Category 4 hurricane, or one of lesser severity, making landfall anywhere in Hawai'i. The Plan/Annex outlines scalable and coordinated strategies to execute a joint state and federal response to catastrophic damage before, during, and following the event. This is a response plan that does not address mitigation goals or actions.	Hawai'i Catastrophic Hurricane Plan, 2015	Hawai'i Emergency Management Agency
Climate Adaptation / Resilience Plan	The Priority Climate Action Plan (PCAP) outlines seventeen (17) actions across islands and sectors to reduce GHG emissions and achieve climate change goals in a manner that is clean, equitable, and resilient. These priority measures complement Hawai'i's existing climate policies and initiatives that mitigate emissions and were chosen based on their GHG reduction potential, high degree of implementation readiness, cost-effectiveness, and the additional community benefits they provide. One of the actions is dedicated to reducing wildfire risk and increasing community resilience in Maui County through the planting of native trees. This state action aligns with several mitigation actions to reduce wildfire risk outlined in the Mitigation Strategy.	Hawai'i Priority Climate Action Plan, 2024	Hawai'i Climate Change Mitigation and Adaptation Commission
Habitat Conservation / Wildlife Management Plan	The State Wildlife Action Plan details the strategy and plans of the Department of Land and Natural Resources and its partners to address the conservation needs of over 10,000 species native to Hawai'i. This plan was critical to compiling a complete County Profile in Chapter 3 of this HMP. The plan describes the impact of natural hazards on the plants, mammals, birds, fishes, reptiles, and ecosystems of Hawai'i.	Hawai'i State Wildlife Action Plan, 2015	Hawai'i Department of Land and Natural Resources
Forest Management Plan	The Hawai'i Forest Action Plan assesses the conditions of Hawai'i's forests, native species, forest product industry, and forest recreational opportunities. The plan also describes the DLNR's strategy to protect, manage, and sustain these resources for current and future generations. The plan specifically details the threat of wildfire and sea level rise to Hawai'i's forest systems.	Hawai'i Forest Action Plan, 2016	Hawai'i Department of Land and Natural Resources

Plan Type	Description	Plan Name and Year	Responsible Agency
Sea Level Rise Plan	The 2022 update to the Hawai'i Sea Level Rise Vulnerability and Adaptation Report recommends continued implementation of the statewide sea level rise action plan created in 2017. This plan is closely aligned with the coastal erosion chapter of this HMP.	Sea Level Rise Vulnerability and Adaptation Report, 2022	Hawai'i State Climate Commission
Shoreline Management Plan	The Hawai'i Ocean Resources Management Plan brought together a multi-agency group of stakeholders to make recommendations to improve State policies for ocean resources by addressing management gaps. Recommendations address coastal erosion and stormwater management.	Hawai'i Ocean Resources Management Plan, 2020	Coastal Zone Management Hawai'i
Stormwater Management Plan	The Stormwater Management Plan was developed to address the requirements of the Municipal Separate Storm Sewer System National Pollutant Discharge Elimination System Permit and reduce, to the maximum extent practicable, the discharge of pollutants to protect Maui's waters. The plan details stormwater education and awareness programs and new development permit requirements for stormwater discharge. The plan could be further integrated with this HMP by addressing stormwater impacts during natural disasters, such as flood, drought, hurricane, and tsunami. Implementation of the Stormwater Management Plan is listed as a mitigation action in the Mitigation Strategy.	Maui Storm Water Management Program Plan, 2023	Hawai'i Department of Transportation
Threat and Hazard Identification and Risk Assessment (THIRA)	A statewide Threat Hazard Identification and Risk Assessment is maintained by the Hawai'i Emergency Management Agency. The Assessment addresses capability targets for cyber-attacks, domestic terrorism, and hurricanes. The mitigation actions listed in this HMP were assessed to ensure that they would support these capability targets. The THIRA could be improved by considering additional natural hazards that have a major impact on government services, such as wildfires.	Threat Hazard Identification and Risk Assessment, 2021	HI-EMA
Transportation Plan	The Action Plan provides a roadmap for HDOT's Highways Division to make the highway system more resilient to climate-related effects. It presents an exposure assessment of climate hazards to the state's highways based on both historical and future climate condition research and data. Hazards assessed include rockfall and landslides, sea level rise, annual high wave flooding, coastal erosion, storm surge, tsunami, wildfire, and lava flow. Portions of Maui's state highways were found to be at risk from all hazards identified except lava flow.	Hawai'i Highways Climate Adaptation Action Plan, 2021	Hawai'i Department of Transportation

Plan Type	Description	Plan Name and Year	Responsible Agency
Tsunami Response Plan	The Tsunami Emergency Plan is intended to inform affected parties of the policies and procedures that the Division of Boating and Ocean Recreation will follow when a tsunami threatens its harbors and facilities. The Hawai'i Boater's Hurricane and Tsunami Safety Manual helps boaters devise their own emergency plan in the event of a hurricane or tsunami.	Tsunami Emergency Plan, 2013	Hawai'i Department of Land and Natural Resources
Water Resource Protection Plan	The Water Resource Protection Plan seeks to protect and sustain statewide ground and surface water resources, watersheds, and natural stream environments. The plan contains a chapter on drought planning and an action plan to implement short- and long-term mitigation projects. The plan references the State HMP and the four county HMPs.	Water Resource Protection Plan, 2019	State Commission on Water Resource Management
Private/Non-Profit			
Climate Adaptation / Resilience Plan	Sustainable Moloka'i, a nonprofit, is developing an action-oriented document that identifies the key climate change issues and ways to build greater community adaptability, resilience, and capacity on the Island of Moloka'i. The plan is primarily concerned with sea level rise projections and the impact of rising sea levels on Moloka'i. Upon release, the plan may be integrated into County planning documents.	Moloka'i Climate Change and Sea Level Adaptation and Resiliency plan, TBD	Sustainable Moloka'i
Community Wildfire Protection Plan	Five Community Wildfire Protection Plans (CWPPs) have been completed for Maui County since 2014 by the Hawai'i Wildfire Management Organization: Western Maui; Upcountry Maui; South Maui; Moloka'i; and Leeward Haleakalā. CWPPs assist communities in identifying and prioritizing areas for hazardous fuel reduction treatments and support communities in taking action to mitigate wildfire risk. Each CWPP aligns with the mission and goals of this HMP and contains a list of recommended wildfire mitigation actions. Implementing the CWPPs is a mitigation action identified in this HMP's Mitigation Strategy.	Western Maui, 2024; Upcountry Maui, 2024; South Maui, 2024; Moloka'i, 2024; Leeward Haleakalā, 2024	Hawai'i Wildfire Management Organization
Wildfire Safety Strategy	Hawaiian Electric provides electrical power for 95 percent of Hawai'i's residents. The Wildfire Safety Strategy was first developed in 2019 and was recently updated to reduce the risk of wildfires associated with utility infrastructure.	Hawaiian Electric Wildfire Safety Strategy, 2025	Hawaiian Electric

18.2 DEVELOPMENT AND PERMITTING CAPABILITY

The Department of Public Works issues development permits. Permits in the floodplain require approval by the County Floodplain Manager. In 2022, Maui County launched Maui's Automated Planning and Permitting System (MAPPS) for all permits. MAPPS provides an efficient interface for flood development permit application documents and review. The system could be improved by tracking permits in other hazard areas, such as wildfire hazard areas and tsunami inundation areas; improvement of MAPPS is listed as a mitigation action.

18.3 ADMINISTRATIVE AND TECHNICAL CAPABILITIES

Administrative and technical capabilities refer to Maui County's staff, skills, and tools. This section identifies staff, stakeholders, and partners with subject-matter expertise and specialized skills that will support hazard mitigation project implementation.

18.3.1 Federal

Federal Emergency Management Agency

FEMA responsibilities related to hazard mitigation include the following:

- FEMA provides assistance before, during, and after disasters.
- FEMA is the federal reviewer of hazard mitigation plans and sets federal standards for local and state hazard mitigation plans.
- FEMA evaluates NFIP minimum compliance through compliance audits known as Community Assistance Visits (CAVs) or Community Assistance Contacts (CACs). CAVs and CACs are performed to ascertain community compliance with the NFIP, at entry into the CRS, and to maintain participation in the CRS. FEMA may conduct these with its own staff, with Maui County staff under the Compliance Assistance Program – State Support Services Element grant, or with private contractors. CAVs are generally more rigorous than CACs. FEMA evaluates the following key areas in a compliance audit:
  - The Community's Flood Damage Prevention Ordinance
  - Mapping Products and other Ordinances used to regulate floodplain development
  - Floodplain Development Permitting Procedures
  - Floodplain Permit Applications and other Forms/Records, including Substantial Damage and Improvement Determinations
  - Floodplain Development Review and Performance Standards
  - Floodplain Development Permits Issued to Applicants

Federal Energy Regulatory Commission Dam Safety Program

The Federal Energy Regulatory Commission (FERC) has the largest dam safety program in the United States, cooperating with many federal and state agencies to ensure and promote dam safety and, more recently, homeland security, on dams associated with hydropower. Every five years, an independent consulting engineer approved by the FERC must inspect and evaluate projects with dams higher than 33 feet (10 meters) or with a total storage capacity of more than 2,000 acre-feet.

HURREVAC

HURREVAC is the decision support tool of the National Hurricane Program, administered by FEMA, USACE, and the NOAA National Hurricane Center used for tracking hurricanes (HURREVAC n.d.). HURREVAC permits governmental agencies to work as a unified team and coordinate notification, communication, activations, public warning, and evacuation and sheltering efforts.

National Weather Service

The NWS monitors weather and delivers weather forecasting for Hawai'i. The state is serviced by one weather forecast office in Honolulu. HI-EMA uses conference calling with the NWS and county emergency management agencies to share specific information and needs when severe weather is forecast. The NWS also offers education and training on weather-related hazards (NWS 2023).

StormReady Program

The NWS StormReady program provides guidelines to emergency managers on how to improve local hazardous weather operations. To be recognized by the program, a community must establish a 24-hour warning point and emergency operations center; have more than one way to receive severe weather warnings and forecasts and to alert the public; create a system that monitors weather conditions locally; promote the importance of public readiness through community seminars; and develop a formal hazardous weather plan that includes training severe weather spotters and holding emergency exercises. Maui County is a StormReady community.

TsunamiReady Program

TsunamiReady is a voluntary community recognition program designed to enhance tsunami hazard preparedness through collaboration among federal, state, and local emergency management agencies, community leaders, and the public. The program's primary goal is to improve public safety before, during, and after tsunami emergencies. It achieves this by establishing guidelines for a standard level of capability to mitigate, prepare for, and respond to tsunamis, and by working with communities to help them meet these guidelines. Once the guidelines are met, communities can be recognized as TsunamiReady by NWS. Maui County is a TsunamiReady community.

U.S. Army Corps of Engineers

USACE has numerous initiatives to support hazard mitigation measures, including the Silver Jackets, planning assistance, and inspections and repair of flood control structures. USACE also maintains the National Inventory of Dams and the National Levee Database.

The USACE Honolulu District, established in 1905, holds the largest geographic responsibility within the Corps of Engineers. It includes Hawai'i, the territories of Guam and American Samoa, the Commonwealth of the Northern Mariana Islands (CNMI), and the Freely Associated States, which comprise the Republic of Palau, the Federated States of Micronesia, and the Republic of the Marshall Islands. The Honolulu District's seven primary missions are Military Construction, Civil Works, Interagency and International Services, Real Estate, Regulatory, Environmental Services, and Emergency Management. The District is equipped to provide a wide range of solutions to meet the engineering, construction, and environmental needs of its customers. Services offered include project management, design, construction management, contracting, and cost engineering (USACE n.d.).

18.3.2 State

State of Hawai‘i Emergency Management Agency

HI-EMA is responsible for planning and responding to both natural and human-caused emergencies, including tsunamis, wildfires, hurricanes, and incidents involving hazardous materials or nuclear power. The agency develops and implements a statewide Comprehensive Emergency Management Plan and regularly conducts extensive exercises to test state and county emergency response capabilities.

HI-EMA serves as the coordinating agency for all types of emergencies between federal and local agencies, including the four county emergency management agencies—Hawai‘i County Civil Defense, Maui Emergency Management Agency, City and County of Honolulu Department of Emergency Management, and Kaua‘i Emergency Management Agency.

Following an incident, HI-EMA conducts damage assessment surveys and advises the governor on emergency declarations and the pursuit of federal relief funds. The agency operates a primary Emergency Operations Center (EOC) in Diamond Head Crater, Honolulu, and runs the State Warning Point, a state emergency communications center staffed 24/7, maintaining statewide communications with county emergency officials and other partners.

State of Hawai‘i Department of Land and Natural Resources

The Department of Land and Natural Resources, overseen by an executive Board of Land and Natural Resources, is tasked with managing, administering, and controlling public lands, water resources, ocean waters, navigable streams, coastal areas (excluding commercial harbors), minerals, and associated interests. The department’s jurisdiction includes state parks, historical sites, forests and forest reserves, aquatic life and sanctuaries, public fishing areas, boating and ocean recreation programs, wildlife and sanctuaries, game management areas, public hunting areas, and natural area reserves.

State of Hawai‘i Department of Health

The State of Hawai‘i’s Department of Health is involved in identifying and addressing health risks associated with natural disasters, such as hurricanes, tsunamis, and volcanic eruptions. It collaborates with local, state, and federal agencies to develop and implement strategies that enhance community resilience and reduce vulnerability to health hazards. Key capabilities include disease surveillance, emergency preparedness and response, public health education, and the promotion of environmental health standards.

Pacific Disaster Center

The Pacific Disaster Center is a University of Hawai’i applied science and research center whose work intersects with government, community, academic, and scientific organizations to build resilience to natural and man-made hazards, assess risk, and enhance the capacity to prepare for new and emerging threats. Following the 2023 Lahaina Wildfires, the Center supported Maui County with humanitarian and disaster response operations; resource allocation; logistics; and public awareness.

Pacific Disaster Center supported this HMP update by attending HMWG meetings and by meeting directly with the HMP Planning Team to discuss capabilities.

Hawai‘i Wildfire Management Organization

The Hawai‘i Wildfire Management Organization serves as a hub of wildfire prevention, mitigation, and planning activities in the Hawai‘i-Pacific region. HWMO works collaboratively with residents and workers in fire-prone areas to reduce wildfires and enhance protection measures. As the authors of the Community Wildfire Protection Plans across the state and the leader in wildfire impact data, HWMO is a critical partner and subject-matter expert for wildfire mitigation in Maui County.

University of Hawaii – Sea Grant

The NOAA-funded Sea Grant program enables two Maui-based extension agents with expertise in coastal hazards to co-locate with the Maui Department of Planning. This long partnership results in a streamlined approach to coastal hazards that incorporates both scientific and planning expertise.

18.3.3 County

Maui Emergency Management Agency

MEMA provides education, prevention, technical support, inter-agency coordination, and direct services to individuals, the public, and private businesses in Maui County. Specialized positions within MEMA are dedicated to hazard mitigation and the implementation of this HMP. MEMA led the update of this HMP and was also an active participant in the HMWG.

Maui Department of Planning

The Maui Department of Planning offers technical advice to the Mayor, County Council, and commissions. The Department has a partnership with the University of Hawai‘i that allows a coastal hazards specialist to be embedded in the agency and support coastal resilience projects. This collaboration amplifies the county’s capacity to mitigate the impacts of coastal erosion. The Department was actively involved in development of this HMP, attended all meetings for the HMP, participated in stakeholder coordination, and reviewed draft sections of the plan.

Maui Department of Public Works

The Maui Department of Public Works employs a full-time floodplain manager whose primary responsibility is to maintain the County’s eligibility for the NFIP and the CRS. The Department also ensures that structures comply with hurricane safety requirements and fire code requirements for land management, firebreaks, and other preventative measures.

County Boards and Commissions

The boards and commissions listed in Table 18-3 assist and advise departments and special groups within the County of Maui.

Table 18-3. Maui County Boards and Commissions

Board/Commission	Responsibilities
Maui Planning Commission	Concerned with the area encompassing the Island of Maui and the adjacent waters. Advises the Mayor, County Council, and Planning Director in matters concerning planning programs.
Hāna Advisory Committee to Maui Planning Commission	Advises the Maui Planning Commission on matters related to East Maui (Kailua to Kaupo) and carries out duties delegated to it by the Maui Planning Commission.
Lānaʻi Planning Commission	Concerned with all planning matters involving the Island of Lānaʻi. Advises the Mayor, County Council, and Planning Director in matters concerning planning programs.
Molokaʻi Planning Commission	Concerned with the area encompassing the Island of Molokaʻi, except that portion of the area known as the Kalaupāpā Settlement. Advises the Mayor, County Council, and Planning Director in matters concerning planning programs.
Pāʻia-Haʻikū Advisory Committee to the Maui Planning Commission	This committee advises the Maui Planning Commission on matters related to Pāʻia-Haʻikū and carries out duties delegated to it by the Maui Planning Commission.
South Maui Advisory Committee to the Maui Planning Commission	This committee advises the Maui Planning Commission on matters related to South Maui and carries out duties delegated to it by the Maui Planning Commission.
Board of Variances and Appeals	Hears and determines applications for variances from the strict application of any general plan, zoning, subdivision, or building ordinances. Holds public hearing prior to ruling on a variance application and issues findings of fact and conclusions of law on decisions granting or denying variance applications.
Maui Redevelopment Agency	Reviews applications for new development and renovation projects in the Wailuku Redevelopment Area authorized by Section 53-5 of the Hawaiʻi Revised Statutes pertaining to the Urban Renewal Law.
Urban Design Review Board	Rules of Practice and Procedure for the Maui County Urban Design Review Board. Advises the appropriate Planning Commission on matters within the jurisdiction of the various Planning Commissions and carries out duties as delegated to it by the Planning Commissions. Reviews and advises the Planning Department on design-related matters involving projects within the County.
Fire & Public Safety Commission	Reviews the operations of the Department of Fire and Public Safety and the Civil Defense Agency. Makes recommendations for changes that may be desirable to improve the performance of emergency functions and the provision of public safety services.
Environmental, Agricultural, and Cultural Preservation	The Environmental, Agricultural, and Cultural Preservation Committee meetings are held in the Council Chamber at 1:30 p.m. on the Tuesday prior to the first and third Fridays of each month; however, the schedule is subject to change. The Committee may also periodically schedule site inspections.
Maui County Arborist Committee	The scope of the committee shall include recommendations for a landscape planting plan in public areas throughout the county, shall be a reviewing body for any landscape planting in public parks and street beautification programs, and shall recommend exceptional trees to be protected and provide appropriate protective ordinances.

Board/Commission	Responsibilities
Maui County Cultural Resources Commission	Works for the preservation of the County's historic and cultural resources through the following functions: advising and assisting federal, state, and county agencies in carrying out their historic preservation responsibilities; administering the provisions of the County's historic districts and advise the Mayor, Council and County Planning Commissions on the establishment of historic districts and their regulation; and providing public information, education, training and technical assistance on national, state and county historic preservation programs.
Maui Economic Development Board	The Maui Economic Development Board believes that economic growth is about more than just creating jobs: it is also about safeguarding the natural environment, honoring Native Hawaiian values and diversity of cultures, and promoting economic equity, where everyone gets an opportunity to benefit.
Workforce Development Board	The Maui Workforce Development Board's vision is to have a globally competitive and skilled workforce, which promotes and nurtures a diverse and prosperous economy and preserves the special quality of life in the County of Maui. The County's Office of Economic Development (OED) has been designated as the grant recipient for WIA funds and is responsible for monitoring and oversight of the implementation of the WIA programs with guidance from the Board. OED also serves as the liaison between the Mayor and the Board on matters concerning WIA. The Coordinator for OED represents the Mayor on the state's Workforce Development Council (WDC).
Wildfire Economic Recovery Commission	Launched in January 2024, the ERC brings together influential stakeholders from various sectors to collaborate, innovate, and uplift Maui after the challenges posed by the 2023 fires. The ERC has now evolved into a Maui-led group and its implementation phase.
Commission on Children and Youth	Advises and assists the Mayor in all matters concerning children & youth, including child care. Also makes recommendations to the County Council on all matters relating to children and youth and children and youth programs proposed for adoption by the County Council.
Commission on Healing Solutions for Homelessness	The commission is established to protect and promote public health, safety, and welfare of residents and maintain the commitment of aloha 'aina. As an advisory group, the commission will provide recommendations to the council and the administration on funding and policies to help combat and eliminate homelessness and poverty in Maui County.
Commission on Persons with Disabilities	The Commission on Persons with Disabilities assists the County in rendering services to persons with disabilities.
Council on Aging	Meets at least every other month for the purpose of advising the County Executive Office on Aging on needs of older persons, plans for helping older persons, programs that service older persons, and legislation and issues affecting older persons.
Board of Water Supply	Powers, Duties and Functions The Board of Water Supply shall be: 1. Review and submit to the Mayor the Department of Water Supply's request for an annual appropriation for operations and capital improvements. 2. Recommend the establishment and adjustment of rates and charges for furnishing water; such rates and charges shall be submitted to the Mayor for review and approval.
East Maui Regional Community Board (Water Authority)	The East Maui Regional Community Board water authority is concerned with the Nāhiku, Ke'anae, Honomanū, and Huelo license areas and shall, investigate, acquire, manage, and control water collection and delivery systems with staff that consists of a regional director, grant writers, community liaisons, and water system technical analysts.

Board/Commission	Responsibilities
Public Works Commission	Advises, assists, and makes recommendations to the Mayor, the Maui County Council, and the Director of Public Works on matters regarding traffic safety, the naming of streets, parks and facilities, subdivision engineering standards and specifications, and outdoor lighting.
Solid Waste Resource and Advisory Committee	The Solid Waste Resource Advisory Committee's duties involve: Reviewing current operations and data to make specific recommendations for increasing efficiencies, diverting more tons, and limiting landfill risk. Building consensus among SWAC, staff, Maui policymakers, and State regulators to pursue one of a number of options that provide a healthy environment and service to the ratepayer. Drafting a practical plan that is a blueprint for implementation.
Wastewater Community Working Group	The Maui Wastewater Community Working Group (CWG) is working to provide enlightened, community-based recommendations to the County of Maui's Department of Environmental Management and Division of Wastewater Reclamation. These recommendations will assist the County in making significant strides toward achieving Mayor Charmaine Tavares' goal of 100 percent recycling of Maui's wastewater.

Summary of Specific Capabilities

Administrative and technical capabilities include those associated with Maui County's existing staff and personnel resources and their skills and tools that can be used for mitigation planning and to implement specific mitigation actions. It also refers to the ability of Maui County to access and coordinate these resources effectively. Table 18-4 provides a listing and summary of these relevant capabilities.

Table 18-4. Administrative and Technical Capability

Staff/Personnel Resources	Department/Agency
Hazard mitigation specialists	MEMA Hazard Mitigation Specialists; American Red Cross; Hawai'i Wildfire Management Organization; DLNR – Maui Dam Specialist; DLNR – Maui Stormwater Specialist
Hazard mitigation planning committee	2025 HMP Update HMWG
Planners or engineers with knowledge of land development and land management practices	Maui County Planning Department; Maui County Department of Public Works; Hawai'i Wildfire Management Organization;
Engineers or professionals trained in building or infrastructure construction practices	Maui County Department of Public Works; Maui Metropolitan Planning Organization; Department of Parks and Recreation
Planners or engineers with an understanding of natural hazards	Maui County Planning Department; Maui County Department of Public Works; Sustainable Moloka'i; Hawai'i Wildfire Management Organization
Staff with training in benefit/cost analysis	MEMA
Surveyors	Engineering Division, Maui County Department of Public Works
Personnel skilled or trained in GIS applications	Maui County GIS Program – Geographic Analysis and Cartographic Services
Scientists familiar with natural hazards in local area	Pacific Disaster Center; UH Manoa; Hawai'i Volcano Observatory

Staff/Personnel Resources	Department/Agency
Emergency manager	Maui County Emergency Management Agency; Pacific Disaster Center; Hawai'i Healthcare Emergency Management
Floodplain manager	Maui County Department of Public Works
Grant writers and/or resource development specialists	MEMA

18.4 FISCAL CAPABILITIES

Fiscal capabilities are the resources that may be used to fund mitigation actions. This may include property, sales, income, or special purpose taxes; general funds; utility service fees; impact fees from new development and redevelopment; general obligation or special purpose bonds; federal or state funding programs; or private, nonprofit, or philanthropic grants or loans. This section summarizes fiscal capabilities in Maui County. In addition, the 2023 Hawai'i State Hazard Mitigation Plan features a section on mitigation-related funding administered by state and federal agencies.

18.4.1 Federal

Hazard Mitigation Funding Opportunities

Table 18-5 provides an overview of funding eligibility and cost share for FEMA programs that provide funding for mitigation planning and projects to reduce disaster losses.

Table 18-5. FEMA Hazard Mitigation Assistance Grant Cost Share Requirements

Programs	Cost Share (% of Federal / Non-Federal Share)
Hazard Mitigation Grant Program (HMGP)	75 / 25[a]
HMGP Post Fire	75 / 25
Flood Mitigation Assistance (FMA) (community flood mitigation, project scoping, individual mitigation of insured properties, and planning grants)	75 / 25
FMA—repetitive loss property[b]	90 / 10
FMA—severe repetitive loss property[b]	100 / 0
Building Resilient Infrastructure & Communities (BRIC) Program	75 / 25
BRIC—small and impoverished community	Up to 90 / 10

Source: FEMA 2023; FEMA 2023

a. *Subapplicants should consult their State Hazard Mitigation Officer (SHMO) for the amount of percentage of HMGP subrecipient management cost funding their State has determined to be passed through subrecipients.*

b. *To be eligible for an increased federal cost share, a FEMA-approved state or tribal (standard or enhanced) mitigation plan that addressed repetitive loss properties must be in effect at the time of award, and the property being submitted for consideration must be a repetitive loss property.*

The Hazard Mitigation Grant Program (HMGP) assists in implementing long-term hazard mitigation planning and projects following a Presidential major disaster declaration. Flood Mitigation Assistance (FMA) provides funds for planning and projects to reduce or eliminate the risk of flood damage to buildings that are insured under the NFIP. The Building Resilient Infrastructure & Communities (BRIC) Program supports communities in hazard mitigation projects, reducing the risks they face from disasters and natural hazards.

Federal mitigation grant funding is available to all communities with a current hazard mitigation plan. Most of these grants require a "local share" in the range of 10 to 25 percent of the total grant amount. The FEMA mitigation grant programs are described below.

Hazard Mitigation Grant Program

The HMGP is a post-disaster mitigation program. It is made available to states by FEMA after each Federal disaster declaration. The HMGP can provide up to 75 percent funding for hazard mitigation measures. The HMGP can be used to fund cost-effective projects that will protect public or private property in an area covered by a federal disaster declaration or that will reduce the likely damage from future disasters. Examples of projects include acquisition and demolition of structures in hazard-prone areas, flood-proofing or elevation to reduce future damage, minor structural improvements, and development of state or local standards. Projects must fit into an overall mitigation strategy for the area identified as part of a local planning effort. All applicants must have a FEMA-approved hazard mitigation plan.

Applicants who are eligible for the HMGP are state and local governments, certain nonprofit organizations or institutions that perform essential government services, and Indian tribes and authorized tribal organizations. Individuals or homeowners cannot apply directly for the HMGP; a local government must apply on their behalf. Applications are submitted to HI-EMA and placed in rank order for available funding and submitted to FEMA for final approval. Eligible projects not selected for funding are placed in an inactive status and may be considered as additional HMGP funding becomes available.

Flood Mitigation Assistance Program

The FMA program combines the previous Repetitive Flood Claims and Severe Repetitive Loss Grants into one grant program. The FMA provides funding to assist states and communities in implementing measures to reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insurable under the NFIP. The FMA is funded annually; no federal disaster declaration is required. Only NFIP-insured homes and businesses are eligible for mitigation in this program. Funding for FMA is very limited and, as with the HMGP, individuals cannot apply directly for the program. Applications must come from local governments or other eligible organizations. The federal cost share for an FMA project is at least 75 percent. At most, 25 percent of the total eligible costs must be provided by a non-federal source. Of this 25 percent, no more than half can be provided as in-kind contributions from third parties. At a minimum, a FEMA-approved local flood mitigation plan is required before a project can be approved. The FMA funds are distributed from FEMA to the state. HI-EMA serves as the grantee and program administrator for the FMA program.

Building Resilient Infrastructure and Communities Program

BRIC supports states, local communities, tribes, and territories as they undertake hazard mitigation projects, reducing the risks they face from disasters and natural hazards. BRIC replaced the Pre-Disaster Mitigation program in 2020. The program can provide up to 90 percent funding for hazard mitigation measures.

Extraordinary Circumstances

For HMGP, BRIC, and FMA, funding may be provided to a jurisdiction without a currently eligible hazard mitigation plan if it is determined that extraordinary circumstances exist. Extraordinary circumstances exist when a determination is made by the applicant and FEMA that the proposed project is consistent with the priorities and strategies identified in the state hazard mitigation plan and that the jurisdiction applying for funding meets at least one of the following criteria:

- The jurisdiction meets the small, impoverished community criteria.
- The jurisdiction has been determined to have had insufficient capacity due to a lack of available funding, staffing, or other necessary expertise to satisfy the mitigation planning requirement prior to the current disaster or application deadline.
- The jurisdiction has been determined to have been at low risk from hazards because of the low frequency of occurrence or minimal damage from previous occurrences as a result of sparse development.
- The jurisdiction experienced significant disruption from a declared disaster or another event that impacts its ability to complete the mitigation planning process prior to award or final approval of a project award.
- The jurisdiction does not have a mitigation plan for reasons beyond its control, such as Disaster Relief Fund restrictions that delay FEMA from granting a subaward prior to the expiration of the hazard mitigation plan.

For HMGP, BRIC, and FMA, the Applicant must provide written justification that identifies the specific criteria or circumstance listed above, explains why there is no longer an impediment to satisfying the mitigation planning requirement and identifies the specific actions or circumstances that eliminated the deficiency. If the jurisdiction does not meet at least one of the criteria, the Region must coordinate with FEMA Headquarters for HMGP. For BRIC and FMA, the Region must coordinate and seek concurrence before granting an exception.

When HMGP project funding is awarded under extraordinary circumstances, the recipient must acknowledge in writing that a plan will be completed within 12 months of the subaward and provide a work plan for completing the plan, including milestones and a timetable. This requirement will be incorporated into the award (both the planning and project subaward agreements if a planning subaward is also awarded).

For BRIC and FMA project subawards, the FEMA Region may apply extraordinary circumstances when justification is provided and with concurrence from FEMA Headquarters prior to granting an exception.

If this exception is granted, a local mitigation plan must be approved by FEMA within 12 months of the award of the project subaward to that community.

Rehabilitation of High Hazard Potential Dams Program

The Rehabilitation of High Hazard Potential Dams (HHPD) grant program provides technical, planning, design, and construction assistance for eligible rehabilitation activities that reduce dam risk and increase community preparedness. A state with a dam safety program authorized by state legislation is the only entity eligible to submit an HHPD Grant Program application to FEMA. In Hawai'i, DLNR serves as the state dam safety program and there is a staff engineer dedicated to supporting dams in Maui County. The HHPD Grant Program assists with technical, planning, design, and construction activities toward repair, removal, or rehabilitation of eligible high hazard potential dams

Disaster and Recovery Assistance Programs

Following a disaster, various types of assistance may be made available through federal agencies. The types and levels of disaster assistance depend on the severity of the damage and the declarations that result from the disaster event. The following sections describe general types of assistance that may be provided should the President of the United States declare an event to be a major disaster.

Individual Assistance

Individual Assistance (IA) provides help for homeowners, renters, businesses, and some nonprofit entities after disasters occur. This program is largely funded by the U.S. Small Business Administration.

For homeowners and renters, those who suffered uninsured or underinsured losses may be eligible for a Home Disaster Loan to repair or replace damaged real estate or personal property (such as clothing, furniture, cars, and appliances). Renters are eligible for loans up to $40,000 to cover personal property losses. Homeowners may borrow up to $200,000 to repair or replace real estate, $40,000 to cover losses to personal property, and an additional 20 percent for mitigation.

For businesses, loans may be made to repair or replace disaster-damaged property owned by the business, including real estate, machinery and equipment, inventory, and supplies. Physical disaster loans of up to $2 million are available to qualified businesses or most private nonprofit organizations such as charities, churches, or private universities. Businesses of any size are eligible.

An Economic Injury Disaster Loan provides necessary working capital until normal operations resume after a physical disaster. These loans are restricted, by law, to small businesses only.

Public Assistance

Public Assistance (PA) provides cost reimbursement aid to local governments (state and county authorities and school districts) and certain nonprofit agencies that were involved in disaster response and recovery programs or that suffered loss or damage to facilities or property used to deliver government-like services. This program is largely funded by FEMA with both local and state matching contributions required.

Department of Homeland Security Grant Program

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. The program supports efforts to build and sustain core capabilities across the prevention, protection, mitigation, response, and recovery mission areas. This includes two priorities: building and sustaining law enforcement terrorism prevention capabilities and maturation and enhancement of state and major urban area fusion centers. HSGP is composed of three interconnected grant programs: the State Homeland Security Program, Urban Areas Security Initiative, and Operation Stonegarden. Together, these grant programs fund a range of preparedness activities, including planning, organization, equipment purchase, training, exercises, and management and administration.

Community Development Block Grants

Community Development Block Grants are federal funds to provide low and moderate-income households with viable communities, including decent housing, a suitable living environment, and expanded economic opportunities. Eligible activities include community facilities and improvements, roads and infrastructure, housing rehabilitation and preservation, development activities, public services, economic development, planning, and administration.

Public improvements may include flood and drainage improvements. In limited instances, and during times of "urgent need" (e.g., post-disaster) as defined by the program, funding may be used to acquire a property located in a floodplain that was severely damaged by a recent flood, demolish a structure severely damaged by an earthquake, or repair a public facility severely damaged by a hazard event.

U.S. Economic Development Administration

The U.S. Economic Development Administration supports regional economic development in communities around the country. It provides funding to support comprehensive planning and makes strategic investments that foster employment creation and attract private investment in economically distressed areas of the United States.

The agency's Public Works Program invests in key public infrastructure, such as in traditional public works projects, including water and sewer systems improvements, expansion of port and harbor facilities, brownfields, multitenant manufacturing and other facilities, business and industrial parks, business incubator facilities, redevelopment technology-based facilities, telecommunications, and development facilities.

The agency's Economic Adjustment Program administers its Revolving Loan Fund Program, which supplies small businesses and entrepreneurs with the gap financing needed to start or expand their business, in areas that have experienced or are under threat of serious structural damage to the underlying economic base.

Federal Highway Administration Emergency Relief

Federal Highway Administration Emergency Relief (FHWA-ER) is a grant program that may be used for repair or reconstruction of Federal-aid highways and roads on Federal lands that have suffered serious damage as a result of a disaster. The Hawai'i Department of Transportation serves as the liaison between local governments and FHWA.

Federal Transit Administration Emergency Relief

Federal Transit Administration Emergency Relief (FTA-E) is a grant program that funds capital projects to protect, repair, reconstruct, or replace equipment and facilities of public transportation systems. Administered by the Federal Transit Authority at the U.S. Department of Transportation and directly allocated to metropolitan transit authorities and port authorities, this transportation-specific fund was created as an alternative to FEMA PA.

18.4.2 State

The State of Hawai'i provides funding to support a variety of mitigation activities, including earmarking funds for its own hazard mitigation projects, providing grant monies to 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 sections below present some of the state funding sources as described in the State of Hawai'i 2023 Hazard Mitigation Plan.

Department of Accounting and General Services Public Works Division

Land Acquisition Program

The Public Works Division plans, coordinates, organizes, directs, and controls a variety of engineering and architectural services 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.

Shelter Upgrade Program

The Public Works Division 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.

Department of Budget and Finance

Capital Improvement Budgets

The Department of Budget and Finance reviews and prioritizes project proposals from state and county agencies to ensure conformity with statewide planning goals and objectives and executive priorities. The department then provides an estimate of the operational costs for each proposed capital improvement project to the governor for consideration for inclusion in the executive capital improvement project budget. The department also 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.

Department of Health

Department of Health All-Hazards Training and Exercise Program

The Department of Health facilitates training and exercises to ensure its ability to respond to and support recovery from public health emergencies

Hospital Preparedness Program

The Department of Health supports the continuity of healthcare system operations during emergencies that exceed the day-to-day capacity of health and emergency response systems. The department's regional healthcare coalition incentivizes healthcare organizations to work together to maintain statewide healthcare services.

Department of Land and Natural Resources

Fire Management Program

DLNR's Division of Forestry and Wildlife (DOFAW) is responsible for the prevention, control, and extinguishment of wildfires on DOFAW-managed lands, which account for 26 percent of the land statewide. DOFAW cooperates for these purposes with county fire departments and federal agencies to an additional 32 percent of land in the state, as 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 the state liaison to the Firewise USA program, which encourages residents to work with neighbors to reduce home ignition potential and increase home survivability.

Legacy Lands Conservation Program

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 grant process. Grants are used 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.

Watershed Partnership Program

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. These funds come from a portion of the conveyance tax on real estate sales. The mission of the program is to increase the management and protection of mauka watershed areas. Watershed protection measures relevant to mitigation goals include recharging water supplies, controlling erosion and runoff, mitigating flooding, and mitigating the impacts of climate change.

Natural Area Partnership Program

The Natural Area Partnership Program was established 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 subzone of the Conservation District.

Natural Area Reserves System

The Natural Area Reserves System was established to preserve land and water areas that support communities of natural flora and fauna, as well as geological sites. The system consists of 21 reserves on five islands, encompassing 123,810 acres. The Strategic Plan for Hawai'i's Natural Area Reserves System (2008) includes objectives and sub-objectives that support mitigation goals.

Hawai'i Emergency Management Agency

Western States Seismic Policy Council

Hawai'i is a member of the Western States Seismic Policy Council (WSSPC), which develops seismic policies and shares information to promote programs to reduce earthquake-related losses. WSSPC also hosts a tsunami center and supports mitigation initiatives in the state, including printing 3,000 copies of the Natural Hazards Preparedness Wheel and general outreach initiatives.

Hawai'i Hazards Awareness and Resilience Program

The aim of the Hawai'i Hazards Awareness and Resilience Program (HHARP) is to help communities prepare to be self-reliant during and after natural hazard events and reduce the negative impacts of disasters. HHARP can enhance community resilience through education and outreach that build understanding of hazard mitigation, preparedness, response, and recovery. State and county emergency management agencies have partnered to administer HHARP.

Hawai'i State Legislature

The Hawai'i State Legislature may award state funds as grants to support the activities that may include hazard mitigation. Such grants are disbursed by a contract between a state agency and the grant recipient. In 2016, the Hawai'i State Legislature appropriated $158,000 to the Hawai'i Wildfire Management Organization (HWMO) to support wildfire prevention and hazardous fuel reduction measures, including the following:

- Create all-agency unified wildfire prevention messaging, related materials, and a public awareness campaign to maximize public protection and preparedness
- Develop cross-boundary fuel reduction priorities, maps, and projects for all four counties in the state.

18.4.3 County

Financial capabilities refer to the fiscal resources that Maui County has access to or is eligible to use to fund hazard mitigation actions, including but not limited to capital projects. The County is able to fund mitigation projects through existing local budgets, local appropriations, and federal and state funding programs. Many agencies noted during the planning process for this HMP that they are faced with increasing fiscal constraints, including decreasing revenues, budget constraints, and tax caps. In an effort to overcome these challenges, agencies have continued to leverage the sharing of resources and combining available funding with grants and other sources. They note that plans and inter-jurisdictional cooperation are beneficial in obtaining grants. Table 18-6 provides a listing and summary of these relevant capabilities.

Table 18-6. Fiscal Capabilities

Financial resources	Accessible/ Eligible to Use	Comments
General Fund	Yes	The general fund accounts for all financial resources except those required to be accounted for in another fund. General funds are used to provide the most basic of county services: police, fire, parks, culture, economic development, and general government.
Special Revenue Funds	Yes	Maui County's Special Revenue Funds were established to account for the proceeds of specific revenue sources that are legally restricted or committed to expenditure for specified purposes. They include the Highway Fund, Sewer Fund, Grant Revenue Fund, Bikeway Fund, and Solid Waste Fund.
Capital Improvement Project Funds	Yes	This fund accounts for the financial resources to be used for the acquisition or construction of major capital facilities and other public infrastructure, including government buildings, roads, sewer systems, parks, drainage systems, and more. There are many factors that determine how a capital project is funded and administered each fiscal year, but they are all outlined in the County's six-year Capital Improvement Program (CIP) plan.
Enterprise Funds	Yes	Revenue from these funds is generally limited to expenses for the operation, maintenance, and capital improvement projects of the Department of Water Supply.
Agency Funds	Yes	These funds are used to account for other monies collected in an agency capacity and include motor vehicle registration fees collected on behalf of the State of Hawai'i and taxes withheld from employee pay.
Debt Service Funds	No	The Debt Service Fund accounts for the accumulation of resources necessary to pay principal and interest payments on general long-term debt obligations and is shown in the county's financial statements.
Emergency Fund	Yes	The Emergency Fund was established for the purpose of building fund balances that allow the County to recover funds more quickly or more effectively in the event of a disaster or emergency.
Incur Debt through Private Activity Bonds	No	Debt financing can include general obligation bonds, revenue bonds, lease/purchase agreements, special obligation bonds, or any other financing instrument allowed under Hawai'i Statutes. Maui County's Debt Policy confines long-term borrowing to capital assets or equipment that cannot be financed from current financial resources. Debt is only to be incurred when necessary and utilizes pay-as-you-go financing to the extent possible.

Financial resources	Accessible/ Eligible to Use	Comments
Development Impact Fees for Homebuyers or Developers	Yes	Impact fees are generally designed to mitigate the impact of new development on infrastructure and public facility systems. Impact fees are one-time payments made by the development, though fees are typically passed on to either the seller of land or homebuyers to pay for the cost of infrastructure caused by new development.
Special Taxing Districts	Yes	Special Taxing Districts can be established to help fund regional infrastructure projects. The purpose of these districts is to create a predictable revenue stream that can pay for all or a portion of the debt service associated with large capital projects.
Federal, State, and Other Non-County Sponsored Grant Programs	Yes	The County is eligible and continues to leverage a variety of Federal and State grant funding sources to support the implementation of hazard mitigation actions. This includes but is not limited to FEMA's Hazard Mitigation Assistance (HMA) and similar programs administered by the state.

18.5 EDUCATION AND OUTREACH CAPABILITIES

Education and outreach capabilities refer to the methods that Maui County can use to implement hazard mitigation activities and communicate hazard-related information. They include the following:

- Local citizen groups or non-profit organizations focused on environmental protection, emergency preparedness, access and functional needs populations, etc.:
  - Maui County's Citizen Corps Council drives local citizen participation by coordinating programs, developing community action plans, assessing possible threats, and identifying local resources.
  - The County's Community Emergency Response Team (CERT) program educates people about disaster preparedness for hazards that may impact their area and trains them in basic disaster response skills, such as fire safety, light search and rescue, team organization, and disaster medical operations.
  - The Maui Community Organizations Active in Disaster (COAD) is a collection of nonprofit organizations that support disaster survivors after a natural disaster.
  - Maui residences are often organized into community or condominium associations that can disseminate disaster and mitigation information.
  - Malama Kula fosters community, provides service and support, safeguards residents from natural disasters, and empowers, educates, informs, and nurtures the town and residents of Kula. They provide community services including disaster relief, fire detection cameras, infrastructure advocacy, and air, soil, and human health testing.
  - The Kula Community Watershed Alliance (KCWA) is a land restoration initiative led by many of the fire survivors living in the burned areas of the August 2023 wildfire that devastated Kula. With the guidance of a team of experienced advisors, neighbors joined together to support recovery from the fires and establish a safer, more resilient landscape in the area.
    - The Kula Fire Restoration Project is committed to regenerating disturbed soil, restoring and protecting native flora and fauna, and stewarding the long-term vitality of the land.

The project looks beyond the bounds of the burn scar to the greater surrounding community to support the watershed health of the entire Kula moku (district).

- The Kula Fuels Reduction Project supports people residing at the wildland-urban interface who want to convert dry forested lands populated by invasive trees to native tree canopies that shade out invasive species, naturally increase humidity, and hold water. KCWA raised enough funding to help all 71 fire-impacted landowners in the Kula Fire burn area, focusing on native restoration of formerly forested areas.

- Ongoing public education or information programs:
  - The "Maui Ready" website helps residents and visitors in Maui County learn how to be prepared for and stay safe from natural disasters and health hazards.
  - MEMA sponsors public education and outreach programs and maintains a Disaster Preparedness Guide to inform the public about how to prepare for a disaster and cope with the aftermath.
  - The Department of Public Works Flood Information website provides detailed information about flood risk and risk reduction measures.
- Natural disaster or safety-related school programs:
  - The County has been working with school complexes to develop a hazard awareness component for middle and high school curriculums.
- Public-private partnership initiatives addressing disaster-related issues:
  - The Maui Voluntary Organizations Active in Disaster (VOAD) consists of nonprofits, faith-based groups, and community organizations, as well as government and private sector partners that voluntarily provide disaster-related services throughout the county. Members attend monthly meetings.
  - The Pacific Disaster Center (PDC) in Kīhei is an applied science, information, and technology center, working to reduce disaster risks and impacts on life, property, and economies. Although PDC serves a global audience, it is headquartered in Maui County and serves as a unique resource to increase local disaster management capacity.
  - The Hawai'i Search and Rescue Conference is the only platform in Hawai'i for sharing tools, technology, and training with all emergency services, public safety, search and rescue agencies and civilian volunteers. It is the foundational networking event for Hawai'i search and rescue, with the goal of enabling and empowering participants to work together more effectively and efficiently to save lives.

18.6 COMMUNITY CLASSIFICATIONS

Table 18-7 summarizes classifications for community programs available to Maui County.

Table 18-7. Community Classifications

Program	Participating?	Classification	Date Classified
Community Rating System (CRS)	Yes	Class 7	1995
Building Code Effectiveness Grading Schedule	No	N/A	N/A
Public Protection (ISO Fire Protection Classes 1 to 10)	No	N/A	N/A
National Weather Service StormReady Certification	Yes	N/A	2001
TsunamiReady	Yes	N/A	2004
Firewise Communities classification[a]	Yes	N/A	As of 2024

a. *Participating Firewise Communities include Kahikinui, Kula; Launiupoko, Lahaina; Paniolo Hale, Maunaloa; Waiohuli, Kula; Vintage Kāʻanapali, Lanikeha Community; Island; and The Bluffs Maui Lani.*

18.7 ADAPTIVE CAPACITY

Adaptive capacity is defined as "the ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or respond to consequences" (IPCC 2022). Every community has a unique combination of capabilities to adjust to, protect from, and withstand a future hazard event, future conditions, and changing risk. Table 18-8 summarizes the adaptive capacity for each identified hazard of concern and the County's capability to address related actions using the following classifications:

- Strong—Capacity exists and is in use.
- Moderate—Capacity might exist; but is not used or could use some improvement.
- Weak—Capacity does not exist or could use substantial improvement

Table 18-8. Adaptive Capacity

Hazard	Adaptive Capacity
Coastal Erosion	Moderate
Dam and Reservoir Failure	Moderate
Drought	Moderate
Earthquake	Moderate
Flood	Moderate
High Windstorms	Moderate
Hurricane	Moderate
Landslide	Moderate
Tsunami	Weak
Volcanic Hazards	Weak
Wildfire	Moderate

18.8 NFIP AND CRS CAPABILITIES

The NFIP provides federally backed flood insurance in exchange for communities enacting floodplain regulations. Participation and good standing under NFIP are prerequisites for community residents to obtain flood insurance policies through the NFIP and for local jurisdictions to be eligible for federal grant funding under the Robert T. Stafford Act. Maui County has participated in good standing with the NFIP since 1995 and continues to adopt regulations that meet the NFIP requirements. As of this plan writing, there are 2,110 NFIP policies in force in Maui County with more than $7.5 million in total annual premiums. Table 18-9 provides a brief summary of the County's current NFIP compliance.

Table 18-9. NFIP Compliance

What local department is responsible for floodplain management?	Department of Public Works (as of September 1, 2024)
Who is the floodplain administrator? (position)	County of Maui Floodplain Manager
Are any certified floodplain managers on staff?	There are 2 CFMs on staff with the County, but neither person works on the Flood Program. Improvement of this capability is listed in the mitigation strategy for this HMP.
What is the date of adoption of the flood damage prevention ordinance?	Title 16, Chapter 16.29 (Ord. 5603 passed 1/26/2024); budget amendment passed 08/19/2024
When was the most recent Community Assistance Visit or Community Assistance Contact?	11/14/2024 (last CRS Verification Visit held on 7/31/2024)
Does the County have any outstanding NFIP compliance violations that need to be addressed?	8 remaining properties on the CAV list were initiated in 2011. The County was waiting for a response from FEMA since 2018. In November 2024, FEMA provided responses on the 8 remaining properties. 35 properties on the National Violations Tracker list.
Do current flood hazard maps adequately address the flood risk within the community?	No. In Lahaina, the FIRM only shows flooding from Kauaula and Kahoma Streams and coastal flooding. Flooding from the watershed above Lahaina town is not shown on the FIRM. FEMA is currently conducting advisory mapping that will show the 100-year floodplain from drainages in between Kauaula and Kahoma Streams.
Does floodplain management staff need any assistance or training to support its floodplain management program?	Yes, there is one person managing flood development permits, NFIP compliance, and CRS requirements. Tools and procedures are needed to efficiently make decisions, increase staff knowledge, and for long-term knowledge transfer.

The CRS is a voluntary program that rewards floodplain management activities that exceed the minimum standards of the NFIP. Communities participating in CRS receive discounted premium rates for all resident NFIP policyholders to reflect the reduced flood risk resulting from community actions. Maui County joined the CRS in 1995 and currently participates as a Class 7 community, resulting in a 15 percent reduction in flood insurance premiums for properties within Special Flood Hazard Areas (SFHAs) and a 5 percent reduction for properties outside of SFHAs. These discounts result in a total of nearly $1 million in annual savings on premiums paid by NFIP policyholders. The County is committed to maintaining its current CRS participation.

The following is a summary of additional information on the County's floodplain management capabilities.

- Examples of Maui County's "higher regulatory standards" that exceed NFIP minimum requirements:
  - 1-foot freeboard for lowest floor and machinery and equipment.
  - Cumulative substantial improvement/substantial damage requirements over a 10-year lookback period.
  - Enclosure limits for V zones (usable solely for vehicular parking, building access, or storage).
  - Compensatory storage for A zones without a floodway.
- Additional floodplain management provisions that are integrated into other plans or processes that the County uses to guide development:
  - Multiple goals, objectives, policies, and actions are identified in the Maui Island Plan, including incentives that minimize development in flood hazard areas.
- Additional CRS activities that Maui County performs that exceed NFIP minimum standards:
  - Follows construction certificate management procedures with coordination between building and flood development permits. Maintains elevation certificates for structures within the special flood hazard area.
  - Provides public inquirers with basic flood zone information from the community's latest Flood Insurance Rate Map (FIRM). Maintains historical and effective flood insurance studies and FIRMs.
  - Maintains flood hazard data and information on the County's "Flood Information" website at https://www.mauicounty.gov/2170/Flood-Information. Documents relating to floodplain management are also available in the Hawai'i Public Library System.
  - Enforces requirements of flood studies for areas not included on the FIRM that exceed minimum mapping standards.
  - Preserves open space within the special flood hazard area to minimize development in high flood risk areas.
  - Enforces additional regulations for development adjacent to drainageways outside of the special flood hazard area, stormwater management, soil and erosion control, and water quality.
  - Maintains a Category B classification for repetitive loss properties and annually informs property owners of flood risk within repetitive loss areas.

The following are impediments to running an effective floodplain management program in the community or improvements needed:

- There are limited staff resources for operations of the floodplain management program. The County's Floodplain Administrator manages flood development permit (FDP) reviews, reviews for subdivision, building, and grading permits, public inquiries of FIRM information and FDP requirements, and NFIP/CRS administrative work (compliance documentation,

annual recertifications, NFIP and CRS audits or non-compliance issues, and flood ordinance updates), as well as implementing CRS program activities.

- A comprehensive, centralized documentation and mapping system is needed to efficiently access records and make decisions on permit requirements or enforcement actions. This would allow more efficient daily operations with limited staff resources, enable knowledge transfer among staff, and ensure timely responses to public requests. Documentation includes certifications for NFIP compliance, FDP requirements and communications, and CRS documentation.

18.9 SUMMARY AND CONCLUSIONS

Maui County has strong capabilities and resources to mitigate the impacts of natural hazards, particularly in terms of planning and regulatory measures to ensure that new and/or substantially improved construction is built to be more resilient to potential hazards. Specific opportunities to improve, expand, or enhance these measures were developed into mitigation actions in partnership with the HMWG and County agencies. While the County's planning and regulatory capacity is fairly strong, the lack of adequate staff capacity and financial resources may hinder its ability to aggressively pursue and implement hazard mitigation actions and projects.

Despite these issues, the County has strong administrative capacity in other areas through its existing staff and partnerships with other organizations. Also, while the County's financial resources to support hazard mitigation actions are limited, it has been successful in obtaining outside financial and technical assistance through federal and state grant programs, which should continue so long as those programs continue to exist. Through actions identified in this HMP, the County will seek to increase its internal capacity to manage community-wide hazard mitigation programs in the future.

The County has been successful in implementing a variety of public safety and other hazard-related public education and awareness programs, including its efforts to prepare this HMP. MEMA provides public outreach to inform residents and visitors about personal preparedness for a wide range of hazards in addition to statewide guidance documents and tools for hazard mitigation and disaster recovery. The County Flood Information website provides links to sources dedicated to risk communication and individual flood preparedness and mitigation, as well as real-time data on current rain gauge data, stream flow data, and current sea levels. The County's participation in national hazard preparedness and prevention programs such as FEMA's CRS program, the NWS StormReady and TsunamiReady initiatives, and the National Fire Protection Association's Firewise USA program are also strong indicators of this capability. Still, education and outreach for remote communities where communications are a challenge are more difficult, particularly during and after hazard events.

Overall, Maui County is well-positioned to mitigate risks from natural hazards. Through the implementation of this HMP and other efforts, it will continue to do so in a deliberate and meaningful manner. This will be accomplished through many of the existing capabilities and resources described in the section, and the County's ability to improve and expand on them as noted herein.

PART 4: MITIGATION STRATEGY

19. MITIGATION STRATEGY

This chapter presents a mitigation strategy for Maui County to reduce potential vulnerability and losses identified as concerns in the risk assessment portion of this plan. The HMWG reviewed the risk assessment and capability assessment to identify and develop this mitigation strategy.

19.1 MITIGATION GOALS

Hazard mitigation goals are summary statements of the benefits that a community wishes to accomplish in terms of reducing or avoiding long-term risks from hazards. They are broad, long-term, policy-type statements that represent a global vision. The success of an HMP is measured by the degree to which its goals have been met.

The HMWG reviewed the goals from the 2020 HMP based on the following considerations:

- Hazard events and losses since the 2020 plan
- The updated hazard profiles and risk assessment
- The goals and objectives established in the 2023 Hawai‘i State Hazard Mitigation Plan
- The County’s interests in integrating this plan with the planning mechanisms listed in the capability assessment
- Input from the HMWG, stakeholders, and the public on how the County needs to move forward to best manage hazard risks
- Discussions and research on existing authorities, policies, programs, and resources
- Support for mitigation through the protection of natural systems

Based on this review, the HMWG determined that the 2020 goals remain appropriate for the 2025 update. The goals are as follows:

- Goal 1—Protect the life, health, safety, and welfare of Maui County residents and visitors.
- Goal 2—Promote the long-term resilience of the County’s economic, environmental, historical and cultural resources.
- Goal 3—Protect and adapt property and infrastructure from the impacts of natural hazards and climate change.
- Goal 4—Improve awareness and mitigation of risks associated with natural hazards and climate change.
- Goal 5—Enhance the implementation of this hazard mitigation plan through active involvement and plan integration across all County departments.

19.2 MITIGATION STRATEGY DEVELOPMENT AND UPDATE PROCESS

19.2.1 Review of Previously Recommended Actions

> ***Mitigation actions*** address potential impacts and costs associated with disaster-related events, including impacts on the population, property, the economy, and the environment. They can include activities such as revisions to land-use planning, training and education, safety measures, or structural improvement projects.

The update of the County mitigation strategy included a review of progress on the mitigation actions identified in the 2020 HMP. Department representatives were provided with a worksheet identifying all mitigation actions from the 2020 plan. These representative reviewed each action and provided information on progress, indicating each action's status as *No Progress*, *In Progress*, *Ongoing*, *Completed*, or *Discontinued*. They also provided review comments on each action.

Table 19-1 indicates progress on the mitigation strategy identified in the previous HMP. Actions identified as *Complete* or *Discontinued* are omitted from the mitigation strategy for this plan update. Actions identified as *No Progress*, *In Progress,* or *Ongoing Capability* have been carried forward in the updated mitigation strategy.

Table 19-1. Status of Previous Mitigation Actions

1	
Hazards Addressed	Drought
Responsible Party	Department of Environmental Management, Department of Water Supply
Summary of Original Problem and Solution (Project)	Explore options and necessary code and regulation changes to allow greywater reuse systems for irrigation and toilet flushing.
Action Review Status	 In Progress
Narrative describing progress or obstacles that have prevented implementation	Department of Water Supply secured DOH permit for greywater reuse for underground irrigation in Launiupoko Beach Park. DOH is reviewing final design plans for greywater reuse for sprinkler irrigation at Kanaha Beach Park. Funded projects are for design and construction of the greywater systems, not exploring code changes, but the DOH permits are case studies for irrigation application under the current code.
Next Steps Include in the 2024 HMP or Discontinue?	 Include
If include, revise/reword as appropriate	Explore options and necessary code and regulation changes to allow greywater reuse systems for irrigation and toilet flushing.

2	
Hazards Addressed	Flood
Responsible Party	Department of Public Works
Summary of Original Problem and Solution (Project)	Adopt the most current building codes to mitigate risk associated with flooding.
Action Review Status	 In Progress
Narrative describing progress or obstacles that have prevented implementation	The building codes do not address flooding. Flooding is addressed by the National Flood Insurance Program and the County's Flood Ordinance. Maui County is a Category B repetitive loss community with approximately 40% of the repetitive loss properties outside of the SFHA.
Next Steps Include in the 2024 HMP or Discontinue?	 Include
If include, revise/reword as appropriate	County will regulate development of repetitive loss properties that are not within a special flood hazard area, conduct a repetitive loss analysis of all repetitive loss areas, and develop a storm documentation system to track storm conditions and impacts.

3	
Hazards Addressed	Drought
Responsible Party	Department of Water Supply
Summary of Original Problem and Solution (Project)	Develop a water conservation ordinance to include xeriscaping regulations to promote water conservation (Maui Island Plan Action 6.3.2)
Action Review Status	 In Progress
Narrative describing progress or obstacles that have prevented implementation	Draft bill submitted with Request for Legal Service to corporation counsel on 10/9/24. Department of Water Supply is awaiting revised bill for further review by the Board of Water Supply prior to County Council.
Next Steps Include in the 2024 HMP or Discontinue?	 Include
If include, revise/reword as appropriate	Develop a water conservation ordinance to include xeriscaping regulations to promote water conservation. In combination with the April 2024 Water Shortage and Conservation Plan, the ordinance will address water use priorities in the event of a water shortage due to drought or unforeseen events. Action aligns with Maui Island Plan Action 6.3.2.

4	
Hazards Addressed	Coastal Erosion, Drought, Extreme Cold, Extreme Heat, Dam/Reservoir Failure, Earthquake, Flood, High Windstorm, Hurricane, Landslides, Tsunamis, Volcanic Hazards, Wildfire, Hazardous Materials, Health Risks
Responsible Party	Emergency Management Agency
Summary of Original Problem and Solution (Project)	To identify and establish MOUs for emergency evacuation and supply chain management for isolated communities or communities that may become isolated as a consequence of disaster.
Action Review Status	In Progress
Narrative describing progress or obstacles that have prevented implementation	Consultant is developing the list of stakeholders and partners within each plan.
Next Steps Include in the 2024 HMP or Discontinue?	Discontinue
If discontinue, explain why	Action will be moved to preparedness plans, including the Commodities points of distribution plan, Mass care and sheltering plan, and Vulnerable Communities plan.

5	
Hazards Addressed	All Hazards
Responsible Party	Emergency Management Agency
Summary of Original Problem and Solution (Project)	Identify alternative locations for emergency supply of diesel, gas, and propane on Molokaʻi for a minimum of 30 days.
Action Review Status	No Progress
Narrative describing progress or obstacles that have prevented implementation	PAR Pacific and is the onsite supporting agencies. Federal Government changes laws for transport of mobile fuels pending process for storage.
Next Steps Include in the 2024 HMP or Discontinue?	Include
If include, revise/reword as appropriate	Identify alternative locations for emergency supply of diesel, gas, and propane on Molokaʻi for a minimum of 30 days.

6	
Hazards Addressed	High Windstorm, Hurricane
Responsible Party	Emergency Management Agency
Summary of Original Problem and Solution (Project)	Share funding sources for building retrofits or other modifications with owners of residential buildings to mitigate the effects of high winds. Encourage the use of load path connectors, hurricane shutters, safe rooms, reinforced garage doors, replacement of non- ductile infrastructure, strengthen structural frames, inspect and retrofit roofs, gable end walls for wind resistance.
Action Review Status	 Ongoing Capability
Narrative describing progress or obstacles that have prevented implementation	For government buildings, these are included in the Departments as CIP projects. For residential buildings, it is the responsibility of the individual homeowner.
Next Steps Include in the 2024 HMP or Discontinue?	 Discontinue
If discontinue, explain why	Education for homeowners about mitigation measures will be folded into other outreach actions.

7	
Hazards Addressed	Coastal Erosion, Drought, Extreme Cold, Extreme Heat, Dam/Reservoir Failure, Earthquake, Flood, High Windstorm, Hurricane, Landslides, Tsunamis, Volcanic Hazards, Wildfire, Hazardous Materials, Health Risks
Responsible Party	Emergency Management Agency
Summary of Original Problem and Solution (Project)	Support Emergency Preparedness Working Groups to form and hold annual preparedness workshops for families in Molokaʻi, Lānaʻi and Hāna.
Action Review Status	 In Progress
Narrative describing progress or obstacles that have prevented implementation	In 2024, MEMA will attend the Taro Festival in Hāna on April 26, Molokaʻi Resource Fair on May 17, and the Lānaʻi Pineapple Festival on July 5.
Next Steps Include in the 2024 HMP or Discontinue?	 Include
If include, revise/reword as appropriate	Provide education about disaster preparedness and mitigation to isolated communities.

8	
Hazards Addressed	Coastal Erosion, Drought, Extreme Cold, Extreme Heat, Dam/Reservoir Failure, Earthquake, Flood, High Windstorm, Hurricane, Landslides, Tsunamis, Volcanic Hazards, Wildfire, Hazardous Materials, Health Risks
Responsible Party	Emergency Management Agency
Summary of Original Problem and Solution (Project)	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.
Action Review	
Status	Completed
Narrative describing progress or obstacles that have prevented implementation	The Hazard Mitigation Plan is a well-known document that is referenced in strategic plan and recovery plans. There is an entire chapter of the Maui Island Plan dedicated to Natural Hazards.
Next Steps	
Include in the 2024 HMP or Discontinue?	Discontinue
If discontinue, explain why	This action is a duplication of other actions.
9	
Hazards Addressed	Coastal Erosion, Drought, Extreme Cold, Extreme Heat, Dam/Reservoir Failure, Earthquake, Flood, High Windstorm, Hurricane, Landslides, Tsunamis, Volcanic Hazards, Wildfire, Hazardous Materials, Health Risks
Responsible Party	Emergency Management Agency
Summary of Original Problem and Solution (Project)	The County of Maui will consider and adapt to all of the hazards listed in this plan as well as emerging hazards, such as the Covid-19 pandemic, that are beyond the current scope of consideration.
Action Review	
Status	Completed
Narrative describing progress or obstacles that have prevented implementation	MEMA is writing a suite of preparedness and response plans, including a public health plan.
Next Steps	
Include in the 2024 HMP or Discontinue?	Discontinue
If discontinue, explain why	Action is complete.

10	
Hazards Addressed	Wildfire
Responsible Party	Fire Prevention Bureau
Summary of Original Problem and Solution (Project)	Support the revitalization and expansion of the Firewise USA program to additional communities.
Action Review	
Status	Ongoing Capability
Narrative describing progress or obstacles that have prevented implementation	Many communities face significant challenges in securing funding for effective brush mitigation. Fortunately, Firewise offers valuable support by helping to offset some of these costs, making it easier to protect neighborhoods from the threat of wildfires. Investing in Firewise can lead to safer, more resilient communities.
Next Steps	
Include in the 2024 HMP or Discontinue?	Include
If include, revise/reword as appropriate	Support the revitalization and expansion of the Firewise USA program to additional communities in Maui County
11	
Hazards Addressed	Coastal Erosion, Dam/Reservoir Failure, Earthquake, Flood, High Windstorm, Hurricane, Landslides, Tsunamis, Volcanic Hazards, Wildfire, Hazardous Materials, Health Risks
Responsible Party	Mayor's Office
Summary of Original Problem and Solution (Project)	Establish an alternative route to and from West Maui for use during disasters.
Action Review	
Status	In Progress
Narrative describing progress or obstacles that have prevented implementation	The major obstacle has been funding. The County of Maui was recently awarded a $15.43 million grant from the federal government to support the first phase of the West Maui Greenway, a project that will contribute to several key areas of Lahaina's recovery from the 2023 Maui wildfires.
Next Steps	
Include in the 2024 HMP or Discontinue?	Include
If include, revise/reword as appropriate	Continue construction of the West Maui Greenway and other alternative routes to facilitate swift evacuation during a disaster.

12	
Hazards Addressed	Coastal Erosion, Flood
Responsible Party	Mayor's Office and Council
Summary of Original Problem and Solution (Project)	Coordinate with the state to adapt State Highway Route 450 in Moloka'i at MM 15-16 (east side experiencing major erosion and undermining in the last few years).
Action Review	
Status	No Progress
Narrative describing progress or obstacles that have prevented implementation	Funding is the major challenge that has prevented this action from being accomplished.
Next Steps	
Include in the 2024 HMP or Discontinue?	Include
If include, revise/reword as appropriate	Coordinate with the state to adapt State Highway Route 450 in Moloka'i at MM 15-16.
13	
Hazards Addressed	Coastal Erosion, Drought, Extreme Cold, Extreme Heat, Dam/Reservoir Failure, Earthquake, Flood, High Windstorm, Hurricane, Landslides, Tsunamis, Volcanic Hazards, Wildfire, Hazardous Materials, Health Risks
Responsible Party	Mayor's Office, Department of Environmental Management
Summary of Original Problem and Solution (Project)	Support cross-departmental collaboration and planning in resilience and climate action efforts.
Action Review	
Status	Completed
Narrative describing progress or obstacles that have prevented implementation	In 2024, Maui adopted the Mayor's Office of Climate Change, Resiliency, and Sustainability Climate Action and Resiliency Plan, a cross-departmental plan to increase resilience and lessen the impact of climate change. Implementation of this plan is included as a mitigation action in this HMP.
Next Steps	
Include in the 2024 HMP or Discontinue?	Discontinue
If discontinue, explain why	Implementation of the above plan replaces this action.

14	
Hazards Addressed	Coastal Erosion, Flood, Hurricane, Tsunamis
Responsible Party	Planning Department
Summary of Original Problem and Solution (Project)	Expand Beach and Dune Restoration Projects: 1) Identify and prioritize erosion hotspots for mitigation via beach nourishment where applicable. 2) Pursue Federal/State/County funding for beach nourishment and restoration (including pre-positioning for post- disaster financial assistance). 3) Work with State regulatory agencies to streamline permitting for beach restoration. 4) Promote living shoreline projects instead of shoreline hardening where feasible. 5) Protect/restore coral reefs as they provide a barrier for erosion, high surf/coastal flooding and tsunamis.
Action Review Status	In Progress
Narrative describing progress or obstacles that have prevented implementation	1) Complete, many hotspots are known and beach nourishment projects have been proposed; however, community concerns have paused implementation. 2) In Progress, although it is now understood that HMGP may not support beach nourishment without permanent structures and NOAA will not support beach nourishment 3) Ongoing with DLNR Office of Conservation and Coastal Lands 4) Ongoing with state and county agencies 5) Ongoing studies and pilot projects with DLNR Division of Aquatic Resources and the Hawai'i Institute of Marine Biology
Next Steps Include in the 2024 HMP or Discontinue?	Include
If include, revise/reword as appropriate	Support beach and dune restoration solutions that limit coastal erosion and protect life and property. Per Hawai'i state law, this include promoting living shorelines projects instead of shoreline hardening where feasible. Specific projects may include streamline permitting for beach restoration; update dune restoration guidance; protect and restore coral reef systems; provide dune restoration training to county officials and the public; develop an outreach initiative to encourage or establish new dune restoration volunteers/stewards; and install ADA compliant dune walkovers in identified locations.

15	
Hazards Addressed	Coastal Erosion, Flood, Hurricane, Tsunamis
Responsible Party	Planning Department
Summary of Original Problem and Solution (Project)	Update dune restoration guidance. Provide dune restoration training. Develop an outreach initiative to encourage or establish new dune restoration volunteers/stewards. Install ADA compliant dune walkovers in identified locations.
Action Review Status	Ongoing Capability
Narrative describing progress or obstacles that have prevented implementation	1) Ongoing, many hotspots are known and beach nourishment projects have been proposed; however, community concerns have paused implementation; 2) Ongoing, although it is now understood that HMGP may not support beach nourishment without permanent structures and NOAA will not support beach nourishment; 3) Ongoing with DLNR Office of Conservation and Coastal Lands; 4) Ongoing with state and county agencies; 5) Ongoing studies and pilot projects with DLNR Division of Aquatic Resources and the Hawai'i Institute of Marine Biology at the University of Hawai'i
Next Steps Include in the 2024 HMP or Discontinue?	Include

If include, revise/reword as appropriate	Support beach and dune restoration solutions that limit coastal erosion and protect life and property. Per Hawai'i state law, this include promoting living shorelines projects instead of shoreline hardening where feasible. Specific projects may include streamline permitting for beach restoration; update dune restoration guidance; protect and restore coral reef systems; provide dune restoration training to county officials and the public; develop an outreach initiative to encourage or establish new dune restoration volunteers/stewards; and install ADA compliant dune walkovers in identified locations.
16	
Hazards Addressed	Flood
Responsible Party	Planning Department
Summary of Original Problem and Solution (Project)	Participate in the CRS program and identify opportunities across all relevant County departments and programs to improve current CRS class.
Action Review	
Status	Ongoing Capability
Narrative describing progress or obstacles that have prevented implementation	The 2024 CRS verification visit was conducted in-person on July 31, 2024, with a follow up on September 9, 2024. The former was attended by the ISO CRS specialist, State NFIP coordinator, and staff from the Planning Department and Department of Public Works (DPW). Maui County was verified as a Class 7 community with 1,889 credit points. There was a reduction in credit points from the 2020 CRS verification visit with 2,080 credit points. A consultant was contracted by DPW to provide technical assistance with preparing documentation submitted to the ISO CRS specialist, as well as coordinating communications with the ISO CRS specialist. A final memorandum on recommendations for improving the CRS program is still pending. The 2024 annual recertification was submitted on October 15, 2024. A response from the CRS Resource Specialist is pending.
Next Steps	
Include in the 2024 HMP or Discontinue?	Include
If include, revise/reword as appropriate	Participate in the CRS program and identify opportunities across all relevant County departments and programs to improve current CRS points.
17	
Hazards Addressed	Flood
Responsible Party	Planning Department
Summary of Original Problem and Solution (Project)	Conduct a multivariate GIS analysis to identify and categorize open spaces for the County of Maui to purchase and preserve based on highest ROI for hydrological capacity and positive impact on flood mitigation.
Action Review	
Status	No Progress
Narrative describing progress or obstacles that have prevented implementation	There has not yet been a comprehensive assessment of existing or potentially available sites to prioritize preservation or acquisition for hazard mitigation and adaptation to future conditions.
Next Steps	
Include in the 2024 HMP or Discontinue?	Include
If include, revise/reword as appropriate	Conduct a multivariate GIS analysis to identify and categorize open spaces for the County of Maui to purchase and preserve based on highest ROI for hydrological capacity and positive impact on flood mitigation.

18	
Hazards Addressed	Flood
Responsible Party	Planning Department
Summary of Original Problem and Solution (Project)	Adopt internal protocols for how to intake, process, approve and file all new FDPs in order to ensure consistent and clear records for upcoming CRS audits. Having a more thorough digital record of approved FDPs will facilitate the Floodplain Manager achieving a greater score during the CRS Audits.
Action Review Status	In Progress
Narrative describing progress or obstacles that have prevented implementation	In 2022, Maui County launched the Maui's Automated Planning and Permitting System (MAPPS) for all permits. MAPPS provides an efficient interface for flood development permit application documents and reviews. Adjustments were made in MAPPS when DPW took over the administration of flood permits. DPW is requesting additional FY26 operational funds for the Flood Program to develop a new data management tool, permit and certificate tracking system, and standardized operating procedure to ensure NFIP and CRS compliance.
Next Steps Include in the 2024 HMP or Discontinue?	Include
If include, revise/reword as appropriate	The Flood Program will develop a new data management tool, permit and certificate tracking system, and standardized operating procedure to ensure NFIP and CRS compliance. Adopt internal protocols for how to intake, process, approve and file all new FDPs in order to ensure consistent and clear records for upcoming CRS audits.

19	
Hazards Addressed	Drought, Extreme Heat, Flood
Responsible Party	Planning Department, Department of Water Supply
Summary of Original Problem and Solution (Project)	Encourage Low Impact Development (LID) approach to site development and stormwater management through development of best practices guide.
Action Review Status	No Progress
Narrative describing progress or obstacles that have prevented implementation	Since the last HMP update, the Low Impact Development Practitioner's Guide for Hawai'i was published by the State Office of Planning and Sustainable Development (https://files.Hawai'i.gov/dbedt/op/czm/ormp/ormp_implementation/2023LIDPractitionersGuide.pdf). Training with Department staff and community outreach is an ongoing need.
Next Steps Include in the 2024 HMP or Discontinue?	Include
If include, revise/reword as appropriate	Encourage Low Impact Development (LID) approach to site development and stormwater management using the Low Impact Development Practitioner's Guide for Hawai'i.

20	
Hazards Addressed	Flood
Responsible Party	Department of Environmental Management
Summary of Original Problem and Solution (Project)	Flood proof water and wastewater treatment facilities located in flood hazard areas and identified as vulnerable to future damage or disruption. This includes but is not limited to the Kaunakakai Wastewater Treatment Facility.
Action Review Status	In Progress
Narrative describing progress or obstacles that have prevented implementation	County will submit HMGP applications for Kehalani Pump Station Mitigation Project, Kīhei Wastewater Pump Station No. 2 Modifications/Upgrade (1977), Kīhei Wastewater Pump Station No. 3 Modifications/Upgrade (1994), Kamaole I Beach Park and Kīhei Wastewater Pump Station No. 7 Relocation Project, Lahaina Recycled Water Force Main Construction/Rehabilitation, Reuse System Backup Generators and Pumps, Roof Replacements-Kīhei Wastewater Reclamation Facility and Pump Stations.
Next Steps Include in the 2024 HMP or Discontinue?	Include
If include, revise/reword as appropriate	Flood proof water and wastewater treatment facilities located in flood hazard areas and identified as vulnerable to future damage or disruption. This includes but is not limited to the Kaunakakai Wastewater Treatment Facility. Long-term solution includes moving critical water infrastructure and community lifeline facilities to higher elevations.

21	
Hazards Addressed	Coastal Erosion, Flood, Hurricane, Tsunamis
Responsible Party	Department of Public Works
Summary of Original Problem and Solution (Project)	Develop a strategy to mitigate risk to coastal roads.
Action Review Status	In Progress
Narrative describing progress or obstacles that have prevented implementation	In progress. DPW partnered with the University of Hawai‘i to complete a coastal roads study in 2024. The County's coastal roads were analyzed in different ocean hazard and climate change scenarios. Prioritization lists and adaptation recommendations were developed. The study will guide DPW's planning for risk mitigation of these roads. There are various studies are underway for specific locations including Kalepa Point, South Kīhei Road, and Lower Honoapi`ilani Road between Puamana Place and Hui Road East.
Next Steps Include in the 2024 HMP or Discontinue?	Include

If include, revise/reword as appropriate	Develop management plans for at-risk coastal roads. DPW partnered with the University of Hawai'i to complete a coastal roads study in 2024. The County's coastal roads were analyzed in different ocean hazard and climate change scenarios. Prioritization lists and adaptation recommendations were developed. The study will guide DPW's planning for risk mitigation of these roads. There are various studies are underway for specific locations including Kalepa Point, South Kīhei Road, and Lower Honoapi`ilani Road between Puamana Place and Hui Road East. Solutions may include moving roads inland, raising roadways, or providing shoreline protection.
22	
Hazards Addressed	Earthquake, Flood
Responsible Party	Department of Public Works
Summary of Original Problem and Solution (Project)	Prepare an inventory of non-NBI bridges using GIS and create a framework for an inspections schedule to help ensure that all bridges are assessed for their structural stability during a natural disaster, and to identify and prioritize the implementation of improvements for long-term resiliency (with an emphasis on bridges serving potentially isolated communities (e.g., East Maui).
Action Review	
Status	No Progress
Narrative describing progress or obstacles that have prevented implementation	DPW does not have sufficient GIS capabilities. $500,000 one-time for mapping and engineering services
Next Steps	
Include in the 2024 HMP or Discontinue?	Include
If include, revise/reword as appropriate	Prepare an inventory of non-NBI bridges using GIS and create a framework for an inspections schedule to help ensure that all bridges are assessed for their structural stability during a natural disaster, and to identify and prioritize the implementation of improvements for long-term resiliency, with an emphasis on bridges serving potentially isolated communities (e.g., East Maui).
23	
Hazards Addressed	Landslide
Responsible Party	Department of Public Works
Summary of Original Problem and Solution (Project)	Identify and inventory areas at risk using GIS to landslides and rockfalls and mitigate risk to these areas. Specific areas to address include Kalepa (East Maui), Kahakuloa (Central/West Maui), and Hāna Highway (in/downslope of high landslide susceptibility areas or that have experienced past rockfalls).
Action Review	
Status	No Progress
Narrative describing progress or obstacles that have prevented implementation	DPW does not have sufficient GIS capabilities. $500,000 one-time for mapping and engineering services
Next Steps	
Include in the 2024 HMP or Discontinue?	Include

If include, revise/reword as appropriate	Identify and inventory areas at risk using GIS to landslides and rockfalls and implement mitigation projects to reduce risk in hazard areas. Specific areas to address include Kalepa (East Maui), Kahakuloa (Central/West Maui), and Hāna Highway (in/downslope of high landslide susceptibility areas or that have experienced past rockfalls).
24	
Hazards Addressed	Landslide
Responsible Party	Department of Public Works
Summary of Original Problem and Solution (Project)	Improve drainage and slope stabilization along steeps areas that are prone to fail due to soil saturation, including the Kahekili Slope Repair project and other locations identified as priorities for hazard risk reduction. These include projects that protect critical facilities and infrastructure such as Pi'ilani Highway (through East Maui) and Kahekili Highway (through Kahakuloa). Develop a GIS data layer for hazard areas.
Action Review Status	 In Progress
Narrative describing progress or obstacles that have prevented implementation	DPW has several slope repair projects along Kahekili Highway at MP15, MP14.5, and MP15.3.
Next Steps Include in the 2024 HMP or Discontinue?	 Include
If include, revise/reword as appropriate	Improve drainage and slope stabilization along steeps areas that are prone to fail due to soil saturation, including the Kahekili Slope Repair project and other locations identified as priorities for hazard risk reduction. These include projects that protect critical facilities and infrastructure such as Pi'ilani Highway (through East Maui) and Kahekili Highway (through Kahakuloa). Develop a GIS data layer for hazard areas.
25	
Hazards Addressed	Flood, Hurricane
Responsible Party	Department of Public Works
Summary of Original Problem and Solution (Project)	Replace aging stormwater infrastructure at the end of its life cycle with new infrastructure designed to future, more extreme events (i.e., above code).
Action Review Status	 Ongoing Capability
Narrative describing progress or obstacles that have prevented implementation	DPW has completed an assessment of its drainage systems in Central Maui, South Maui, and West Maui since 2020. Drainage pipes and structures were evaluated for structural and functional defects. DPW continues to program drain line repair and replacement projects.
Next Steps Include in the 2024 HMP or Discontinue?	 Include
If include, revise/reword as appropriate	Expand stormwater infrastructure capacity to effectively manage drainage during intense rainfall episodes and reduce the likelihood that intense rainfall will result in flash floods.

26	
Hazards Addressed	Coastal Erosion, Flood, Hurricane, Tsunamis
Responsible Party	Emergency Management Agency
Summary of Original Problem and Solution (Project)	Identify critical infrastructure, lifelines, roads, and populations that are vulnerable to coastal hazards, and encourage strategic retreat, relocation or retrofit. Aligns with Maui Island Plan 3.1.2 Natural Hazards.
Action Review	
Status	In Progress
Narrative describing progress or obstacles that have prevented implementation	Genasys and Ladrys Evac program secured will have layers for each evacuation need.
Next Steps	
Include in the 2024 HMP or Discontinue?	Include
If include, revise/reword as appropriate	Implement the goal, objectives, policies, and actions of Chapter 3 Natural Hazards of the Maui Island Plan, part of the County's General Plan 2030.

27	
Hazards Addressed	Coastal Erosion, Flood, Hurricane, Tsunami
Responsible Party	Emergency Management Agency
Summary of Original Problem and Solution (Project)	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 repetitive loss and severe repetitive loss properties as priority.
Action Review	
Status	In Progress
Narrative describing progress or obstacles that have prevented implementation	Crisis track online form that meet HI-EMA and FEMA requirements.
Next Steps	
Include in the 2024 HMP or Discontinue?	Include
If include, revise/reword as appropriate	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 repetitive loss and severe repetitive loss properties as priority.

28	
Hazards Addressed	Coastal Erosion, Earthquake, Flood, High Windstorm, Hurricane, Landslides, Tsunamis, Volcanic Hazards, Wildfire
Responsible Party	Emergency Management Agency
Summary of Original Problem and Solution (Project)	Implement the guidance and tools identified in the 2019 Guidance for Disaster Recovery Preparedness in Hawai'i, which was supported by Maui County.
Action Review	
Status	Ongoing Capability
Narrative describing progress or obstacles that have prevented implementation	MEMA is writing a suite of preparedness and response plans. The guidance should be implemented in consideration of lessons learned from the 2023 Lahaina Wildfire recovery.
Next Steps	
Include in the 2024 HMP or Discontinue?	Include
If include, revise/reword as appropriate	Implement the guidance and tools identified in the 2019 Guidance for Disaster Recovery Preparedness in Hawai'i and lessons learned from the 2023 Lahaina Wildfire recovery.

29	
Hazards Addressed	Earthquake, Flood, High Windstorm, Hurricane, Tsunamis, Wildfire
Responsible Party	Emergency Management Agency
Summary of Original Problem and Solution (Project)	Obtain FEMA's Substantial Damage Estimator and attend training to be prepared to use it when damage occurs; and develop mutual aid agreements with other jurisdictions to augment local inspection personnel after major disasters.
Action Review	
Status	No Progress
Narrative describing progress or obstacles that have prevented implementation	Funding is the major challenge that has prevented this action from being accomplished.
Next Steps	
Include in the 2024 HMP or Discontinue?	Include
If include, revise/reword as appropriate	Obtain FEMA's Substantial Damage Estimator and attend training to be prepared to use it when damage occurs; and develop mutual aid agreements with other jurisdictions to augment local inspection personnel after major disasters.

30	
Hazards Addressed	Dam/Reservoir Failure, Earthquake, Flood, High Windstorm, Hurricane, Landslides, Tsunamis, Volcanic Hazards, Wildfire
Responsible Party	Emergency Management Agency
Summary of Original Problem and Solution (Project)	Conduct a detailed needs assessment and capital planning/feasibility study for additional emergency shelters for both residents and visitors. This includes retrofitting existing public facilities and structures to withstand up to a Category 3 hurricane (e.g., high school gym on Moloka'i).
Action Review	
Status	In Progress
Narrative describing progress or obstacles that have prevented implementation	DOE shelters rated and complete. County shelters not rated; do not meet specifications currently.
Next Steps	
Include in the 2024 HMP or Discontinue?	Include
If include, revise/reword as appropriate	Conduct a detailed needs assessment and capital planning/feasibility study for additional emergency shelters for both residents and visitors. This includes retrofitting existing public facilities and structures to withstand up to a Category 3 hurricane and other natural hazards.

31	
Hazards Addressed	Coastal Erosion, Drought, Extreme Cold, Extreme Heat, Dam/Reservoir Failure, Earthquake, Flood, High Windstorm, Hurricane, Landslides, Tsunamis, Volcanic Hazards, Wildfire, Hazardous Materials, Health Risks
Responsible Party	Emergency Management Agency
Summary of Original Problem and Solution (Project)	Implement the Teen CERT Hero Project and promote the culture and resiliency of youth in Maui County.
Action Review	
Status	In Progress
Narrative describing progress or obstacles that have prevented implementation	CERT program ongoing, Teen CERT annually completed.
Next Steps	
Include in the 2024 HMP or Discontinue?	Include
If include, revise/reword as appropriate	Implement the CERT and Teen CERT Project and promote the culture and resiliency in Maui County.

32	
Hazards Addressed	Coastal Erosion, Drought, Extreme Cold, Extreme Heat, Dam/Reservoir Failure, Earthquake, Flood, High Windstorm, Hurricane, Landslides, Tsunamis, Volcanic Hazards, Wildfire, Hazardous Materials, Health Risks
Responsible Party	Emergency Management Agency
Summary of Original Problem and Solution (Project)	Hire a Capital Improvement Project Coordinator. Promote the availability of hazard mitigation grant funding sources (including but not limited to FEMA's HMA or BRIC programs) to all appropriate departments or agencies to implement mitigation actions.
Action Review Status	 No Progress
Narrative describing progress or obstacles that have prevented implementation	CIP is not part of the organizational structure of MEMA and would be in the Managing Director's office or associated Departments.
Next Steps Include in the 2024 HMP or Discontinue?	 Discontinue
If discontinue, explain why	CIP is not part of the organizational structure of MEMA and would be in the Managing Director's office or associated Departments.

33	
Hazards Addressed	Wildfire
Responsible Party	Fire Prevention Bureau
Summary of Original Problem and Solution (Project)	Research, promote, and support the implementation of wildfire mitigation practices for Wildland Urban Interface (WUI) and other areas identified as high risk but not covered by a current Community Wildfire Protection Plan (CWPPs). Practices may include but not be limited to the following: • Retrofit at-risk County structures with ignition-resistant materials • Initiating programs aimed at reducing fuel loads (removing non-native grasses and shrubs with native/fire-resistant species) • Prevent wildfire burn areas from being replanted with non-native vegetation • Implementing defensible space and firebreaks in rural developments through existing codes and development standards
Action Review Status	 In Progress
Narrative describing progress or obstacles that have prevented implementation	The Fire Prevention Bureau (FPB) has conducted fire hazard assessments and identified key locations within Kīhei, Kahului, Oluwalu, Lahaina, Kāʻanapali, and Molokaʻi for the implementation of strategically placed fuel breaks. These fuel breaks are designed to create defensible spaces around communities particularly susceptible to wildfires, especially in high-hazard areas characterized by dense vegetation and dry conditions. By establishing these protective barriers, the Bureau aims to mitigate the spread of fires, enhance firefighting efforts, and ultimately safeguard both the residents and the natural landscape of these vulnerable regions. In 2025, the FPB implemented new county codes regarding required brush heights near structures. These codes aim to create space around homes to reduce the risk of ember and brush ignition to structures.
Next Steps Include in the 2024 HMP or Discontinue?	 Include

If include, revise/reword as appropriate	Research, promote, and support the implementation of wildfire mitigation practices for Wildland Urban Interface (WUI) and other areas identified as high risk but not covered by a current Community Wildfire Protection Plan (CWPPs). Practices may include but not be limited to the following: • Retrofit at-risk County structures with ignition-resistant materials • Initiating programs aimed at reducing fuel loads (removing non-native grasses and shrubs with native/fire-resistant species) • Prevent wildfire burn areas from being replanted with non-native vegetation • Implementing defensible space and firebreaks in rural developments through existing codes and development standards
34	
Hazards Addressed	Wildfire
Responsible Party	Fire Prevention Bureau
Summary of Original Problem and Solution (Project)	Support the Hawai'i Wildfire Management Organization, the Maui Wildfire Coordinating Group, local fire task forces, and other stakeholder organizations with the implementation of mitigation action items as identified in all current Community Wildfire Protection Plans (CWPPs).
Action Review Status	Ongoing Capability
Narrative describing progress or obstacles that have prevented implementation	The Fire Prevention Bureau continues to assist HWMO in assessing communities for fire hazard mitigation and achieving Firewise community status. The Bureau holds bi-monthly meetings to discuss available grants and the county's urgent needs, helping to implement effective solutions for fire safety.
Next Steps Include in the 2024 HMP or Discontinue?	Include
If include, revise/reword as appropriate	Support the Hawai'i Wildfire Management Organization, the Maui Wildfire Coordinating Group, local fire task forces, and other stakeholder organizations with the implementation of mitigation action items as identified in all current CWPPs.
35	
Hazards Addressed	Coastal Erosion, Flood, Hurricane, Tsunamis
Responsible Party	Mayor's Office
Summary of Original Problem and Solution (Project)	Develop a Master Plan for the use of County owned land along the Honoapi`ilani Highway.
Action Review Status	No Progress
Narrative describing progress or obstacles that have prevented implementation	Funding is the major challenge that has prevented this action from being accomplished.
Next Steps Include in the 2024 HMP or Discontinue?	Include
If include, revise/reword as appropriate	Develop a Master Plan for the use of County owned land along the Honoapi`ilani Highway.

36	
Hazards Addressed	Coastal Erosion, Flood
Responsible Party	Mayor's Office
Summary of Original Problem and Solution (Project)	Mitigate the impacts of saltwater intrusion, exacerbated by flooding and/or erosion from Sea Level Rise, on utilities, ecosystems and other public facilities.
Action Review	
Status	No Progress
Narrative describing progress or obstacles that have prevented implementation	Funding is the major challenge that has prevented this action from being accomplished.
Next Steps	
Include in the 2024 HMP or Discontinue?	Include
If include, revise/reword as appropriate	Mitigate the impacts of saltwater intrusion, exacerbated by flooding and/or erosion from Sea Level Rise, on utilities, ecosystems and other public facilities.
37	
Hazards Addressed	Coastal Erosion, Drought, Extreme Cold, Extreme Heat, Dam/Reservoir Failure, Earthquake, Flood, High Windstorm, Hurricane, Landslides, Tsunamis, Volcanic Hazards, Wildfire, Hazardous Materials, Health Risks
Responsible Party	Mayor's Office
Summary of Original Problem and Solution (Project)	Establish a revolving fund that can support grant matching funds for hazard mitigation and climate action strategies.
Action Review	
Status	Completed
Narrative describing progress or obstacles that have prevented implementation	Federal grant funds are being utilized.
Next Steps	
Include in the 2024 HMP or Discontinue?	Discontinue
If discontinue, explain why	Federal grant funds are being utilized.

38	
Hazards Addressed	Coastal Erosion, Drought, Extreme Cold, Extreme Heat, Dam/Reservoir Failure, Earthquake, Flood, High Windstorm, Hurricane, Landslides, Tsunamis, Volcanic Hazards, Wildfire, Hazardous Materials, Health Risks
Responsible Party	Mayor's Office
Summary of Original Problem and Solution (Project)	Support the development of a network of community resilience hubs across Maui County that complements the emergency preparedness, response and recovery efforts of the MEMA.
Action Review	
Status	No Progress
Narrative describing progress or obstacles that have prevented implementation	Funding is the major challenge that has prevented this action from being accomplished.
Next Steps	
Include in the 2024 HMP or Discontinue?	Include
If include, revise/reword as appropriate	Support the development of a network of community resilience hubs across Maui County that complements the emergency preparedness, response and recovery efforts of the MEMA.

39	
Hazards Addressed	Flood
Responsible Party	Planning Department
Summary of Original Problem and Solution (Project)	Increase the number of NFIP-trained staff members, including those who are Coastal Zone Management planners, working to support the County's floodplain management program to build administrative capacity and increase performance efficiencies. Have each plan reviewer and building inspector attend a training or workshop related to floodplain management. Sponsor a periodic NFIP workshop for local surveyors and builders. Encourage or require more County staff positions to obtain and maintain Certified Floodplain Manager (CFM) certification, ideally having 2-3 dedicated CFMs optimizing the flood program.
Action Review	
Status	No Progress
Narrative describing progress or obstacles that have prevented implementation	Two CFM staff in the Planning Department have left the County. Currently, there are two County staff with CFM certification, but neither works on the Flood Program. Staff training workshops and NFIP workshops for local surveyors have been suspended since about 2018. The annual Hawai'i Floodplain Management Conference was postponed starting in 2020. Five staff from Planning (1 staff) and DPW (4 staff) attended the conference in 2024; travel expenses were reimbursed by the State Department of Land and Natural Resources.
Next Steps	
Include in the 2024 HMP or Discontinue?	Include

If include, revise/reword as appropriate	Encourage the integration of floodplain best practices across county agencies, including, but not limited to: • Provide floodplain training to County staff who are working to support the County's floodplain management program to build administrative capacity and increase performance efficiencies. Have each plan reviewer and building inspector attend a training or workshop related to floodplain management. • Sponsor a periodic NFIP workshop for local surveyors and builders. • Encourage or require more County staff positions to obtain and maintain Certified Floodplain Manager (CFM) certification, ideally having 2-3 dedicated CFMs optimizing the flood program. • Conduct information sessions regarding the NFIP for public officials and appointees of the Flood Management Program with an emphasis on the importance of the County's participation in the NFIP and the impact of failing to enforce requirements.
40	
Hazards Addressed	Flood
Responsible Party	Planning Department
Summary of Original Problem and Solution (Project)	Conduct information sessions regarding the NFIP for public officials and appointees of the Flood Management Program with an emphasis on the importance of the County's participation in the NFIP and the impact of failing to enforce requirements.
Action Review Status	No Progress
Narrative describing progress or obstacles that have prevented implementation	Annual evaluation reports to the County Council was last conducted in 2018.
Next Steps Include in the 2024 HMP or Discontinue?	Include
If include, revise/reword as appropriate	Combined with Action 39.
41	
Hazards Addressed	Flood
Responsible Party	Planning Department
Summary of Original Problem and Solution (Project)	Maintain NFIP Compliance. Continue to maintain good standing and compliance under the NFIP through implementation of floodplain management programs that, at a minimum, meet the NFIP requirements: enforce the flood damage prevention ordinance, participate in floodplain identification and mapping updates, provide public assistance/information on floodplain requirements and impacts.
Action Review Status	Ongoing Capability
Narrative describing progress or obstacles that have prevented implementation	In 2023, FEMA and DLNR restarted communications for NFIP compliance issues, which were pending a response since 2018. DPW is actively working to resolve these issues. DPW is also actively participating in a FEMA floodplain identification and mapping study.
Next Steps Include in the 2024 HMP or Discontinue?	Include

If include, revise/reword as appropriate	Continue to maintain good standing and compliance under the NFIP through implementation of floodplain management programs that, at a minimum, meet the NFIP requirements: enforce the flood damage prevention ordinance, participate in floodplain identification and mapping updates, provide public assistance/information on floodplain requirements and impacts.
42	
Hazards Addressed	Coastal Erosion, Drought, Extreme Cold, Extreme Heat, Dam/Reservoir Failure, Earthquake, Flood, High Windstorm, Hurricane, Landslides, Tsunamis, Volcanic Hazards, Wildfire
Responsible Party	Planning Department, Emergency Management Agency
Summary of Original Problem and Solution (Project)	Promote public education and involvement related to natural hazards awareness preparedness. (Maui Island Policy 3.1.4a)
Action Review	
Status	In Progress
Narrative describing progress or obstacles that have prevented implementation	Funding is the major challenge that has prevented this action from being accomplished.
Next Steps	
Include in the 2024 HMP or Discontinue?	Include
If include, revise/reword as appropriate	Implement the goal, objectives, policies, and actions of Chapter 3 Natural Hazards of the Maui Island Plan, part of the County's General Plan 2030.
43	
Hazards Addressed	Drought
Responsible Party	Department of Environmental Management, Department of Water Supply
Summary of Original Problem and Solution (Project)	Coordinate with industry stakeholders to develop alternative sources of irrigation water including wastewater reuse, recycled stormwater runoff, and brackish well water.
Action Review	
Status	In Progress
Narrative describing progress or obstacles that have prevented implementation	R1 expansion was already planned in WW's 6 year CIP Plan. Lahaina recovery has expedited and expanded the plan to help offset potable water to be available for recovery.
Next Steps	
Include in the 2024 HMP or Discontinue?	Include
If include, revise/reword as appropriate	Coordinate with industry stakeholders to develop alternative sources of irrigation water including wastewater reuse, recycled stormwater runoff, and brackish well water.

44	
Hazards Addressed	Drought
Responsible Party	Department of Environmental Management, Department of Water Supply
Summary of Original Problem and Solution (Project)	Increase water storage and development of additional capacity in Upcountry Maui and other areas susceptible to drought and encourage efficiency in conservation programs. Maui Island Plan 3.1.2 -Action 10
Action Review	
Status	In Progress
Narrative describing progress or obstacles that have prevented implementation	Conventional water sources are in the process of being developed, additional storage capacity is being pursued, and alternative sources are being investigated.
Next Steps	
Include in the 2024 HMP or Discontinue?	Include
If include, revise/reword as appropriate	Increase water storage and development of additional capacity in Upcountry Maui, West Maui, and other areas susceptible to drought and encourage efficiency in conservation programs. Aligns with Maui Island Plan 3.1.2-Action 10.

45	
Hazards Addressed	Flood
Responsible Party	Department of Public Works
Summary of Original Problem and Solution (Project)	Implement the mitigation actions identified in the existing and future drainage master plans.
Action Review	
Status	In Progress
Narrative describing progress or obstacles that have prevented implementation	DPW completed the Kīhei Drainage Master Plan in 2022 and an Ecological Alternatives Analysis in 2023. DPW is underway with a coastal engineering analysis of the Kīhei Drainage Master Plan starting in 2025. The EPA began an update to the Lahaina Drainage Master Plan in 2025 to recommend nature-based solutions.
Next Steps	
Include in the 2024 HMP or Discontinue?	Include
If include, revise/reword as appropriate	Implement the mitigation actions identified in the existing and future drainage master plans, including, but not limited to, the Kīhei Drainage Master Plan, Ecological Alternatives Analysis, Coastal Engineering Analysis, and Lahaina Drainage Master Plan.

46	
Hazards Addressed	Extreme Heat
Responsible Party	Emergency Management Agency
Summary of Original Problem and Solution (Project)	Identify permanent and temporary facilities that could be used as cooling centers for vulnerable populations as extreme heat events become more intense/more frequent.
Action Review Status	No Progress
Narrative describing progress or obstacles that have prevented implementation	Funding is the major challenge that has prevented this action from being accomplished.
Next Steps Include in the 2024 HMP or Discontinue?	Include
If include, revise/reword as appropriate	Conduct a detailed needs assessment and capital planning/feasibility study for additional emergency shelters for both residents and visitors. This includes retrofitting existing public facilities and structures to withstand up to a Category 3 hurricane and other natural hazards.

47	
Hazards Addressed	Flood
Responsible Party	Emergency Management Agency
Summary of Original Problem and Solution (Project)	Promote the availability of flood insurance to property owners in areas subject to flooding but not located within FEMA-mapped special flood hazard areas, with an emphasis on the ability to purchase for lower premium rates (via preferred risk policies).
Action Review Status	In Progress
Narrative describing progress or obstacles that have prevented implementation	Move to Department of Public Works, this is an action for the Floodplain Manager.
Next Steps Include in the 2024 HMP or Discontinue?	Include
If include, revise/reword as appropriate	Promote the availability of flood insurance to property owners in areas subject to flooding but not located within FEMA-mapped special flood hazard areas, with an emphasis on the ability to purchase for lower premium rates (via preferred risk policies).

48	
Hazards Addressed	Coastal Erosion
Responsible Party	Planning Department
Summary of Original Problem and Solution (Project)	Provide funding support to the University of Hawai'i (Coastal Geology Group) to complete shoreline erosion studies to include Moloka'i and Lāna'i and continue to update studies for Maui.
Action Review Status	In Progress
Narrative describing progress or obstacles that have prevented implementation	Funding is the major challenge that has prevented this action from being accomplished.
Next Steps Include in the 2024 HMP or Discontinue?	Include
If include, revise/reword as appropriate	Support to the joint efforts of the University of Hawai'i (Coastal Geology Group) and Planning Department to complete shoreline erosion studies, to include Moloka'i and Lāna'i and continue to update studies for Maui.

49	
Hazards Addressed	Tsunami
Responsible Party	Planning Department
Summary of Original Problem and Solution (Project)	Propose an amendment to the Zoning Code to prohibit building schools, daycare centers or other facilities that serve vulnerable populations, in tsunami evacuation zones.
Action Review Status	No Progress
Narrative describing progress or obstacles that have prevented implementation	The Department's continued evaluation of alternative construction/design methodology that may deem a revision to this action strategy.
Next Steps Include in the 2024 HMP or Discontinue?	Discontinue
If discontinue, explain why	Much of Hawai'i's shoreline is exposed to the potential for tsunami hazards due to the state's position in the central Pacific and the islands' volcanic activity. Development in tsunami zones should be attuned to the unique risks posed by tsunami and incorporate mitigation measures to the extent possible. Here are the risks to consider: 1. Consider risk in site placement. 2. Consider risk level along with the vulnerability of the proposed development. 3. Evacuation routes should be prioritized. 4. Consider bio-shields and methods of construction/design.

50	
Hazards Addressed	Flood
Responsible Party	Planning Department
Summary of Original Problem and Solution (Project)	Establish an ad-hoc mobile application allowing "on-the-ground" recorded observations of flooding from citizens to create a high-resolution GIS layer of flooding spanning all county parcels.
Action Review Status	In Progress
Narrative describing progress or obstacles that have prevented implementation	Pilot application completed for West Maui in the West Maui Wave-Driven Flooding with Sea Level Rise Tool (https://www.pacioos.Hawai'i .edu/shoreline/slr-westmaui/). The same model is now being applied statewide and should be available, contingent on funding, in a next generation Hawai'i Sea Level Rise Viewer.
Next Steps Include in the 2024 HMP or Discontinue?	Include
If include, revise/reword as appropriate	Continue developing the West Maui Wave-Driven Flooding with Sea Level Rise Tool for other areas of the county, including Moloka'i and Lāna'i.

19.2.2 Identifying New Actions

Throughout the course of the plan update, additional regional and County-level mitigation actions were identified by the following processes:

- Review of the results and findings of the updated risk assessment
- Review of available regional and County plans, reports, and studies
- Direct input from County departments and other regional agencies, including:
  - Office of the Mayor
  - MEMA
  - Department of Public Works
  - Department of Planning
  - Department of Environmental Management
  - Board of Water Supply
  - Fire Prevention Bureau
- Input received through the public and stakeholder outreach process

The HMWG worked to update this HMP with a mitigation strategy focused on well-defined, implementable projects that meet the definition or characteristics of mitigation. Mitigation actions were selected with a careful consideration of benefits (risk reduction, losses avoided), costs, and possible funding sources (including mitigation grant programs). The following sections describe considerations that went into the development of the updated mitigation strategy.

Addressing Known Vulnerabilities

To help support the selection of an appropriate risk-based mitigation strategy, each hazard profile in this HMP includes a summary of hazard vulnerability issues. These were identified during the plan update process by HMWG members, through review of available plans and reports, or through the hazard profiling and risk assessment process.

Focused problem statements were developed based on the identified issues related to hazards in the County. The problem statements provide a detailed description of a problem area, including its impacts on the community; past damage; loss of service; etc. An effort was made to include the street address of the problem location, adjacent streets, water bodies, and well-known structures as well as a brief description of existing conditions (topography, terrain, hydrology) of the site. These problem statements form a bridge between the hazard risk assessment, which quantifies impacts on the community, and the development of an actionable mitigation strategy.

Incorporating a Range of Action Types

Concerted efforts were made to ensure that the updated mitigation strategy covers the range of mitigation action types described in recent FEMA guidance documents (FEMA 2023, FEMA 2018):

- From FEMA Local Mitigation Planning Handbook:
  - **Local Plans and Regulations (LPR)**—These actions include government authorities, policies or codes that influence the way land and buildings are developed and built.
  - **Structure and Infrastructure Project (SIP)**—These actions involve modifying existing structures and infrastructure to protect them from a hazard or remove them from a hazard area. This could apply to public or private structures as well as community lifelines and other critical facilities. This type of action also involves projects to construct structures to reduce the impact of hazards.
  - **Natural Systems Protection (NSP)**—These are actions that minimize damage and losses to natural systems and preserve or restore their functions.
  - **Education and Awareness Programs (EAP)**—These are actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them. These actions may also include participation in national programs, such as the National Flood Insurance Program, Community Rating System, StormReady (NOAA), and Firewise (NFPA).
- From CRS bulletin on key topics:
  - **Preventative Measures (PM)**—Government administrative or regulatory actions or processes that influence the way land and buildings are developed and built. Examples include planning and zoning, local floodplain laws, capital improvement programs, open space preservation, and stormwater management regulations.
  - **Property Protection (PP)**—These actions include public activities to reduce hazard losses or actions that involve modification of existing buildings or structures to protect them from a hazard or removal of the structures from the hazard area. Examples include acquisition, elevation, relocation, structural retrofits, storm shutters, and shatter-resistant glass.

- **Public Information (PI)**—Actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them. Such actions include outreach projects, real estate disclosure, hazard information centers, and educational programs for school-age children and adults.
- **Natural Resource Protection (NR)**—Actions that minimize hazard loss and also preserve or restore the functions of natural systems. These actions include sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, and wetland restoration and preservation.
- **Structural Flood Control Projects (SP)**—Actions that involve the construction of structures to reduce the impact of a hazard. Such structures include dams, setback levees, floodwalls, retaining walls, and safe rooms.
- **Emergency Services (ES)**—Actions that protect people and property during and immediately following a disaster or hazard event. Services include warning systems, emergency response services, and the protection of essential facilities

Protecting Critical Facilities

Mitigation actions that address vulnerable critical facilities have been proposed in consideration of protection against worst-case scenarios. For projects funded through federal mitigation programs, the level of protection may be influenced by cost-effectiveness as determined through a formal benefit-cost analysis. For locally self-funded projects, local discretion must be recognized. It must be recognized that the County has limited authority with regard to mitigation at any level of protection over privately owned critical facilities.

Accounting for Climate Change

As discussed in the hazard profiles in this HMP, the long-term effects of climate change are anticipated to exacerbate the impacts of weather-related hazards (e.g., drought, flood, hurricane, and wildfire). Communities are working to evaluate and recognize these long-term implications and to incorporate mitigation into planning and capital improvement updates.

Mitigation Best Practices

Catalogs of hazard mitigation best practices were developed that present a broad range of alternatives to be considered for use in the mitigation strategy, in compliance with 44 CFR Section 201.6(c)(3)(ii). One catalog was developed for each hazard of concern evaluated in this plan. The catalogs present alternatives that are categorized based on the following:

- Who would have responsibility for implementation:
  - Individuals—personal scale
  - Businesses—corporate scale
  - Government—government scale
- What the alternatives would do:
  - Manipulate the hazard

- Reduce vulnerability to the hazard
- Reduce impacts from the hazard
- Build local capacity to respond to or be prepared for the hazard

The alternatives include actions that would mitigate current risk from hazards and actions that would help reduce risk from changes in the impacts of these hazards resulting from climate change. The catalogs provide a baseline of mitigation alternatives that are backed by a planning process, are consistent with the established mitigation goals, and are within the capabilities of the County to implement. Some of these actions may not be feasible based on the selection criteria identified for this plan. The purpose of the catalogs was to provide a list of what could be considered to reduce risk from natural hazards within the planning area. Appropriate hazard mitigation actions were selected from among the alternatives in the catalogs for inclusion in the mitigation strategy. Actions in the catalog that are not included in the mitigation strategy were not selected for one or more of the following reasons:

- The action is not feasible
- The action is already being implemented
- There is an apparently more cost-effective alternative
- The action does not have public or political support.

The catalogs are included in Appendix I.

19.3 ACTIONS INCLUDED IN THE UPDATED MITIGATION STRATEGY

The mitigation action worksheets included at the end of this chapter list the mitigation actions that Maui County will pursue in the future to reduce the effects of hazards. The actions are dependent upon available funding (grants and local match availability) and may be modified or omitted at any time based on the occurrence of new hazard events and changes in County priorities.

19.3.1 Mitigation Strategy Analysis

Table 19-2 and Table 19-3 indicate the range of proposed mitigation actions. The tables list the action numbers by the hazards that each action addresses and the FEMA and CRS action type categories they fall under.

Table 19-2. Analysis of Mitigation Actions by Hazard and Action Type Category from FEMA Local Planning Handbook

Actions That Address the Designated Hazard, By FEMA Action Type Category[a]			
LPR	SIP	NSP	EAP
Coastal Erosion			
10. Molokaʻi Energy Supply; 15. Disaster Recovery Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 18. Molokaʻi Risk Assessment; 20. Implement Lahaina Long-Term Recovery Plan; 24. Open Space Analysis; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan; 30. Implement Hele Mai Maui 2045; 31. Undeveloped Land Master Plan; 32. Evacuation Routes; 35. General Plan; 37. Coastal Road Management Plan; 46. Community Resilience Hubs; 48. Wave-Driven Flooding Tool; 49. County Bridge Inventory	6. Homeowner Mitigation Assistances; 16. Implement Maui Island Plan Natural Hazards Chapter; 20. Implement Lahaina Long-Term Recovery Plan; 25. Flood Proof Water Facilities; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan; 30. Implement Hele Mai Maui 2045; 33. State Highway Route 450; 45. Saltwater Intrusion Mitigation; 46. Community Resilience Hubs	16. Implement Maui Island Plan Natural Hazards Chapter; 20. Implement Lahaina Long-Term Recovery Plan; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan; 30. Implement Hele Mai Maui 2045; 45. Saltwater Intrusion Mitigation	3. Isolated Community Preparedness; 6. Homeowner Mitigation Assistances; 16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 20. Implement Lahaina Long-Term Recovery Plan; 21. Molokaʻi Working Group; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan; 30. Implement Hele Mai Maui 2045; 46. Community Resilience Hubs
Dam and Reservoir Failure			
9. Shelter Assessment; 10. Molokaʻi Energy Supplies; 16. Implement Maui Island Plan Natural Hazards Chapter; 18. Molokaʻi Risk Assessment; 23. Water Conservation Ordinance; 29. Implement Climate Action and Resiliency Plan; 32. Evacuation Routes; 35. General Plan; 46. Community Resilience Hubs; 52. HHPD Emergency Actions Plans	16. Implement Maui Island Plan Natural Hazards Chapter; 29. Implement Climate Action and Resiliency Plan; 33. State Highway Route 450; 46. Community Resilience Hubs; 53. HHPD Infrastructure Reinforcement Projects	16. Implement Maui Island Plan Natural Hazards Chapter; 29. Implement Climate Action and Resiliency Plan	3. Isolated Community Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 21. Molokaʻi Working Group; 29. Implement Climate Action and Resiliency Plan; 46. Community Resilience Hubs

Actions That Address the Designated Hazard, By FEMA Action Type Category[a]			
LPR	SIP	NSP	EAP
Drought			
8. Greywater Code and Regulation Changes; 10. Molokaʻi Energy Supply; 12. Low Impact Developments; 16. Implement Maui Island Plan Natural Hazards Chapter; 18. Molokaʻi Risk Assessment; 23. Water Conservation Ordinance; 29. Implement Climate Action and Resiliency Plan; 32. Evacuation Routes; 35. General Plan; 46. Community Resilience Hubs	16. Implement Maui Island Plan Natural Hazards Chapter; 29. Implement Climate Action and Resiliency Plan; 33. State Highway Route 450; 34. Aquifer Source Development; 40. Water Storage and Conservation; 41. Upcountry Emergency Waterline; 46. Community Resilience Hubs; 50. Alternative Irrigation Sources; 51. Kamole Water Treatment Plant	12. Low Impact Developments; 16. Implement Maui Island Plan Natural Hazards Chapter; 22. Axis Deer Mitigation; 29. Implement Climate Action and Resiliency Plan	3. Isolated Community Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 21. Molokaʻi Working Group; 22. Axis Deer Mitigation; 29. Implement Climate Action and Resiliency Plan; 46. Community Resilience Hubs
Earthquake			
9. Shelter Assessment; 10. Molokaʻi Energy Supply; 15. Disaster Recovery Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 18. Molokaʻi Risk Assessment; 29. Implement Climate Action and Resiliency Plan; 32. Evacuation Routes; 35. General Plan; 43. Substantial Damage Estimator; 46. Community Resilience Hubs	16. Implement Maui Island Plan Natural Hazards Chapter; 29. Implement Climate Action and Resiliency Plan; 33. State Highway Route 450; 46. Community Resilience Hubs	16. Implement Maui Island Plan Natural Hazards Chapter; 29. Implement Climate Action and Resiliency Plan	3. Isolated Community Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 21. Molokaʻi Working Group; 29. Implement Climate Action and Resiliency Plan; 46. Community Resilience Hubs

Actions That Address the Designated Hazard, By FEMA Action Type Category[a]			
LPR	SIP	NSP	EAP
Flood			
1. NFIP/CRS Compliance; 7. Flood Insurance Outside SFHA; 9. Shelter Assessment; 10. Molokaʻi Energy Supply; 12. Low Impact Development; 14. Expand MAPPS Capabilities; 15. Disaster Recovery Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 17. Stream Maintenance Plan; ; 18. Molokaʻi Risk Assessment; 20. Implement Lahaina Long-Term Recovery Plan; 24. Open Space Analysis; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan; 30. Implement Hele Mai Maui 2045; 31. Undeveloped Land Master Plan; 32. Evacuation Routes; 35. General Plan; 36. Repetitive Loss Outside SFHA; 43. Substantial Damage Estimator; 44. Drainage Plan Implementation; 45. Saltwater Intrusion Mitigation; 46. Community Resilience Hubs; 48. Wave-Driven Flooding Tool; 49. County Bridge Inventory	6. Homeowner Mitigation Assistances; 16. Implement Maui Island Plan Natural Hazards Chapter; 20. Implement Lahaina Long-Term Recovery Plan; 25. Flood Proof Water Facilities; 27. Upper Kula Water Transmission Retrofit; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan; 30. Implement Hele Mai Maui 2045; 33. State Highway Route 450; 39. Stormwater Drainage System; 44. Drainage Plan Implementation; 45. Saltwater Intrusion Mitigation; 46. Community Resilience Hubs	12. Low Impact Developments; 16. Implement Maui Island Plan Natural Hazards Chapter; 20. Implement Lahaina Long-Term Recovery Plan; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan; 30. Implement Hele Mai Maui 2045; 44. Drainage Plan Implementation; 45. Saltwater Intrusion Mitigation	2. Maintain CRS Class 7; 3. Isolated Community Preparedness; 6. Homeowner Mitigation Assistance; 7. Flood Insurance Outside SFHAs; 16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 20. Implement Lahaina Long-Term Recovery Plan; 21. Molokaʻi Working Group; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan; 30. Implement Hele Mai Maui 2045; 42. Floodplain Training and Certification; 46. Community Resilience Hubs
High Windstorm			
9. Shelter Assessment; 10. Molokaʻi Energy Supply; 15. Disaster Recovery Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 18. Molokaʻi Risk Assessment; 20. Implement Lahaina Long-Term Recovery Plan; 29. Implement Climate Action and Resiliency Plan; 32. Evacuation Routes; 35. General Plan; 43. Substantial Damage Estimator; 46. Community Resilience Hubs	13. Emergency Generators for Critical Water Infrastructures; 16. Implement Maui Island Plan Natural Hazards Chapter; 20. Implement Lahaina Long-Term Recovery Plan; 29. Implement Climate Action and Resiliency Plan; 33. State Highway Route 450; 46. Community Resilience Hubs	16. Implement Maui Island Plan Natural Hazards Chapter; 20. Implement Lahaina Long-Term Recovery Plan; 29. Implement Climate Action and Resiliency Plan	3. Isolated Community Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 20. Implement Lahaina Long-Term Recovery Plan; 21. Molokaʻi Working Group; 29. Implement Climate Action and Resiliency Plan; 46. Community Resilience Hubs

Actions That Address the Designated Hazard, By FEMA Action Type Category[a]			
LPR	SIP	NSP	EAP
Hurricane			
9. Shelter Assessment; 10. Molokaʻi Energy Supply; 12. Low Impact Development; 15. Disaster Recovery Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 18. Molokaʻi Risk Assessment; 24. Open Space Analysis; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan; 32. Evacuation Routes; 35. General Plan; 43. Substantial Damage Estimator; 46. Community Resilience Hubs	6. Homeowner Mitigation Assistance; 13. Emergency Generators for Critical Water Infrastructures; 16. Implement Maui Island Plan Natural Hazards Chapter; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan; 33. State Highway Route 450; 39. Stormwater Drainage System; 46. Community Resilience Hubs; 51. Kamole Water Treatment Plant	12. Low Impact Developments; 16. Implement Maui Island Plan Natural Hazards Chapter; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan	3. Isolated Community Preparedness; 6. Homeowner Mitigation Assistances; 16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 21. Molokaʻi Working Group; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan; 46. Community Resilience Hubs
Landslide			
9. Shelter Assessment; 10. Molokaʻi Energy Supply; 15. Disaster Recovery Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 18. Molokaʻi Risk Assessment; 20. Implement Lahaina Long-Term Recovery Plan; 26. Landslide and Rockfall Hazard Area; 29. Implement Climate Action and Resiliency Plan; 32. Evacuation Routes; 35. General Plan; 46. Community Resilience Hubs	13. Emergency Generators for Critical Water Infrastructures; 16. Implement Maui Island Plan Natural Hazards Chapter; 20. Implement Lahaina Long-Term Recovery Plan; 26. Landslide and Rockfall Hazard Area; 29. Implement Climate Action and Resiliency Plan; 33. State Highway Route 450; 38. Drainage and Slope Stabilization; 41. Upcountry Emergency Waterline; 46. Community Resilience Hubs	16. Implement Maui Island Plan Natural Hazards Chapter; 20. Implement Lahaina Long-Term Recovery Plan; 29. Implement Climate Action and Resiliency Plan; 38. Drainage and Slope Stabilization	3. Isolated Community Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 20. Implement Lahaina Long-Term Recovery Plan; 21. Molokaʻi Working Group; 29. Implement Climate Action and Resiliency Plan; 46. Community Resilience Hubs

Actions That Address the Designated Hazard, By FEMA Action Type Category[a]			
LPR	SIP	NSP	EAP
Tsunami			
9. Shelter Assessment; 10. Molokaʻi Energy Supply; 15. Disaster Recovery Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 18. Molokaʻi Risk Assessment; 24. Open Space Analysis; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan; 31. Undeveloped Land Master Plan; 32. Evacuation Routes; 35. General Plan; 43. Substantial Damage Estimator; 46. Community Resilience Hubs; 49. County Bridge Inventory	6. Homeowner Mitigation Assistance; 13. Emergency Generators for Critical Water Infrastructures; 16. Implement Maui Island Plan Natural Hazards Chapter; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan; 33. State Highway Route 450; 41. Upcountry Emergency Waterline; 46. Community Resilience Hubs	16. Implement Maui Island Plan Natural Hazards Chapter; 25. Flood Proof Water Facilities; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan	3. Isolated Community Preparedness; 6. Homeowner Mitigation Assistances; 16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 21. Molokaʻi Working Group; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan; 46. Community Resilience Hubs
Volcanic			
9. Shelter Assessment; 10. Molokaʻi Energy Supply; 15. Disaster Recovery Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 18. Molokaʻi Risk Assessment; 29. Implement Climate Action and Resiliency Plan; 32. Evacuation Routes; 35. General Plan; 46. Community Resilience Hubs	16. Implement Maui Island Plan Natural Hazards Chapter; 29. Implement Climate Action and Resiliency Plan; 33. State Highway Route 450; 46. Community Resilience Hubs	16. Implement Maui Island Plan Natural Hazards Chapter; 29. Implement Climate Action and Resiliency Plan	3. Isolated Community Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 21. Molokaʻi Working Group; 29. Implement Climate Action and Resiliency Plan; 46. Community Resilience Hubs

Actions That Address the Designated Hazard, By FEMA Action Type Category[a]			
LPR	SIP	NSP	EAP
Wildfire			
4. CWPP Implementation; 5. Wildfire Mitigation in Non-CWPP Areas; 9. Shelter Assessment; 10. Molokaʻi Energy Supply; 12. Low Impact Development; 15. Disaster Recovery Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 18. Molokaʻi Risk Assessment; 20. Implement Lahaina Long-Term Recovery Plan; 29. Implement Climate Action and Resiliency Plan; 30. Implement Hele Mai Maui 2045; 32. Evacuation Routes; 35. General Plan; 43. Substantial Damage Estimator; 46. Community Resilience Hubs	13. Emergency Generators for Critical Water Infrastructures; 16. Implement Maui Island Plan Natural Hazards Chapter; 20. Implement Lahaina Long-Term Recovery Plan; 27. Upper Kula Water Transmission Retrofit; 29. Implement Climate Action and Resiliency Plan; 30. Implement Hele Mai Maui 2045; 33. State Highway Route 450; 34. Aquifer Source Development; 40. Water Storage and Conservation; 41. Upcountry Emergency Waterline; 46. Community Resilience Hubs; 50. Alternative Irrigation Sources	4. CWPP Implementation; 5. Wildfire Mitigation in Non-CWPP Areas; 12. Low Impact Development; s; 16. Implement Maui Island Plan Natural Hazards Chapter; 20. Implement Lahaina Long-Term Recovery Plan; 29. Implement Climate Action and Resiliency Plan; 30. Implement Hele Mai Maui 2045	3. Isolated Community Preparedness; 4. CWPP Implementation; 5. Wildfire Mitigation in Non-CWPP Areas; 11. Firewise Expansions; 16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 20. Implement Lahaina Long-Term Recovery Plan; 21. Molokaʻi Working Group; 29. Implement Climate Action and Resiliency Plan; 30. Implement Hele Mai Maui 2045; 46. Community Resilience Hubs

a. Action type codes are defined in the bullet list under "Incorporating a Range of Action Types" in Section 19.2.2.

Table 19-3. Analysis of Mitigation Actions by Hazard and Action Type Category from CRS Key Topics Bulletin

Actions That Address the Designated Hazard, By CRS Action Type Category[a]					
PM	PP	PI	NR	SP	ES
Coastal Erosion					
10. Molokaʻi Energy Supply; 15. Disaster Recovery Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 18. Molokaʻi Risk Assessment; 20. Implement Lahaina Long-Term Recovery Plan; 24. Open Space Analysis; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan; 30. Implement Hele Mai Maui 2045; 31. Undeveloped Land Master Plan; 32. Evacuation Routes; 33. State Highway Route 450; 35. General Plan; 45. Saltwater Intrusion Mitigation; 46. Community Resilience Hubs; 47. Shoreline Erosion Studies; 49. County Bridge Inventory	6. Homeowner Mitigation Assistances; 16. Implement Maui Island Plan Natural Hazards Chapter; 20. Implement Lahaina Long-Term Recovery Plan; 25. Flood Proof Water Facilities; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan; 30. Implement Hele Mai Maui 2045; 33. State Highway Route 450; 45. Saltwater Intrusion Mitigation; 46. Community Resilience Hubs	3. Isolated Community Preparedness; 6. Homeowner Mitigation Assistances; 16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 20. Implement Lahaina Long-Term Recovery Plan; 21. Molokaʻi Working Group; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan; 30. Implement Hele Mai Maui 2045; 46. Community Resilience Hubs; 48. Wave-Driven Flooding Tool	16. Implement Maui Island Plan Natural Hazards Chapter; 20. Implement Lahaina Long-Term Recovery Plan; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan; 30. Implement Hele Mai Maui 2045; 45. Saltwater Intrusion Mitigation	16. Implement Maui Island Plan Natural Hazards Chapter; 20. Implement Lahaina Long-Term Recovery Plan; 29. Implement Climate Action and Resiliency Plan; 30. Implement Hele Mai Maui 2045; 33. State Highway Route 450; 45. Saltwater Intrusion Mitigation	15. Disaster Recovery Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 20. Implement Lahaina Long-Term Recovery Plan; 25. Flood Proof Water Facilities; 29. Implement Climate Action and Resiliency Plan; 30. Implement Hele Mai Maui 2045; 46. Community Resilience Hubs

Actions That Address the Designated Hazard, By CRS Action Type Category[a]					
PM	PP	PI	NR	SP	ES
Dam and Reservoir Failure					
9. Shelter Assessment; 10. Molokaʻi Energy Supplies; 16. Implement Maui Island Plan Natural Hazards Chapter; 18. Molokaʻi Risk Assessment; 23. Water Conservation Ordinance; 29. Implement Climate Action and Resiliency Plan; 32. Evacuation Routes; 33. State Highway Route 450; 35. General Plan; 46. Community Resilience Hubs; 52. HHPD Emergency Action Plans	16. Implement Maui Island Plan Natural Hazards Chapter; 29. Implement Climate Action and Resiliency Plan; 33. State Highway Route 450; 46. Community Resilience Hubs	3. Isolated Community Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 21. Molokaʻi Working Group; 29. Implement Climate Action and Resiliency Plan; 46. Community Resilience Hubs	16. Implement Maui Island Plan Natural Hazards Chapter; 29. Implement Climate Action and Resiliency Plan	16. Implement Maui Island Plan Natural Hazards Chapter; 29. Implement Climate Action and Resiliency Plan; 33. State Highway Route 450; 53. HHPD Infrastructure Reinforcement Projects	16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 29. Implement Climate Action and Resiliency Plan; 46. Community Resilience Hubs
Drought					
10. Molokaʻi Energy Supply; 12. Low Impact Developments; 16. Implement Maui Island Plan Natural Hazards Chapter; 18. Molokaʻi Risk Assessment; 23. Water Conservation Ordinance; 29. Implement Climate Action and Resiliency Plan; 32. Evacuation Routes; 33. State Highway Route 450; 35. General Plan; 40. Water Storage and Conservation; 46. Community Resilience Hubs; 50. Alternative Irrigation Sources	16. Implement Maui Island Plan Natural Hazards Chapter; 29. Implement Climate Action and Resiliency Plan; 33. State Highway Route 450; 46. Community Resilience Hubs	3. Isolated Community Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 21. Molokaʻi Working Group; 22. Axis Deer Mitigation; 29. Implement Climate Action and Resiliency Plan; 46. Community Resilience Hubs	8. Greywater Code and Regulation Changes; 16. Implement Maui Island Plan Natural Hazards Chapter; 22. Axis Deer Mitigation; 29. Implement Climate Action and Resiliency Plan; 34. Aquifer Source Development; 51. Kamole Water Treatment Plant	16. Implement Maui Island Plan Natural Hazards Chapter; 29. Implement Climate Action and Resiliency Plan; 33. State Highway Route 450; 34. Aquifer Source Development; 51. Kamole Water Treatment Plant	16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 29. Implement Climate Action and Resiliency Plan; 41. Upcountry Emergency Waterline; 46. Community Resilience Hubs

Actions That Address the Designated Hazard, By CRS Action Type Category[a]					
PM	PP	PI	NR	SP	ES
Earthquake					
9. Shelter Assessment; 10. Molokaʻi Energy Supply; 15. Disaster Recovery Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 18. Molokaʻi Risk Assessment; 29. Implement Climate Action and Resiliency Plan; 32. Evacuation Routes; 33. State Highway Route 450; 35. General Plan; 43. Substantial Damage Estimator; 46. Community Resilience Hubs	16. Implement Maui Island Plan Natural Hazards Chapter; 29. Implement Climate Action and Resiliency Plan; 33. State Highway Route 450; 46. Community Resilience Hubs	3. Isolated Community Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 21. Molokaʻi Working Group; 29. Implement Climate Action and Resiliency Plan; 46. Community Resilience Hubs	16. Implement Maui Island Plan Natural Hazards Chapter; 29. Implement Climate Action and Resiliency Plan	16. Implement Maui Island Plan Natural Hazards Chapter; 29. Implement Climate Action and Resiliency Plan; 33. State Highway Route 450	15. Disaster Recovery Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 29. Implement Climate Action and Resiliency Plan; 46. Community Resilience Hubs

Actions That Address the Designated Hazard, By CRS Action Type Category[a]					
PM	PP	PI	NR	SP	ES
Flood					
1. NFIP/CRS Compliance; 9. Shelter Assessment; 10. Molokaʻi Energy Supply; 12. Low Impact Development; 14. Expand MAPPS Capabilities; 15. Disaster Recovery Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 17. Stream Maintenance Plan; 18. Molokaʻi Risk Assessment; 20. Implement Lahaina Long-Term Recovery Plan; 24. Open Space Analysis; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan; 30. Implement Hele Mai Maui 2045; 31. Undeveloped Land Master Plan; 32. Evacuation Routes; 33. State Highway Route 450; 35. General Plan; 36. Repetitive Loss Outside SFHA; 43. Substantial Damage Estimator; 44. Drainage Plan Implementation; 45. Saltwater Intrusion Mitigation; 46. Community Resilience Hubs; 49. County Bridge Inventory	6. Homeowner Mitigation Assistance; 7. Flood Insurance Outside SFHAs; 16. Implement Maui Island Plan Natural Hazards Chapter; 20. Implement Lahaina Long-Term Recovery Plan; 25. Flood Proof Water Facilities; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan; 30. Implement Hele Mai Maui 2045; 33. State Highway Route 450; 44. Drainage Plan Implementation; 45. Saltwater Intrusion Mitigation; 46. Community Resilience Hubs	1. NFIP/CRS Compliance; 2. Maintain CRS Class 7; 3. Isolated Community Preparedness; 6. Homeowner Mitigation Assistance; 7. Flood Insurance Outside SFHAs; 16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 20. Implement Lahaina Long-Term Recovery Plan; 21. Molokaʻi Working Group; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan; 30. Implement Hele Mai Maui 2045; 42. Floodplain Training and Certification; 46. Community Resilience Hubs; 48. Wave-Driven Flooding Tool	16. Implement Maui Island Plan Natural Hazards Chapter; 20. Implement Lahaina Long-Term Recovery Plan; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan; 30. Implement Hele Mai Maui 2045; 44. Drainage Plan Implementation; 45. Saltwater Intrusion Mitigation	16. Implement Maui Island Plan Natural Hazards Chapter; 20. Implement Lahaina Long-Term Recovery Plan; 29. Implement Climate Action and Resiliency Plan; 30. Implement Hele Mai Maui 2045; 33. State Highway Route 450; 39. Stormwater Drainage System; 44. Drainage Plan Implementation; 45. Saltwater Intrusion Mitigation; 45. Saltwater Intrusion Mitigation	15. Disaster Recovery Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 20. Implement Lahaina Long-Term Recovery Plan; 25. Flood Proof Water Facilities; 27. Upper Kula Water Transmission Retrofit; 29. Implement Climate Action and Resiliency Plan; 30. Implement Hele Mai Maui 2045; 44. Drainage Plan Implementation; 46. Community Resilience Hubs

Actions That Address the Designated Hazard, By CRS Action Type Category[a]					
PM	PP	PI	NR	SP	ES
High Windstorm					
9. Shelter Assessment; 10. Molokaʻi Energy Supply; 15. Disaster Recovery Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 18. Molokaʻi Risk Assessment; 20. Implement Lahaina Long-Term Recovery Plan; 29. Implement Climate Action and Resiliency Plan; 32. Evacuation Routes; 33. State Highway Route 450; 35. General Plan; 43. Substantial Damage Estimator; 46. Community Resilience Hubs	16. Implement Maui Island Plan Natural Hazards Chapter; 20. Implement Lahaina Long-Term Recovery Plan; 29. Implement Climate Action and Resiliency Plan; 33. State Highway Route 450; 46. Community Resilience Hubs	3. Isolated Community Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 20. Implement Lahaina Long-Term Recovery Plan; 21. Molokaʻi Working Group; 29. Implement Climate Action and Resiliency Plan; 46. Community Resilience Hubs	16. Implement Maui Island Plan Natural Hazards Chapter; 20. Implement Lahaina Long-Term Recovery Plan; 29. Implement Climate Action and Resiliency Plan	16. Implement Maui Island Plan Natural Hazards Chapter; 20. Implement Lahaina Long-Term Recovery Plan; 29. Implement Climate Action and Resiliency Plan; 33. State Highway Route 450	13. Emergency Generators for Critical Water Infrastructure; 15. Disaster Recovery Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 20. Implement Lahaina Long-Term Recovery Plan; 29. Implement Climate Action and Resiliency Plan; 46. Community Resilience Hubs
Hurricane					
9. Shelter Assessment; 10. Molokaʻi Energy Supply; 12. Low Impact Development; 15. Disaster Recovery Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 18. Molokaʻi Risk Assessment; 24. Open Space Analysis; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan; 32. Evacuation Routes; 33. State Highway Route 450; 35. General Plan; 43. Substantial Damage Estimator; 46. Community Resilience Hubs	6. Homeowner Mitigation Assistances; 16. Implement Maui Island Plan Natural Hazards Chapter; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan; 33. State Highway Route 450; 46. Community Resilience Hubs	3. Isolated Community Preparedness; 6. Homeowner Mitigation Assistances; 16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 21. Molokaʻi Working Group; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan; 46. Community Resilience Hubs	16. Implement Maui Island Plan Natural Hazards Chapter; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan; 51. Kamole Water Treatment Plant	16. Implement Maui Island Plan Natural Hazards Chapter; 29. Implement Climate Action and Resiliency Plan; 33. State Highway Route 450; 39. Stormwater Drainage System; 51. Kamole Water Treatment Plant	13. Emergency Generators for Critical Water Infrastructure; 15. Disaster Recovery Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 29. Implement Climate Action and Resiliency Plan; 46. Community Resilience Hubs

Actions That Address the Designated Hazard, By CRS Action Type Category[a]					
PM	PP	PI	NR	SP	ES
Landslide					
9. Shelter Assessment; 10. Molokaʻi Energy Supply; 15. Disaster Recovery Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 18. Molokaʻi Risk Assessment; 20. Implement Lahaina Long-Term Recovery Plan; 26. Landslide and Rockfall Hazard Area; 29. Implement Climate Action and Resiliency Plan; 32. Evacuation Routes; 33. State Highway Route 450; 35. General Plan; 46. Community Resilience Hubs	16. Implement Maui Island Plan Natural Hazards Chapter; 20. Implement Lahaina Long-Term Recovery Plan; 29. Implement Climate Action and Resiliency Plan; 33. State Highway Route 450; 46. Community Resilience Hubs	3. Isolated Community Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 20. Implement Lahaina Long-Term Recovery Plan; 21. Molokaʻi Working Group; 29. Implement Climate Action and Resiliency Plan; 46. Community Resilience Hubs	16. Implement Maui Island Plan Natural Hazards Chapter; 20. Implement Lahaina Long-Term Recovery Plan; 26. Landslide and Rockfall Hazard Area; 29. Implement Climate Action and Resiliency Plan; 38. Drainage and Slope Stabilization	16. Implement Maui Island Plan Natural Hazards Chapter; 20. Implement Lahaina Long-Term Recovery Plan; 29. Implement Climate Action and Resiliency Plan; 33. State Highway Route 450	13. Emergency Generators for Critical Water Infrastructure; 15. Disaster Recovery Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 20. Implement Lahaina Long-Term Recovery Plan; 29. Implement Climate Action and Resiliency Plan; 41. Upcountry Emergency Waterline; 46. Community Resilience Hubs
Tsunami					
9. Shelter Assessment; 10. Molokaʻi Energy Supply; 15. Disaster Recovery Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 18. Molokaʻi Risk Assessment; 24. Open Space Analysis; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan; 31. Undeveloped Land Master Plan; 32. Evacuation Routes; 33. State Highway Route 450; 35. General Plan; 43. Substantial Damage Estimator; 46. Community Resilience Hubs; 49. County Bridge Inventory	6. Homeowner Mitigation Assistances; 16. Implement Maui Island Plan Natural Hazards Chapter; 25. Flood Proof Water Facilities; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan; 33. State Highway Route 450; 46. Community Resilience Hubs	3. Isolated Community Preparedness; 6. Homeowner Mitigation Assistances; 16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 21. Molokaʻi Working Group; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan; 46. Community Resilience Hubs	16. Implement Maui Island Plan Natural Hazards Chapter; 28. Beach and Dune Restoration; 29. Implement Climate Action and Resiliency Plan	16. Implement Maui Island Plan Natural Hazards Chapter; 29. Implement Climate Action and Resiliency Plan; 33. State Highway Route 450	13. Emergency Generators for Critical Water Infrastructure; 15. Disaster Recovery Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 25. Flood Proof Water Facilities; 29. Implement Climate Action and Resiliency Plan; 41. Upcountry Emergency Waterline; 46. Community Resilience Hubs

Actions That Address the Designated Hazard, By CRS Action Type Category[a]					
PM	PP	PI	NR	SP	ES
Volcanic					
9. Shelter Assessment; 10. Molokaʻi Energy Supply; 15. Disaster Recovery Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 18. Molokaʻi Risk Assessment; 29. Implement Climate Action and Resiliency Plan; 32. Evacuation Routes; 33. State Highway Route 450; 35. General Plan; 46. Community Resilience Hubs	16. Implement Maui Island Plan Natural Hazards Chapter; 29. Implement Climate Action and Resiliency Plan; 33. State Highway Route 450; 46. Community Resilience Hubs	3. Isolated Community Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 21. Molokaʻi Working Group; 29. Implement Climate Action and Resiliency Plan; 46. Community Resilience Hubs	16. Implement Maui Island Plan Natural Hazards Chapter; 29. Implement Climate Action and Resiliency Plan	16. Implement Maui Island Plan Natural Hazards Chapter; 29. Implement Climate Action and Resiliency Plan; 33. State Highway Route 450	15. Disaster Recovery Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 29. Implement Climate Action and Resiliency Plan; 46. Community Resilience Hubs
Wildfire					
4. CWPP Implementation; 5. Wildfire Mitigation in Non-CWPP Areas; 9. Shelter Assessment; 10. Molokaʻi Energy Supply; 12. Low Impact Development; 15. Disaster Recovery Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 18. Molokaʻi Risk Assessment; 20. Implement Lahaina Long-Term Recovery Plan; 29. Implement Climate Action and Resiliency Plan; 30. Implement Hele Mai Maui 2045; 32. Evacuation Routes; 33. State Highway Route 450; 35. General Plan; 40. Water Storage and Conservation; 43. Substantial Damage Estimator; 46. Community Resilience Hubs; 50. Alternative Irrigation Sources	4. CWPP Implementation; 5. Wildfire Mitigation in Non-CWPP Areas; 16. Implement Maui Island Plan Natural Hazards Chapter; 20. Implement Lahaina Long-Term Recovery Plan; 29. Implement Climate Action and Resiliency Plan; 30. Implement Hele Mai Maui 2045; 33. State Highway Route 450; 46. Community Resilience Hubs	3. Isolated Community Preparedness; 4. CWPP Implementation; 5. Wildfire Mitigation in Non-CWPP Areas; 11. Firewise Expansions; 16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 20. Implement Lahaina Long-Term Recovery Plan; 21. Molokaʻi Working Group; 29. Implement Climate Action and Resiliency Plan; 30. Implement Hele Mai Maui 2045; 46. Community Resilience Hubs	4. CWPP Implementation; 5. Wildfire Mitigation in Non-CWPP Areas; 16. Implement Maui Island Plan Natural Hazards Chapter; 20. Implement Lahaina Long-Term Recovery Plan; 29. Implement Climate Action and Resiliency Plan; 30. Implement Hele Mai Maui 2045; 34. Aquifer Source Development	16. Implement Maui Island Plan Natural Hazards Chapter; 20. Implement Lahaina Long-Term Recovery Plan; 29. Implement Climate Action and Resiliency Plan; 30. Implement Hele Mai Maui 2045; 33. State Highway Route 450; 34. Aquifer Source Development	13. Emergency Generators for Critical Water Infrastructure; 15. Disaster Recovery Preparedness; 16. Implement Maui Island Plan Natural Hazards Chapter; 19. CERT and Teen CERT; 20. Implement Lahaina Long-Term Recovery Plan; 27. Upper Kula Water Transmission Retrofit; 29. Implement Climate Action and Resiliency Plan; 30. Implement Hele Mai Maui 2045; 41. Upcountry Emergency Waterline; 46. Community Resilience Hubs; 47. Shoreline Erosion Studies

a. *Action type codes are defined in the bullet list under "Incorporating a Range of Action Types" in Section 19.2.2.*

19.3.2 Prioritization

Section 201.c.3.iii of 44 CFR establishes how mitigation strategies are to be prioritized, implemented, and administered by local jurisdictions. For this plan update, each mitigation action, including mitigation actions for high hazard potential dams, was prioritized using suitable criteria for evaluating hazard mitigation. This method provided a systematic approach that considered the opportunities and constraints of implementing each mitigation action.

For the plan update there has been an effort to develop a more clearly defined and action-oriented mitigation strategy. The updated strategy includes actions that are seen by the community as the most effective approaches to advance local mitigation goals within the County's capabilities. In addition, each County agency was asked to develop problem statements. Ultimately, the County developed an action-oriented and achievable mitigation strategy.

Benefit/Cost Review

Section 201.6.c.3iii of 44 CFR requires the prioritization of the mitigation strategy to emphasize a benefit/cost comparison of the proposed actions. For all actions identified in the mitigation strategy, the County identified the associated costs and benefits as follows:

- **Costs** presented include the total project estimation. This can include administrative, construction (engineering, design, and permitting), and maintenance costs.
- **Benefits** are the savings from losses avoided through project implementation. These can include life safety, structure and infrastructure damage, loss of service or function, and economic and environmental damage and losses.

When possible, actual or estimated dollar costs and associated benefits were developed. Where estimates of costs and benefits were available, the ratings were defined follows:

Low < = $10,000 Medium = $10,000 to $100,000 High > = $100,000

Where numerical costs or benefits could not be quantified, cost-effectiveness was evaluated using qualitative *high*, *medium*, and *low* ratings based on the following definitions:

- Costs
  - High—Existing funding levels are not adequate to cover the costs of the proposed project, and implementation would require an increase in revenue through an alternative source (e.g., bonds, grants, and fee increases).
  - Medium—The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.
  - Low—The project could be funded under the existing budget. The project is part of or can be part of an existing, ongoing program.

- Benefits
  - High—Project will have an immediate impact on the reduction of risk exposure to life and property.
  - Medium—Project will have a long-term impact on the reduction of risk exposure to life and property or will provide an immediate reduction in the risk exposure to property.
  - Low—Long-term benefits of the project are difficult to quantify in the short-term.

Using this approach, projects with positive benefit versus cost ratios (such as high over high, high over medium, medium over low, etc.) are considered cost-effective.

Prioritization Scoring

Each mitigation action was assigned a priority based on the following equation and the scores for costs, benefits, goals, and time frame shown in Table 19-4.

Action Prioritization Equation

Priority = [(Costs) + (Benefits) + (Goals Met) + (Time Frame)]

Table 19-4. Scoring System for Prioritizing Mitigation Actions

Criteria	Score
Costs	
High	1 point
Medium	2 points
Low	3 points
Benefits	
High	3 points
Medium	2 points
Low	1 point
Number of Goals Met	
1 Goal	0.2 points
2 Goals	0.4 points
3 Goals	0.6 points
4 Goals	0.8 points
5 Goals	1 point
Implementation Time Frame	
1-5 Years	2 points
1-10 Years	1 point

The numerical results were totaled and then used to help prioritize the action as *low*, *medium*, or *high*. Actions that had a numerical value between 0 and 5 were categorized as *low priority*; actions with numerical values between 5 and 7 were categorized as *medium priority*; and actions with numerical values between 7 and 9 were categorized as *high priority*. While this provided a consistent, systematic methodology to support the evaluation and prioritization of mitigation actions, the County may have additional considerations that could influence the overall prioritization of mitigation actions.

Prioritization Results

Table 19-5 summarizes the prioritization of all proposed mitigation actions for the HMP update.

Table 19-5. Summary of Prioritization of Actions

Final Rank	Mitigation Action Title	Cost	Benefit	Goals	Time Frame	Score	Priority	Area
1	NFIP/CRS Compliance	Low	Medium	3	1-5 years	7.6	High*	All County
2	Maintain CRS Class 7	Low	High	3	1-5 years	8.6	High	All County
3	Isolated Community Preparedness	Low	High	2	1-5 years	8.4	High	Molokaʻi, Lānaʻi and Hāna
4	CWPP Implementation	Medium	High	5	1-5 years	8	High	All County
5	Wildfire Mitigation in Non-CWPP Areas	Medium	High	5	1-5 years	8	High	Maui and Molokaʻi
6	Homeowner Mitigation Assistance	Medium	High	3	1-5 years	7.6	High	All County
7	Flood Insurance Outside SFHA	Low	Medium	3	1-5 years	7.6	High	All County
8	Greywater Code and Regulation Changes	Low	Medium	2	1-5 years	7.4	High	All County
9	Shelter Assessment	Low	Low	5	1-5 years	7	High	All County
10	Molokaʻi Energy Supply	Low	Medium	2	1-5 years	7.4	High	Molokaʻi
11	Firewise Expansion	Low	Medium	4	1-5 years	7.4	High	All County
12	Low Impact Development	Low	Medium	2	1-5 years	7.4	High	All County
13	Emergency Generators for Critical Water Infrastructure	High	High	1	1-5 years	6.2	Medium*	All County
14	Expand MAPPS Capabilities	Low	Medium	1	1-5 years	7.2	High	All County
15	Disaster Recovery Preparedness	Medium	Medium	5	1-5 years	7	Medium	All County
16	Implement Maui Island Plan Natural Hazards Chapter	Medium	Medium	5	1-5 years	7	Medium	All County
17	Stream Maintenance Plan	Medium	Medium	3	1-5 years	6.6	Medium	All County
18	Molokaʻi Risk Assessment	Medium	Medium	3	1-5 years	6.6	Medium	Molokaʻi
19	CERT and Teen CERT	Low	Low	2	1-5 years	6.4	Medium	All County
20	Implement Lahaina Long-Term Recovery Plan	High	Medium	5	1-5 years	6	Medium	West Maui
21	Molokaʻi Working Group	Medium	Medium	4	1-5 years	6.4	Medium	Molokaʻi
22	Axis Deer Mitigation	High	High	4	1-5 years	6.4	Medium	All County
23	Water Conservation Ordinance	Low	Low	1	1-5 years	6.2	Medium	All County

Final Rank	Mitigation Action Title	Cost	Benefit	Goals	Time Frame	Score	Priority	Area
24	Open Space Analysis	Low	Low	1	1-5 years	6.2	Medium	All County
25	Flood Proof Water Facilities	High	High	1	1-5 years	6.2	Medium	All County (Kaunakaka)
26	Landslide and Rockfall Hazard Area	High	High	1	1-5 years	6.2	Medium	All County
27	Upper Kula Water Transmission Retrofit	High	High	1	1-5 years	6.2	Medium	Makawao-Pukalani-Kula
28	Beach and Dune Restoration	High	High	5	1-10 years	6	Medium	All County
29	Implement Climate Action and Resiliency Plan	High	Medium	5	1-5 years	6	Medium	All County
30	Implement Hele Mai Maui 2045	High	Medium	5	1-5 years	6	Medium	All County
31	Undeveloped Land Master Plan	Medium	Low	5	1-5 years	6	Medium	West Maui
32	Evacuation Routes	High	High	3	1-10 years	5.6	Medium	All County
33	State Highway Route 450	High	High	3	1-10 years	5.6	Medium	Moloka‘i
34	Aquifer Source Development	High	Medium	3	1-5 years	5.6	Medium	West Maui
35	General Plan	Medium	Low	3	1-5 years	5.6	Medium	All County
36	Repetitive Loss Outside SFHA	High	Medium	2	1-5 years	5.4	Medium	All County
37	Coastal Road Management Plan	High	Medium	2	1-5 years	5.4	Medium	All County
38	Drainage and Slope Stabilization	High	High	1	1-10 years	5.2	Medium	All County
39	Stormwater Drainage System	High	High	1	1-10 years	5.2	Medium	All County
40	Water Storage and Conservation	High	Medium	1	1-5 years	5.2	Medium	All County
41	Upcountry Emergency Waterline	High	Medium	1	1-5 years	5.2	Medium	Makawao-Pukalani-Kula
42	Floodplain Training and Certification	Low	Medium	2	1-5 years	7.4	Medium*	All County
43	Substantial Damage Estimator	Low	Low	5	1-5 years	7	Medium*	All County
44	Drainage Plan Implementation	High	Medium	5	1-10 years	5	Low	South Maui, West Maui
45	Saltwater Intrusion Mitigation	High	Low	5	1-5 years	5	Low	All County
46	Community Resilience Hubs	High	Low	5	1-5 years	5	Low	All County
47	Shoreline Erosion Studies	High	Low	3	1-5 years	4.6	Low	All County
48	Wave-Driven Flooding Tool	High	Low	3	1-5 years	4.6	Low	All County
49	County Bridge Inventory	High	Low	2	1-5 years	4.4	Low	All County
50	Irrigation Water Alternate Sources	High	Medium	1	1-10 years	4.2	Low	All County
51	Kamole Water Treatment Plant	High	Medium	1	1-10 years	4.2	Low	Makawao-Pukalani-Kula
52	HHPD Emergency Actions Plans	Low	High	1	1-5 years	8.2	High	All County
53	HHPD Infrastructure Reinforcement Projects	High	High	2	1-10 years	5.4	Medium	All County

Note: Priority was assigned based on Low (0 to 5), Medium (5 to 7), and High (7 to 9).
**Adjustments were made for these projects based on County priorities.*

For some of the Maui County actions identified, the County may seek financial assistance under FEMA's Hazard Mitigation Assistance (HMA) programs. These programs require detailed benefit/cost

analysis as part of the application process. The benefit/cost review for the prioritization of actions in this update did not include the level of detail required by FEMA for project grant eligibility under HMA grant programs. These analyses will be performed when funding applications are prepared, using FEMA's Benefit-Cost Analysis model.

The County is committed to implementing a mitigation strategy with benefits that exceed costs. For projects not seeking financial assistance from grant programs that require this sort of analysis, the County reserves the right to define benefits according to parameters that meet its needs and the goals of this plan.

19.4 MITIGATION ACTION WORKSHEETS

The mitigation action worksheets describe the costs, benefits, and other information for each mitigation action that Maui County will pursue in the future to reduce the effects of hazards. The actions are dependent upon available funding (grants and local match availability) and may be modified or omitted at any time based on the occurrence of new hazard events and changes in County priorities.

1. NFIP/CRS Compliance

Lead Agency:	Department of Public Works
Supporting Agencies:	County Council, Department of Planning
Hazards of Concern:	Flood
Description of the Problem:	There are repetitive loss and severe repetitive loss properties within Maui County.
Description of the Solution:	Continue to maintain good standing and compliance under the NFIP through implementation of floodplain management programs that, at a minimum, meet the NFIP requirements: enforce the flood damage prevention ordinance, participate in floodplain identification and mapping updates, provide public assistance/information on floodplain requirements and impacts.
Estimated Cost:	Low
Potential Funding Source:	County Budget and Staff Time; FEMA Flood Mitigation Assistance
Implementation Timeline:	One to five years
Goals Met:	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. Goal 4: Improve awareness and mitigation of risks associated with natural hazards and climate change.
Benefits:	Action will provide a long-term reduction of risk for life and property.
Mitigation Category	Local Plans and Regulations
CRS Category	Preventive Measures, Public Information
Priority	Medium

2. Maintain CRS Class 7

Lead Agency:	Department of Public Works
Supporting Agencies:	Department of Planning, Emergency Management Agency
Hazards of Concern:	Flood
Description of the Problem:	Maui is currently a Class 7 CRS community. The County does not meet the prerequisites for a Class 6 community, thus cannot improved the CRS class. CRS classification is an ongoing process where points must be accumulated and verified.
Description of the Solution:	Participate in the CRS program and identify opportunities across all relevant County departments and programs to improve current CRS points.
Estimated Cost:	Low
Potential Funding Source:	County Budget and Staff Time; FEMA Flood Mitigation Assistance
Implementation Timeline:	One to five years
Goals Met:	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. Goal 4: Improve awareness and mitigation of risks associated with natural hazards and climate change.
Benefits:	Benefit of CRS participation is the flood insurance premium discount available to all Maui County residents. Action will provide an immediate reduction of risk for life and property.
Mitigation Category	Education and Awareness Programs
CRS Category	Public Information
Priority	High

3. Isolated Community Preparedness

Lead Agency:	Maui Emergency Management Agency
Supporting Agencies:	Fire Prevention Bureau, Department of Housing, Molokaʻi Planning Commission, Hāna Advisory, Lanaʻi Community Plan Advisory Committee
Hazards of Concern:	All Hazards
Description of the Problem:	Isolated communities in the County have the potential to be physically cut off from the more populated areas of Maui Island. Isolated communities include, but are not limited to, Molokaʻi, Lānaʻi and Hāna. These communities must be prepared to be self-reliant for up to several days at a time if County emergency responders cannot reach them. Isolation may include inhibited access to airports, ports, emergency supplies, and critical infrastructure.
Description of the Solution:	Provide education about disaster preparedness and mitigation to isolated communities.
Estimated Cost:	Low
Potential Funding Source:	County budget and staff time; FEMA Hazard Mitigation Grant Program; FEMA Pre-Disaster Mitigation Grant Program
Implementation Timeline:	One to five years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors. Goal 4: Improve awareness and mitigation of risks associated with natural hazards and climate change.
Benefits:	Action will provide an immediate reduction of risk for life and property. This action will align with the Molokaʻi Community Plans, including the Molokaʻi Community Energy Resilience Action Plan (CERAP), Molokaʻi Climate Change and Sea Level Rise Adaptation Resiliency Master Plan, and Molokaʻi Coastal Homestead Community Resilience Plan.
Mitigation Category	Education and Awareness
CRS Category	Public Information
Priority	High

4. CWPP Implementation

Lead Agency:	Fire Prevention Bureau
Supporting Agencies:	Department of Fire and Public Safety, Maui Farm Bureau, Watershed Partners, Department of Land and Natural Resources Division of Forestry and Wildlife, Hawai'i Wildfire Management Organization
Hazards of Concern:	Wildfire
Description of the Problem:	Many areas of Maui County naturally have a dry, arid climate. When combined with waterways diverted for irrigation, non-native land cover, drought conditions, and large tracts of land that are remnants of sugarcane and pineapple plantations, most of the populated areas of the County are located in the wildfire hazard area.
Description of the Solution:	Support the Hawai'i Wildfire Management Organization, the Maui Wildfire Coordinating Group, local fire task forces, and other stakeholder organizations with the implementation of mitigation action items as identified in all current CWPPs. See Chapter 16 Wildfire for specific mitigation actions in each of the 5 CWPPs.
Estimated Cost:	Medium
Potential Funding Source:	FEMA Hazard Mitigation Grant Program; FEMA Pre-Disaster Mitigation Grant Program; U.S. Forest Service State Fire Assistance Program; Staff Time
Implementation Timeline:	1-5 years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors. Goal 2: Promote the long-term resilience of the County's economic, environmental, historical and cultural resources. Goal 3: Protect and adapt property and infrastructure from the impacts of natural hazards and climate change. Goal 4: Improve awareness and mitigation of risks associated with natural hazards and climate change. Goal 5: Enhance the implementation of this Hazard Mitigation Plan through active involvement and Plan integration across all County Departments.
Benefits:	Action will provide an immediate reduction of risk for life and property.
Mitigation Category	Local Plans and Regulations, Natural Systems Protection, Education and Awareness Programs
CRS Category	Preventive Activities, Property Protection, Natural Resource Protection, Public Information
Priority	High

5. Wildfire Mitigation in Non-CWPP Areas

Lead Agency:	Fire Prevention Bureau
Supporting Agencies:	Department of Land and Natural Resources, Hawai'i Wildfire Management Organization, Moloka'i and West Maui Fire Task Force
Hazards of Concern:	Wildfire
Description of the Problem:	Brush mitigation is a significant issue on Maui and Moloka'i. Large tracts of land that have not been farmed for many years, combined with dry conditions, create a high fire hazard. Implementing a fuel break program is one approach to addressing this issue. However, establishing the necessary fuel breaks for these expansive areas may impose a financial burden on property owners.
Description of the Solution:	Research, promote, and support the implementation of wildfire mitigation practices for Wildland Urban Interface (WUI) and other areas identified as high risk but not covered by a current Community Wildfire Protection Plan (CWPPs). This project focuses on unmaintained land surrounding communities in the Wildland Urban Interface. Practices may include but not be limited to the following:
	• Retrofit at-risk County structures with ignition-resistant materials
	• Initiating programs aimed at reducing fuel loads (removing non-native grasses and shrubs with native/fire-resistant species)
	• Prevent wildfire burn areas from being replanted with non-native vegetation
	• Implementing defensible space and firebreaks in rural developments through existing codes and development standards • Educate homeowners about wildfire mitigation practices • Fund CWPPs for areas not covered by an existing CWPP
Estimated Cost:	Medium
Potential Funding Source:	FEMA Hazard Mitigation Grant Program; FEMA Pre-Disaster Mitigation Grant Program; U.S. Forest Service State Fire Assistance Program; Staff Time
Implementation Timeline:	One to five years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors. Goal 2: Promote the long-term resilience of the County's economic, environmental, historical and cultural resources. Goal 3: Protect and adapt property and infrastructure from the impacts of natural hazards and climate change. Goal 4: Improve awareness and mitigation of risks associated with natural hazards and climate change. Goal 5: Enhance the implementation of this Hazard Mitigation Plan through active involvement and Plan integration across all County Departments.
Benefits:	Action will provide an immediate reduction of risk for life and property.
Mitigation Category	Local Plans and Regulations, Natural Systems Protection, Education and Awareness Programs
CRS Category	Preventive Activities, Property Protection, Natural Resource Protection, Public Information
Priority	High

6. Homeowner Mitigation Assistance

Lead Agency:	Maui Emergency Management Agency
Supporting Agencies:	Maui Department of Public Works, Department of Housing, Department of Human Concerns, Hawai'i Home Ownership Center
Hazards of Concern:	Coastal Erosion, Flood, Hurricane, Tsunami
Description of the Problem:	Homeowners often do not have the capital to invest in home mitigation measures.
Description of the Solution:	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 repetitive loss and severe repetitive loss properties as priority.
Estimated Cost:	Medium
Potential Funding Source:	County budget and staff time; FEMA Hazard Mitigation Grant Program; FEMA Flood Mitigation Assistance; FEMA Pre-Disaster Mitigation Grant Program
Implementation Timeline:	One to five years
Goals Met:	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. Goal 4: Improve awareness and mitigation of risks associated with natural hazards and climate change.
Benefits:	Action will provide an immediate reduction of risk for life and property.
Mitigation Category	Structure and Infrastructure Project, Education and Awareness Program
CRS Category	Property Protection, Public Information
Priority	High

7. Flood Insurance Outside SFHA

Lead Agency:	Department of Public Works
Supporting Agencies:	Maui Emergency Management Agency, Maui Planning Department
Hazards of Concern:	Flood
Description of the Problem:	Homeowners are often unaware of flood risk and flood insurance policies.
Description of the Solution:	Promote the availability of flood insurance to property owners in areas subject to flooding but not located within FEMA-mapped special flood hazard areas, with an emphasis on the ability to purchase for lower premium rates (via preferred risk policies).
Estimated Cost:	Low
Potential Funding Source:	County budget and staff time; FEMA Hazard Mitigation Grant Program; FEMA Flood Mitigation Assistance; FEMA Pre-Disaster Mitigation Grant Program
Implementation Timeline:	One to five years
Goals Met:	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. Goal 4: Improve awareness and mitigation of risks associated with natural hazards and climate change.
Benefits:	Action will provide a long-term reduction of risk for life and property.
Mitigation Category	Local Plans and Regulations, Education and Awareness Program
CRS Category	Preventive Measures, Public Information
Priority	High

8. Greywater Code and Regulation Changes

Lead Agency:	Department of Water Supply, Department of Environmental Management
Supporting Agencies:	Maui Farm Bureau, Maui Department of Parks & Recreation, Hawai'i Department of Agriculture
Hazards of Concern:	Drought
Description of the Problem:	Drought and periods of reduced rainfall lead to mandatory water restrictions, impacting the community's water supply. Water shortages in drought would still generate shower and sink greywater to be used for irrigation.
Description of the Solution:	Explore options and necessary code and regulation changes to allow greywater reuse systems for irrigation and toilet flushing.
Estimated Cost:	Low
Potential Funding Source:	Staff Time
Implementation Timeline:	One to five years
Goals Met:	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.
Benefits:	Code changes to allow irrigation and toilet flushing using greywater can diversify water source and improves resiliency in water scarcity driven by climate change. Action will provide a long-term reduction of risk for life and property.
Mitigation Category	Local Plans and Regulations
CRS Category	Natural Resource Protection
Priority	Medium

9. Shelter Assessment

Lead Agency:	Maui Emergency Management Agency
Supporting Agencies:	Maui Department of Parks and Recreation, American Red Cross, USACE, Department of Public Works, Hawai'i Department of Education Maui District
Hazards of Concern:	Dam/Reservoir Failure, Earthquake, Flood, High Windstorm, Hurricane, Landslides, Tsunamis, Volcanic Hazards, Wildfire
Description of the Problem:	MEMA maintains list of potential shelters. These sites should be assessed by the U.S. Army Corps of Engineers using Best Available Refuge Area criteria and by the American Red Cross for access and functional needs.
Description of the Solution:	Conduct a detailed needs assessment and capital planning/feasibility study for additional emergency shelters for both residents and visitors. This includes retrofitting existing public facilities and structures to withstand up to a Category 3 hurricane and other natural hazards.
Estimated Cost:	Low
Potential Funding Source:	County budget and staff time; FEMA Hazard Mitigation Grant Program; FEMA Pre-Disaster Mitigation Grant Program
Implementation Timeline:	One to five years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors. Goal 2: Promote the long-term resilience of the County's economic, environmental, historical and cultural resources. Goal 3: Protect and adapt property and infrastructure from the impacts of natural hazards and climate change. Goal 4: Improve awareness and mitigation of risks associated with natural hazards and climate change. Goal 5: Enhance the implementation of this Hazard Mitigation Plan through active involvement and Plan integration across all County Departments.
Benefits:	Long-term benefits of the action are difficult to quantify in the short term.
Mitigation Category	Local Plans and Regulations
CRS Category	Preventive Measures
Priority	High

10. 30-Day Energy Supply

Lead Agency:	Department of Public Works
Supporting Agencies:	Maui Emergency Management Agency, Pulama Lānaʻi
Hazards of Concern:	All Hazards
Description of the Problem:	Molokaʻi is an isolated island in the County that is dependent upon supplies that arrives via the Kaunakakai Harbor. In the event of a disaster, the island's food, water, and fuel supply chain could be disrupted, leaving residents stranded.
Description of the Solution:	Identify alternative locations for emergency supply of diesel, gas, and propane on Molokaʻi and Lānaʻi for a minimum of 30 days.
Estimated Cost:	Low
Potential Funding Source:	County budget and staff time; FEMA Hazard Mitigation Grant Program; FEMA Pre-Disaster Mitigation Grant Program
Implementation Timeline:	One to five years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors. Goal 2: Promote the long-term resilience of the County's economic, environmental, historical and cultural resources.
Benefits:	Action will provide a long-term reduction of risk for life and property.
Mitigation Category	Local Plans and Regulations
CRS Category	Preventive Measures
Priority	High

11. Firewise Expansion

Lead Agency:	Fire Prevention Bureau
Supporting Agencies:	Maui Emergency Management Agency, West Maui Fire Task Force, Molokaʻi Wildfire Task Force, Hawaiʻi Wildfire Management Organization
Hazards of Concern:	Wildfire
Description of the Problem:	Many communities face significant challenges in securing funding for effective brush mitigation. Fortunately, Firewise offers valuable support by helping to offset some of these costs, making it easier to protect neighborhoods from the threat of wildfires. Four communities—Launiupoko, Waiohuli, Kahikinui, and Paniolo Hale—have been part of the Firewise program since 2016. In 2024, four additional communities—Vintage Kāʻanapali, Lanikeha Community, Island, and The Bluffs Maui Lani—joined the program.
Description of the Solution:	Support the revitalization and expansion of the Firewise USA program and Hawaiʻi Hazards Awareness and Resilience Program to additional communities in Maui County
Estimated Cost:	Low
Potential Funding Source:	Staff Time; U.S. Forest Service State Fire Assistance Program; FEMA Hazard Mitigation Grant Program; FEMA Pre-Disaster Mitigation Grant Program
Implementation Timeline:	One to five years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors. Goal 2: Promote the long-term resilience of the County's economic, environmental, historical and cultural resources. Goal 4: Improve awareness and mitigation of risks associated with natural hazards and climate change. Goal 5: Enhance the implementation of this Hazard Mitigation Plan through active involvement and Plan integration across all County Departments.
Benefits:	Firewise is dedicated to fostering resilient communities that are well-prepared to face the threat of wildfires. Through comprehensive home assessments, they identify potential vulnerabilities and provide tailored recommendations for enhancing safety. Additionally, Firewise actively educates the public on effective home hardening techniques, empowering homeowners to fortify their properties against the devastating impacts of wildfires. Action will provide a long-term reduction of risk for life and property.
Mitigation Category	Education and Awareness Programs
CRS Category	Public Information Activities
Priority	High

12. Low Impact Development

Lead Agency:	Department of Water Supply, Department of Planning
Supporting Agencies:	Department of Public Works, Emergency Management Agency
Hazards of Concern:	Drought, Flood, Hurricane, Wildfire
Description of the Problem:	Increased storm runoff degrades nearshore environment. There is no code requirement for development projects to incorporate water retention or reclamation design features for the purpose of supplementing non-potable water supplies.
Description of the Solution:	Encourage Low Impact Development (LID) approach to site development and stormwater management using the Low Impact Development Practitioner's Guide for Hawai'i.
Estimated Cost:	Low
Potential Funding Source:	FEMA Hazard Mitigation Grant Program; FEMA Pre-Disaster Mitigation Grant Program; EPA Clean Water State Revolving Fund and 319 Funding; County Budget
Implementation Timeline:	One to five years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors. Goal 2: Promote the long-term resilience of the County's economic, environmental, historical and cultural resources.
Benefits:	Low impact design techniques that mimic predevelopment hydrology can be included in site design to address water quality. The next step is stormwater reuse. Action will provide a long-term reduction of risk for life and property.
Mitigation Category	Local Plans and Regulations, Natural Systems Protection
CRS Category	Preventative Activities
Priority	High

13. Emergency Generators for Critical Water Infrastructure

Lead Agency:	Department of Water Supply
Supporting Agencies:	Office of Recovery
Hazards of Concern:	Wildfire, Tsunami, Landslides, High Windstorms, Hurricane
Description of the Problem:	Mitigation of water system outages due to power outages caused by severe storms, tsunami, mudslides, windstorms, and wildfire is critical for the health and safety of Maui County residents.
Description of the Solution:	Installation of permanent generators and automatic transfer switches at 32 critical water infrastructure sites. Project is at preliminary design stage. A complete Hazard Mitigation Grant Program sub-application was submitted for Hazard Mitigation Grant Program funding in 2025, showing project eligibility, cost effectiveness, and environmental and historic preservation considerations.
Estimated Cost:	High
Potential Funding Source:	FEMA Hazard Mitigation Grant Program; FEMA Pre-Disaster Mitigation Grant Program; Drinking Water State Revolving Fund, State DLNR funding, Maui Department of Water Supply Capital Revolving Fund, HUD Community Development Block Grant-Disaster Recovery, and U.S. Bureau of Reclamation WaterSMART
Implementation Timeline:	One to five years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors.
Benefits:	Action will provide an immediate reduction of risk for life and property.
Mitigation Category	Structure and Infrastructure Project
CRS Category	Emergency Services
Priority	High

14. Expand MAPPS Capabilities

Lead Agency:	Department of Public Works
Supporting Agencies:	Department of Planning
Hazards of Concern:	Flood
Description of the Problem:	In 2022, Maui County launched the Maui's Automated Planning and Permitting System (MAPPS) for all permits. MAPPS provides an efficient interface for flood development permit application documents and reviews. The flood development permit workflow in MAPPS does not provide all the necessary information for CRS audits or HMP updates.
Description of the Solution:	The Flood Program will develop a new data management tool, permit and certificate tracking system, and standardized operating procedure to ensure NFIP and CRS compliance. Adopt internal protocols for how to intake, process, approve and file all new FDPs in order to ensure consistent and clear records for upcoming CRS audits.
Estimated Cost:	Low
Potential Funding Source:	County Budget and Staff Time
Implementation Timeline:	One to five years
Goals Met:	Goal 3: Protect and adapt property and infrastructure from the impacts of natural hazards and climate change.
Benefits:	Having a more thorough digital record of approved FDPs will facilitate the Floodplain Manager achieving a greater score during the CRS Audits. Action will provide a long-term reduction of risk for life and property.
Mitigation Category	Local Plans and Regulations
CRS Category	Preventative Activities
Priority	High

15. Disaster Recovery Preparedness

Lead Agency:	Maui Emergency Management Agency
Supporting Agencies:	Maui Department of Public Works, Office of Recovery, Planning Department, Department of Housing, Department of Human Concerns, Office of Economic Development
Hazards of Concern:	Coastal Erosion, Earthquake, Flood, High Windstorm, Hurricane, Landslides, Tsunamis, Volcanic Hazards, Wildfire
Description of the Problem:	Disaster recovery is a long and complicated process. Maui County will be better prepared for future recovery initiatives if training, knowledge transfer, and procedures are implemented. Several response and preparedness recommendations were identified in the 2023 Wildfire After-Action Report; however, the report did not include long-term disaster recovery recommendations.
Description of the Solution:	Implement the guidance and tools identified in the 2019 Guidance for Disaster Recovery Preparedness in Hawai'i and lessons learned from the 2023 Lahaina Wildfire recovery.
Estimated Cost:	Medium
Potential Funding Source:	County budget and staff time; FEMA Hazard Mitigation Grant Program; FEMA Pre-Disaster Mitigation Grant Program
Implementation Timeline:	One to five years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors. Goal 2: Promote the long-term resilience of the County's economic, environmental, historical and cultural resources. Goal 3: Protect and adapt property and infrastructure from the impacts of natural hazards and climate change. Goal 4: Improve awareness and mitigation of risks associated with natural hazards and climate change. Goal 5: Enhance the implementation of this Hazard Mitigation Plan through active involvement and Plan integration across all County Departments.
Benefits:	Action will provide a long-term reduction of risk for life and property.
Mitigation Category	Local Plans and Regulations
CRS Category	Preventive Measures
Priority	Medium

16. Implement Maui Island Plan Natural Hazards Chapter

Lead Agency:	Department of Planning, Emergency Management Agency
Supporting Agencies:	Mayor's Office, Department of Public Works, Department of Water Supply, Maui County Council, Pacific Disaster Center, Department of Water Supply
Hazards of Concern:	All Hazards
Description of the Problem:	Chapter 3 of the Maui Island Plan, a part of the County General Plan 2030, lists natural hazard mitigation actions identified in their planning process.
Description of the Solution:	Implement the goal, objectives, policies, and implementing actions of Chapter 3 Natural Hazards of the Maui Island Plan, part of the County's General Plan 2030. Potential mitigation projects include but are not limited to developing GIS hazard data, establishing multi-agency coordination groups, developing plans or incentives, updating hazard rules, documenting hazard impacts, increasing water storage capacity, developing emergency plans, and providing mitigation training.
Estimated Cost:	Medium
Potential Funding Source:	County Budget and Staff Time; FEMA Hazard Mitigation Grant Program; FEMA Pre-Disaster Mitigation Grant Program;
Implementation Timeline:	One to ten years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors. Goal 2: Promote the long-term resilience of the County's economic, environmental, historical and cultural resources. Goal 3: Protect and adapt property and infrastructure from the impacts of natural hazards and climate change. Goal 4: Improve awareness and mitigation of risks associated with natural hazards and climate change. Goal 5: Enhance the implementation of this Hazard Mitigation Plan through active involvement and Plan integration across all County Departments.
Benefits:	Continually building awareness of natural hazard risks and impacts on communities helps to promote community resilience through mitigation, adaptation, capital improvement planning, policies, and funding priorities. Action will provide a long-term reduction of risk for life and property.
Mitigation Category	Local Plans and Regulations, Structure and Infrastructure Project, Natural Systems Protection, Education and Awareness Programs
CRS Category	Preventive Measures, Property Protection, Public Information, Natural Resource Protection, Structural Flood Control Project, Emergency Services
Priority	Medium

17. Stream Maintenance Plan

Lead Agency:	Planning, DPW
Supporting Agencies:	USACE, Hawai'i Office of Planning and Sustainable Development, Silver Jackets
Hazards of Concern:	Flood;
Description of the Problem:	At the local level, there is no regulation that supports mitigation efforts and flood prevention in streams. Annual storms can bring multiple hazards that impact coastal and inland areas such impacts include flash floods and hurricanes. Major flood problems are associated with the heavy flow of streams which causes blockage due to inadequate bridge openings or deposits of eroded sediment and often times runs freely on highways and roads because of inadequate drainage and storm water infrastructure (areas such as Wailua, Ohi'a, One Ali'i, Kamililoa, and Kalama'ula).
Description of the Solution:	Work with local and state agencies to create a path forward in developing a regulatory framework for stream maintenance.
Estimated Cost:	Medium
Potential Funding Source:	NOAA National Coastal Fund (NCF) National Fish and Wildlife Foundation (NFWF). Along with State, Federal, and County funding.
Implementation Timeline:	January 2026-December 2031
Goals Met:	Goal 2: Promote the long-term resilience of the County's economic, environmental, historical and cultural resources. Goal 4: Improve awareness and mitigation of risks associated with natural hazards and climate change. Goal 5: Enhance the implementation of this Hazard Mitigation Plan through active involvement and Plan integration across all County Departments.
Benefits:	Reference Moloka'i Island Community Plan Action Items 4.10, 4.15. Many identified streams across the County are located in socially vulnerable populations and underserved communities. By establishing a regulatory framework, it will greatly benefit these areas. This project will positively impact future development by reducing damages to structures and infrastructures when those properties are being negatively impacted by flood, hurricanes, and storm events. Critical infrastructures such as roads will greatly benefit this project and keep people safer on the road during these storm events. Currently, the County resources are exacerbated during high response events such as storm and hurricane events. With this potential project, it will alleviate County's staff and equipment resources during a response event to be able to respond more effectively and efficiently. Proper maintenance and continued maintenance will help mitigate through climate change and withstand long term climate conditions until relocation and "moving out of harm's way" become inevitable. This action will align with the Moloka'i Community Plans, including the Moloka'i Community Energy Resilience Action Plan (CERAP), Moloka'i Climate Change and Sea Level Rise Adaptation Resiliency Master Plan, and Moloka'i Coastal Homestead Community Resilience Plan.
Mitigation Category	Local Plans and Regulations (government authorities, policies, or codes that influence the way land and buildings are developed and built);
CRS Category	Preventative Measures (floodplain mapping and data, open space preservation, erosion setbacks, stormwater management, building codes, planning and zoning);
Priority	Medium

18. Risk Assessments

Lead Agency:	Planning/MEMA, Mokupuni Community Development Corporation (Molokaʻi)
Supporting Agencies:	National Disaster Preparedness Training Center, Silver Jackets, Pacific Disaster Center, Molokaʻi Planning Commission, Department of Public Works, University of Hawaiʻi Sea Grant Program, Hawaii Department of Transportation, Pulama Lānaʻi
Hazards of Concern:	All Hazards;
Description of the Problem:	Molokaʻi and Lānaʻi are rural communities that are highly vulnerable to natural hazards and is a substantially underserved community. Both islands cannot solely depend upon other islands for resources for hazard and emergency response.
Description of the Solution:	With the re-establishment of the Molokaʻi Working Group and the development of a task force, the goal is to complete a comprehensive and locally specific hazard risk assessment for each island. The risk assessment would serve as a foundation for a response and recovery plan and training program in partnership with other organizations, such as the National Disaster Preparedness Training Center.
Estimated Cost:	Medium
Potential Funding Source:	Advance Assistance Project; NOAA National Coastal Fund (NCF) National Fish and Wildlife Foundation (NFWF); Federal, State, and County funding.
Implementation Timeline:	October 2025-October 2030
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors. Goal 2: Promote the long-term resilience of the County's economic, environmental, historical and cultural resources. Goal 4: Improve awareness and mitigation of risks associated with natural hazards and climate change.
Benefits:	As background, previous working group has recently been re-established to organize responses after emergencies such as flooding events, including DPW, HDOT, Planning Department, and Fire. This shall encompass community engagement, agency and partnership collaboration by ensuring complementary of beneficial inter-agency policies/planning/roles and responsibilities within the plan. Reference Molokaʻi Island Community Plan Action Items 4.01, 4.05, 4.06,4.09, 4.14,4.17, 4.18 9.2.03Molokaʻi is highly vulnerable to natural hazards, and is a substantially underserved community. This project will positively impact future development by reducing damages to structures and infrastructures on the island of Moloka'i through a Disaster Response, Recovery and Resilience Implementation Plan. This shall encompass community engagement, agency and partnership collaboration by ensuring complementary of beneficial inter-agency policies, planning, roles, and responsibilities. This project will improve the County's ability to mitigate against future natural hazards through proper planning and a vetting system utilizing community-led processes. This project will be designed to withstand long-term climate conditions.
Mitigation Category	Local Plans and Regulations
CRS Category	Preventative Measures
Priority	Medium

19. CERT and Teen CERT

Lead Agency:	Maui Emergency Management Agency
Supporting Agencies:	Hawai'i Emergency Management Agency, Department of Education – Maui District, Maui Fire Department, Maui Police Department
Hazards of Concern:	All Hazards
Description of the Problem:	Capacity is a challenge for both County agencies and local organizations. The Community Emergency Response Team (CERT) provides training to volunteers to supplement government and nonprofit staff during emergencies.
Description of the Solution:	Support the development of the CERT and Teen CERT Project and promote the culture and resiliency throughout Maui County.
Estimated Cost:	Low
Potential Funding Source:	County budget and staff time; FEMA Hazard Mitigation Grant Program; FEMA Pre-Disaster Mitigation Grant Program
Implementation Timeline:	One to five years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors. Goal 4: Improve awareness and mitigation of risks associated with natural hazards and climate change.
Benefits:	Long-term benefits of the action are difficult to quantify in the short term.
Mitigation Category	Education and Awareness Program
CRS Category	Public Information, Emergency Services
Priority	Medium

20. Implement Lahaina Long-Term Recovery Plan

Lead Agency:	Mayor's Office of Recovery
Supporting Agencies:	Emergency Management Agency
Hazards of Concern:	Wildfire, High Windstorms, Landslide, Coastal Erosion, Flood
Description of the Problem:	On August 8, 2023, devasting wind-driven wildfires burned through Lahaina, Kula, Olinda, and Pūlehu, on Maui Island in the State of Hawai'i. Lahaina was severely impacted by the wildfires that caused the death of at least 102 individuals, destroyed more than 2,200 structures and resulted in approximately $5.5 billion in damages.
Description of the Solution:	Implement the Lahaina Long-Term Recovery Plan. Potential project include but are not limited to improving pipeline and water facility deficiencies; installing emergency generators for critical facilities; installing backup wells; increasing the capacity and level of protection provided by the fire suppression systems; rehabilitating and finishing waterlines; and increasing access to existing groundwater sources and establishing new connections to the County's potable water system.
Estimated Cost:	High
Potential Funding Source:	County staff time; FEMA Hazard Mitigation Grant Program; FEMA Pre-Disaster Mitigation Grant Program
Implementation Timeline:	One to five years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors. Goal 2: Promote the long-term resilience of the County's economic, environmental, historical and cultural resources. Goal 3: Protect and adapt property and infrastructure from the impacts of natural hazards and climate change. Goal 4: Improve awareness and mitigation of risks associated with natural hazards and climate change. Goal 5: Enhance the implementation of this Hazard Mitigation Plan through active involvement and Plan integration across all County Departments.
Benefits:	Action will provide a long-term reduction of risk for life and property.
Mitigation Category	Local Plans and Regulations, Structure and Infrastructure Project, Natural Systems Protection, Education and Awareness Programs
CRS Category	Preventive Measures, Property Protection, Public Information, Natural Resource Protection, Structural Flood Control Project, Emergency Services
Priority	Medium

21. Molokaʻi Working Group

Lead Agency:	Planning, Mokupuni Community Development Corporation (Molokaʻi)
Supporting Agencies:	National Disaster Preparedness Training Center, MEMA, NOAA
Hazards of Concern:	All Hazards;
Description of the Problem:	The current mitigation and response framework does not recognize ʻOiwi/indigenous or place-based knowledge as a necessary and fundamental pillar for decision making and planning. The lack of inclusion and consideration fosters policies and solutions that further strain natural resources; creating temporary fixes rather than permanent benefits and sustainable strategies for island communities.
Description of the Solution:	To re-establish the Molokaʻi Working Group to identify place-based and natural science. Reference Molokaʻi Island Community Plan Action Items 4.16.
Estimated Cost:	Medium
Potential Funding Source:	NOAA National Coastal Fund (NCF) National Fish and Wildlife Foundation (NFWF)
Implementation Timeline:	One to five years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors. Goal 2: Promote the long-term resilience of the County's economic, environmental, historical and cultural resources. Goal 4: Improve awareness and mitigation of risks associated with natural hazards and climate change. Goal 5: Enhance the implementation of this Hazard Mitigation Plan through active involvement and Plan integration across all County Departments.
Benefits:	Enhanced disaster preparedness, response and recovery capabilities for Molokaʻi island; Increased native Hawaiian intellectual property; increased disaster and climate ready native Hawaiian students who are graduating; Increased preservation and perpetuation of Hawaiian language, culture, traditions and identity; increased restoration and stewardship of Hawaiʻi 's natural and cultural resources; enhanced disaster resilience social networks in native Hawaiian communities. Molokaʻi is highly vulnerable to natural hazards and is a substantially underserved community. This project will positively impact future development by reducing damages to structures and infrastructures with adaptation and evolutionary methods derived from 'Oiwi Resources and Science. Developing and connecting both with ʻOiwi Science and Science will provide the ability to adapt and design resilience within critical facilities. This project will improve the County's ability to mitigate against future natural hazards and decision making can be more transparent. Adaptation and evolution of ʻOiwi Science and Science will find solutions to mitigate climate change for the next generations to come. This action will align with the Molokaʻi Community Plans, including the Molokaʻi Community Energy Resilience Action Plan (CERAP), Molokaʻi Climate Change and Sea Level Rise Adaptation Resiliency Master Plan, and Molokaʻi Coastal Homestead Community Resilience Plan.
Mitigation Category	Education and Awareness Program (disaster preparedness and distribution of resources, information, and response plans);
CRS Category	Public Information (outreach projects, real estate disclosure, hazard information centers, educational programs);
Priority	Medium

22. Axis Deer Mitigation

Lead Agency:	Department of Planning, Department of Agriculture
Supporting Agencies:	Hawai'i Department of Land and Natural Resources, Hawai'i Department of Hawaiian Home Lands, Hawai'i Department of Transportation, NOAA, Mokupuni Community Development Corporation (Moloka'i), Moloka'i Homestead Associations
Hazards of Concern:	Drought
Description of the Problem:	Nineteenth Emergency Proclamation relating to Axis Deer crisis in Maui County designated as a primary natural disaster area due to drought conditions by the U.S. Department of Agriculture in 2022 and continues to moderate extreme drought conditions, according to data from the National Oceanic and Atmospheric Administration and the National Weather Service.
Description of the Solution:	To create a deer management plan designed to incorporate place-based knowledge and expertise interconnected with 'Oiwi Science and Science so there is balance between the ecosystem and food sustainability within rural communities and those that are affected by the overpopulation of axis deer.
Estimated Cost:	High
Potential Funding Source:	NOAA National Coastal Fund (NCF) National Fish and Wildlife Foundation (NFWF)
Implementation Timeline:	One to five years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors. Goal 2: Promote the long-term resilience of the County's economic, environmental, historical and cultural resources. Goal 4: Improve awareness and mitigation of risks associated with natural hazards and climate change. Goal 5: Enhance the implementation of this Hazard Mitigation Plan through active involvement and Plan integration across all County Departments.
Benefits:	Conduct a deer count and analysis to determine the actual deer count and establish deer patterns to use the results in creating a successful management plan. The success of the plan will increase the economics of the island and food security. A community led process and a management plan will positively impact socially vulnerable area and underserved communities through implementation of a deer management plan that can sustain the deer count while creating food security. By controlling and managing the axis deer, this project will reduce damage to structures and infrastructures which will keep deer from destroying agricultural crops and home gardens. It will have little to no impact on critical facilities. This project will lessen the burden of existing County resources that have been impacted by the overpopulation of deer. The Moloka'i Island Community Plan Policy on Infrastructures support HDOT Highways Division efforts to address the hazard of deer on highway. Drought has been a hazard and the overpopulation has exacerbated many natural resources. This project will mitigate against climate change through the management of deer. Axis deer has been identified on Moloka'i as a food source as 35% of the population relies on deer for subsistence. This action will align with the Moloka'i Community Plans, including the Moloka'i Community Energy Resilience Action Plan (CERAP), Moloka'i Climate Change and Sea Level Rise Adaptation Resiliency Master Plan, and Moloka'i Coastal Homestead Community Resilience Plan.
Mitigation Category	Natural Systems Protection; Education and Awareness Program
CRS Category	Natural Resource Protection; Public Information
Priority	Medium

23. Water Conservation Ordinance

Lead Agency:	Department of Water Supply
Supporting Agencies:	Mayor's Office, Maui Emergency Management Agency
Hazards of Concern:	Drought, Dam/Reservoir Failure
Description of the Problem:	Drought and periods of reduced rainfall lead to mandatory water restrictions, impacting the community's water supply.
Description of the Solution:	Develop a water conservation ordinance to include xeriscaping regulations to promote water conservation. In combination with the April 2024 Water Shortage and Conservation Plan, the ordinance will address water use priorities in the event of a water shortage due to drought or unforeseen events. Action aligns with Maui Island Plan Action 6.3.2.
Estimated Cost:	Low
Potential Funding Source:	County Budget and Staff Time
Implementation Timeline:	One to five years
Goals Met:	Goal 2: Promote the long-term resilience of the County's economic, environmental, historical and cultural resources.
Benefits:	Long-term benefits of the action are difficult to quantify in the short term. In combination with the April 2024 Water Shortage and Conservation Plan, the ordinance will address water use priorities in the event of a water shortage due to drought or unforeseen events.
Mitigation Category	Local Plans and Regulations
CRS Category	Preventative Actions
Priority	Medium

24. Open Space Analysis

Lead Agency:	Department of Planning
Supporting Agencies:	Department of Public Works, Department of Parks and Recreation, Hawai'i Department of Land and Natural Resources
Hazards of Concern:	Coastal Erosion, Flood, Hurricane, Tsunami
Description of the Problem:	Open space is the best form of hazard mitigation, although often overlooked because of barriers to implementation, such as availability and cost. However, there has not yet been a comprehensive assessment of existing or potentially available sites to prioritize preservation or acquisition for hazard mitigation and adaptation to future conditions.
Description of the Solution:	Conduct a multivariate GIS analysis to identify and categorize open spaces for the County of Maui to purchase and preserve based on highest return on investment for hydrological capacity and positive impact on flood mitigation.
Estimated Cost:	Low
Potential Funding Source:	Staff Time
Implementation Timeline:	One to five years
Goals Met:	Goal 2: Promote the long-term resilience of the County's economic, environmental, historical and cultural resources.
Benefits:	Long-term benefits of the action are difficult to quantify in the short term.
Mitigation Category	Local Plans and Regulations
CRS Category	Preventative Activities
Priority	Medium

25. Flood Proof Water Facilities

Lead Agency:	Department of Environmental Management
Supporting Agencies:	Maui Emergency Management Agency, Maui Department of Public Works
Hazards of Concern:	Coastal Erosion, Flood, Tsunami
Description of the Problem:	Water and wastewater treatment facilities are located in flood hazard areas and vulnerable to coastal erosion, flood, and tsunami.
Description of the Solution:	Flood proof and retrofit water and wastewater treatment facilities located in flood hazard areas and identified as vulnerable to future damage or disruption. This includes but is not limited to the Kaunakakai Wastewater Treatment Facility. Long-term solution includes moving critical water infrastructure and community lifeline facilities to higher elevations.
Estimated Cost:	High
Potential Funding Source:	EPA Clean Water State Revolving Fund; FEMA Hazard Mitigation Grant Program; FEMA Flood Mitigation Assistance; FEMA Pre-Disaster Mitigation Grant Program
Implementation Timeline:	One to five years
Goals Met:	Goal 3: Protect and adapt property and infrastructure from the impacts of natural hazards and climate change.
Benefits:	Action will provide an immediate reduction of risk for life and property.
Mitigation Category	Structure and Infrastructure Project
CRS Category	Property Protection, Emergency Services
Priority	Medium

26. Landslide and Rockfall Hazard Area

Lead Agency:	Department of Public Works
Supporting Agencies:	Maui Department of Management/GIS, Hawai'i Department of Transportation
Hazards of Concern:	Landslide
Description of the Problem:	Landslides and rockfalls cause the loss of evacuation routes and emergency access to private property.
Description of the Solution:	Identify and inventory areas at risk using GIS to landslides and rockfalls and implement mitigation projects to reduce risk in hazard areas. Specific areas to address include Kalepa (East Maui), Kahakuloa (Central/West Maui), Kaupo-Kipahulu (East Maui) and Hāna Highway (in/downslope of high landslide susceptibility areas or that have experienced past rockfalls).
Estimated Cost:	High
Potential Funding Source:	FEMA Hazard Mitigation Grant Program; FEMA Pre-Disaster Mitigation Grant Program; County Budget and Staff Time
Implementation Timeline:	One to five years
Goals Met:	Goal 3: Protect and adapt property and infrastructure from the impacts of natural hazards and climate change.
Benefits:	Action will provide an immediate reduction of risk for life and property.
Mitigation Category	Local Plans and Regulations, Structure and Infrastructure Project
CRS Category	Preventative Activities, Natural Resource Protection
Priority	Medium

27. Upper Kula Water Transmission Retrofit

Lead Agency:	Department of Water Supply
Supporting Agencies:	Office of Recovery
Hazards of Concern:	Flood, Wildfire
Description of the Problem:	A critical waterline serving 2800+ people in Upcountry is at risk of damage due to debris-flow and flooding within Upcountry gulches in Upper Kula, causing water system outages.
Description of the Solution:	Project increases level of protection for storms from 80-year to at least 100-year storms and increases level of protection against wildfire by using ignition-resistant materials. Project is at 90% design stage. A complete Hazard Mitigation Grant Program sub-application was submitted for Hazard Mitigation Grant Program funding in 2025, showing project eligibility, cost effectiveness, and environmental and historic preservation considerations.
Estimated Cost:	High
Potential Funding Source:	FEMA Hazard Mitigation Grant Program; FEMA Pre-Disaster Mitigation Grant Program; Drinking Water State Revolving Fund, Maui Department of Water Supply Capital Revolving Fund, and U.S. Bureau of Reclamation WaterSMART
Implementation Timeline:	One to five years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors.
Benefits:	Action will provide an immediate reduction of risk for life and property.
Mitigation Category	Structure and Infrastructure Project
CRS Category	Emergency Services
Priority	Medium

28. Beach and Dune Restoration

Lead Agency:	Department of Planning
Supporting Agencies:	Maui Department of Parks & Recreation, Hawai'i Department of Land and Natural Resources, UH-Sea Grant
Hazards of Concern:	Coastal Erosion, Flood, Hurricane, Tsunami
Description of the Problem:	Coastal erosion is having widespread impacts on Maui, and these conditions are expanding and worsening in the face of sea level rise. Beach and dune restoration has been proposed and planned for several sites, although funding has been a major barrier to implementation. Hawai'i state laws prohibit sea walls, therefore armoring the shoreline is not an option. Most federal grants do not allow beach nourishment.
Description of the Solution:	Support beach and dune restoration solutions that limit coastal erosion and protect life and property. Per Hawai'i state law, this include promoting living shorelines projects instead of shoreline hardening where feasible. Specific projects may include streamline permitting for beach restoration; update dune restoration guidance; protect and restore coral reef systems; provide dune restoration training to county officials and the public; develop an outreach initiative to encourage or establish new dune restoration volunteers/stewards; and install ADA compliant dune walkovers in identified locations.
Estimated Cost:	High
Potential Funding Source:	NOAA Coastal Resilience Grant; NOAA National Marine Fisheries Service Ecosystem Restoration Grant; FWS Coastal Program; Hawai'i DLNR Beach Fund; Hawai'i Tourism Authority; County Budget
Implementation Timeline:	One to ten years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors. Goal 2: Promote the long-term resilience of the County's economic, environmental, historical and cultural resources. Goal 3: Protect and adapt property and infrastructure from the impacts of natural hazards and climate change. Goal 4: Improve awareness and mitigation of risks associated with natural hazards and climate change. Goal 5: Enhance the implementation of this Hazard Mitigation Plan through active involvement and Plan integration across all County Departments.
Benefits:	Well-engineered solutions to coastal erosion will protect private property, County-owned property, State-managed conservation lands, and the community resource that is Maui County's beaches. A solution that prevents coastal erosion would have an immediate reduction of risk for life and property.
Mitigation Category	Local Plans and Regulations, Structure and Infrastructure Project, Natural Systems Protection, Education and Awareness Programs
CRS Category	Preventative Activities, Property Protection, Natural Resource Protection, and Public Information
Priority	Medium

29. Implement Climate Action and Resiliency Plan

Lead Agency:	Mayor's Office of Climate Change, Resiliency, and Sustainability
Supporting Agencies:	Emergency Management Agency
Hazards of Concern:	All Hazards
Description of the Problem:	Increased development, tourism, and environmental impacts have exacerbated community, cultural, and environmental challenges.
Description of the Solution:	Implement the Maui Climate Action and Resiliency Plan to secure the people, infrastructure, and natural systems of Maui County. Potential mitigation projects include but are not limited to public education, buyout programs, building codes, GIS mapping, emergency power for critical facilities, critical infrastructure resilience studies, water storage, water re-use, stormwater management, cesspool conversions, resilience hubs, evacuation route planning, low impact development, open space conservation, wetland restoration, and marine resource management.
Estimated Cost:	High
Potential Funding Source:	FEMA Hazard Mitigation Grant Program; FEMA Pre-Disaster Mitigation Grant Program
Implementation Timeline:	One to five years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors. Goal 2: Promote the long-term resilience of the County's economic, environmental, historical and cultural resources. Goal 3: Protect and adapt property and infrastructure from the impacts of natural hazards and climate change. Goal 4: Improve awareness and mitigation of risks associated with natural hazards and climate change. Goal 5: Enhance the implementation of this Hazard Mitigation Plan through active involvement and Plan integration across all County Departments.
Benefits:	Action will provide a long-term reduction of risk for life and property.
Mitigation Category	Local Plans and Regulations, Structure and Infrastructure Project, Natural Systems Protection, Education and Awareness Programs
CRS Category	Preventive Measures, Property Protection, Public Information, Natural Resource Protection, Structural Flood Control Project, Emergency Services
Priority	Medium

30. Implement Hele Mai Maui 2045

Lead Agency:	Department of Public Works
Supporting Agencies:	Maui Metropolitan Planning Organization
Hazards of Concern:	Coastal Erosion, Flood, Wildfire
Description of the Problem:	On August 8, 2023, a series of devastating wildfires tore through Olinda, Kula, Pulehu, and Lahaina, the last of which claimed more than 100 lives. Homes and businesses were destroyed, including important cultural, historical, and spiritual sites. Sadly, the fires are not the only natural disasters Maui has faced recently. Each year, flooding has left South Kīhei Road impassable and waves have overtopped Honoapi'ilani Highway. The increasing frequency and severity of climate events has pushed resiliency to the forefront of residents' minds, and the transportation system has an important role to play in ensuring safe evacuations, reducing emissions, and providing good options for community members to get to the places they need to go. Public transportation in the County is limited and not currently a viable option for natural hazards with a short warning time.
Description of the Solution:	Implement the Hele Mai Maui 2045 Long-Range Transportation Plan. Potential mitigation projects include but are not limited to planning for emergency access routes, landscaping and stormwater programs, infrastructure improvements, drainage improvements, rockfall mitigation, and shoreline mitigation.
Estimated Cost:	High
Potential Funding Source:	County staff time; FEMA Hazard Mitigation Grant Program; FEMA Pre-Disaster Mitigation Grant Program
Implementation Timeline:	One to five years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors. Goal 2: Promote the long-term resilience of the County's economic, environmental, historical and cultural resources. Goal 3: Protect and adapt property and infrastructure from the impacts of natural hazards and climate change. Goal 4: Improve awareness and mitigation of risks associated with natural hazards and climate change. Goal 5: Enhance the implementation of this Hazard Mitigation Plan through active involvement and Plan integration across all County Departments.
Benefits:	Action will provide a long-term reduction of risk for life and property.
Mitigation Category	Local Plans and Regulations, Structure and Infrastructure Project, Natural Systems Protection, Education and Awareness Programs
CRS Category	Preventive Measures, Property Protection, Public Information, Natural Resource Protection, Structural Flood Control Project, Emergency Services
Priority	Medium

31. Undeveloped Land Master Plan

Lead Agency:	Maui Emergency Management Agency
Supporting Agencies:	Maui Department of Parks and Recreation, USACE, Department of Planning, Department of Public Works, University of Hawai'i Sea Grant Program
Hazards of Concern:	Coastal Erosion, Flood, Tsunami
Description of the Problem:	Coastal erosion is threatening County-owned coastal land, especially during high tides and high waves. And area of particular concern is the parcel of land located along the Honoapi`ilani Highway.
Description of the Solution:	Develop a Master Plan for the use of County owned land along the Honoapi`ilani Highway.
Estimated Cost:	Medium
Potential Funding Source:	County budget and staff time; FEMA Hazard Mitigation Grant Program; FEMA Pre-Disaster Mitigation Grant Program
Implementation Timeline:	One to five years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors. Goal 2: Promote the long-term resilience of the County's economic, environmental, historical and cultural resources. Goal 3: Protect and adapt property and infrastructure from the impacts of natural hazards and climate change. Goal 4: Improve awareness and mitigation of risks associated with natural hazards and climate change. Goal 5: Enhance the implementation of this Hazard Mitigation Plan through active involvement and Plan integration across all County Departments.
Benefits:	Long-term benefits of the action are difficult to quantify in the short term.
Mitigation Category	Local Plans and Regulations
CRS Category	Preventive Measures
Priority	Medium

32. Evacuation Routes

Lead Agency:	Mayor's Office
Supporting Agencies:	Department of Public Works, Hawai'i Department of Transportation
Hazards of Concern:	All Hazards
Description of the Problem:	Isolated communities in the County have the potential to be physically cut off from the more populated areas of the island due to limited roads.
Description of the Solution:	Explore and support construction of alternative routes to facilitate swift evacuation during a disaster.
Estimated Cost:	High
Potential Funding Source:	County budget and staff time; FEMA Hazard Mitigation Grant Program; FEMA Pre-Disaster Mitigation Grant Program
Implementation Timeline:	One to ten years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors. Goal 2: Promote the long-term resilience of the County's economic, environmental, historical and cultural resources. Goal 3: Protect and adapt property and infrastructure from the impacts of natural hazards and climate change.
Benefits:	Action will provide an immediate reduction of risk for life and property.
Mitigation Category	Local Plans and Regulations
CRS Category	Preventive Measures
Priority	Medium

33. State Highway Route 450

Lead Agency:	Mayor's Office and County Council
Supporting Agencies:	Department of Public Works, Hawai'i Department of Transportation
Hazards of Concern:	All Hazards
Description of the Problem:	State Highway Route 450 on Moloka'i has been experiencing major erosion and undermining.
Description of the Solution:	Coordinate with the state to adapt State Highway Route 450 in Moloka'i at MM 15-16.
Estimated Cost:	High
Potential Funding Source:	County budget and staff time; FEMA Hazard Mitigation Grant Program; FEMA Pre-Disaster Mitigation Grant Program
Implementation Timeline:	One to ten years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors. Goal 2: Promote the long-term resilience of the County's economic, environmental, historical and cultural resources. Goal 3: Protect and adapt property and infrastructure from the impacts of natural hazards and climate change.
Benefits:	Action will provide an immediate reduction of risk for life and property. This action will align with the Moloka'i Community Plans, including the Moloka'i Community Energy Resilience Action Plan (CERAP), Moloka'i Climate Change and Sea Level Rise Adaptation Resiliency Master Plan, and Moloka'i Coastal Homestead Community Resilience Plan, and the Maui County Coastal Roads Report.
Mitigation Category	Structure and Infrastructure Project
CRS Category	Preventive Measures, Property Protection, Structural Flood Control Projects
Priority	Medium

34. Launiupoko and Honolua Aquifer Source Development

Lead Agency:	Department of Water Supply
Supporting Agencies:	Office of Recovery
Hazards of Concern:	Drought, Wildfire
Description of the Problem:	Drought and periods of reduced rainfall lead to mandatory water restrictions, impacting the community's water supply in West Maui.
Description of the Solution:	Mitigation of drought-related water shortages and protection against wildfire. Construction of new wells, storage tanks, and connecting waterlines. First phase of project is at 100% design stage. A phased Hazard Mitigation Grant Program sub-application was submitted for Hazard Mitigation Grant Program funding in 2025, showing phased project eligibility, cost effectiveness, and environmental and historic preservation considerations.
Estimated Cost:	High
Potential Funding Source:	FEMA Hazard Mitigation Grant Program; FEMA Pre-Disaster Mitigation Grant Program; Drinking Water State Revolving Fund, State DLNR funding, USDA Water and Waste Disposal program, Maui Department of Water Supply Capital Revolving Fund, HUD Community Development Block Grant-Disaster Recovery, and U.S. Bureau of Reclamation Title XVI and WaterSMART
Implementation Timeline:	One to five years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors. Goal 2: Promote the long-term resilience of the County's economic, environmental, historical and cultural resources. Goal 3: Protect and adapt property and infrastructure from the impacts of natural hazards and climate change.
Benefits:	Action will provide a long-term reduction of risk for life and property.
Mitigation Category	Structure and Infrastructure Project
CRS Category	Natural Resource Protection, Structural Flood Control Project
Priority	Medium

35. General Plan

Lead Agency:	Planning
Supporting Agencies:	County Departments, National Park Service, Department of Land and Natural Resources, State Historic Preservation Division
Hazards of Concern:	All Hazards
Description of the Problem:	The Maui County General Plan is a sprawling document inclusive of over 1200 implementing actions and countless other goals and policies. The Planning Departments ability to initiate, implement, and monitor progress on these actions, in cooperation with 14 other county departments or agencies, is severely limited in that this information is not organized in a comprehensive database or similar software. In addition, there is repetitive loss of historic properties within Maui County that jeopardizes the integrity of historic districts and compromises the consideration of establishing new historic districts.
Description of the Solution:	Incorporation of the General Plans goals, policies, and actions into a dashboard type data visualization tool would greatly assist the Planning Departments ability to track, sort or filter, monitor, and share this data amongst the various county departments. Use of a dashboard type software would also provide an ability to publicly display the County's progress on implementing the General Plan. Consolidated and centralized data that is regularly updated and maintained. This data will be analyzed to identify at risk historic properties to be considered for preservation, restoration, rehabilitation and proposed new historic districts. This data will incorporate historic preservation and cultural resources goals, policies, objectives and actions from the various plans within the Department of Planning.
Estimated Cost:	Medium
Potential Funding Source:	County Fund
Implementation Timeline:	One to five years
Goals Met:	Goal 2: Promote the long-term resilience of the County's economic, environmental, historical and cultural resources. Goal 4: Improve awareness and mitigation of risks associated with natural hazards and climate change. Goal 5: Enhance the implementation of this Hazard Mitigation Plan through active involvement and Plan integration across all County Departments.
Benefits:	Improved inter-department coordination on implementation of the General Plan. This tool would provide for improved inter-department and agency coordination early on in the planning process and enhance public access to the implementing goals, policies, and actions contained within the General Plan, and lead to better informed decisions and coordination on plan, program, or capital project development.
Mitigation Category	Local Plans and Regulations
CRS Category	Preventative Measures
Priority	Medium

36. Repetitive Loss Outside SFHA

Lead Agency:	Department of Public Works
Supporting Agencies:	Maui Emergency Management Agency, Hawai'i Department of Land and Natural Resources
Hazards of Concern:	Flood
Description of the Problem:	Maui County is a Category B repetitive loss community with approximately 40% of the repetitive loss properties outside of the SFHA.
Description of the Solution:	County will regulate development of repetitive loss properties that are not within a special flood hazard area, conduct a repetitive loss analysis of all repetitive loss areas, and develop a storm documentation system to track storm conditions and impacts.
Estimated Cost:	High
Potential Funding Source:	Staff Time and County Budget; FEMA Hazard Mitigation Grant Program; FEMA Flood Mitigation Assistance; FEMA Pre-Disaster Mitigation Grant Program
Implementation Timeline:	One to five years
Goals Met:	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.
Benefits:	Action will provide a long-term reduction of risk for life and property.
Mitigation Category	Local Plans and Regulations
CRS Category	Preventative Activities
Priority	Medium

37. Coastal Road Management Plan

Lead Agency:	Department of Public Works
Supporting Agencies:	Maui Emergency Management Agency, Maui Department of Planning, Hawai'i Department of Transportation
Hazards of Concern:	Coastal Erosion, Flood, Tsunami
Description of the Problem:	Many of the County's roadways are at risk of shoreline erosion and inundation.
Description of the Solution:	Develop management plans for at-risk coastal roads. DPW partnered with the University of Hawai'i to complete a coastal roads study in 2024. The County's coastal roads were analyzed in different ocean hazard and climate change scenarios. Prioritization lists and adaptation recommendations were developed. The study will guide DPW's planning for risk mitigation of these roads. There are various studies are underway for specific locations including Kalepa Point, South Kīhei Road, and Lower Honoapi`ilani Road between Puamana Place and Hui Road East. Solutions may include moving roads inland, raising roadways, or providing shoreline protection.
Estimated Cost:	High
Potential Funding Source:	FEMA Hazard Mitigation Grant Program; FEMA Pre-Disaster Mitigation Grant Program; Staff Time
Implementation Timeline:	One to five years
Goals Met:	Goal 3: Protect and adapt property and infrastructure from the impacts of natural hazards and climate change. Goal 5: Enhance the implementation of this Hazard Mitigation Plan through active involvement and Plan integration across all County Departments.
Benefits:	Action will provide a long-term reduction of risk for life and property.
Mitigation Category	Local Plans and Regulations; Structure and Infrastructure Project
CRS Category	Preventative Measures
Priority	Medium

38. Drainage and Slope Stabilization

Lead Agency:	Department of Public Works
Supporting Agencies:	Maui Department of Management/GIS, Hawai'i Department of Transportation
Hazards of Concern:	Landslide
Description of the Problem:	Landslides and rockfalls cause the loss of evacuation routes and emergency access to private property. DPW has several slope repair projects along Kahekili Highway at MP15, MP14.5, and MP15.3.
Description of the Solution:	Improve drainage and slope stabilization along steeps areas that are prone to fail due to soil saturation, including the Kahekili Slope Repair project and other locations identified as priorities for hazard risk reduction. These include projects that protect critical facilities and infrastructure such as Pi'ilani Highway (through East Maui) and Kahekili Highway (through Kahakuloa). Develop a GIS data layer for hazard areas.
Estimated Cost:	High
Potential Funding Source:	FEMA Hazard Mitigation Grant Program; FEMA Pre-Disaster Mitigation Grant Program; USDA Natural Resources Conservation Service Emergency Watershed Program; Hawai'i Department of Land and Natural Resources; Staff Time
Implementation Timeline:	One to ten years
Goals Met:	Goal 3: Protect and adapt property and infrastructure from the impacts of natural hazards and climate change.
Benefits:	Action will provide an immediate reduction of risk for life and property.
Mitigation Category	Structure and Infrastructure Project, Natural Systems Protection
CRS Category	Natural Resource Protection
Priority	Medium

39. Stormwater Drainage System

Lead Agency:	Department of Public Works
Supporting Agencies:	Maui Department of Environmental Management, Hawai'i Department of Transportation
Hazards of Concern:	Flood, Hurricane
Description of the Problem:	The storm drainage system is an important capital asset which requires routine maintenance to optimize the level of service and protect the public and environmental health. Defects in the storm drainage system may results in roadway sinkholes, flooding of properties, and loss of life. DPW has completed an assessment of its drainage systems in Central Maui, South Maui, and West Maui since 2020.
Description of the Solution:	Expand stormwater infrastructure capacity to effectively manage drainage during intense rainfall episodes and reduce the likelihood that intense rainfall will result in flash floods.
Estimated Cost:	High
Potential Funding Source:	EPA Clean Water State Revolving Fund; FEMA Hazard Mitigation Grant Program; FEMA Flood Mitigation Assistance; FEMA Pre-Disaster Mitigation Grant Program
Implementation Timeline:	One to ten years
Goals Met:	Goal 3: Protect and adapt property and infrastructure from the impacts of natural hazards and climate change.
Benefits:	Action will provide an immediate reduction of risk for life and property.
Mitigation Category	Structure and Infrastructure Project
CRS Category	Structural Projects
Priority	Medium

40. Water Storage and Conservation

Lead Agency:	Department of Water Supply
Supporting Agencies:	Planning Department, Department of Public Works
Hazards of Concern:	Drought, Wildfire
Description of the Problem:	Conventional water sources are in the process of being developed, additional storage capacity is being pursued, and alternative sources are being investigated. Drought and periods of reduced rainfall lead to mandatory water restrictions, impacting the community's water supply.
Description of the Solution:	Increase water storage and development of additional capacity in Upcountry Maui, West Maui, and other areas susceptible to drought and encourage efficiency in conservation programs. Maui Island Plan 3.1.2 -Action 10.
Estimated Cost:	High
Potential Funding Source:	FEMA Hazard Mitigation Grant Program; FEMA Pre-Disaster Mitigation Grant Program; County Budget; Drinking Water State Revolving Fund, State DLNR funding; USDA Water and Waste Disposal program; Maui Department of Water Supply Capital Revolving Fund; U.S. Bureau of Reclamation Title XVI and WaterSMART
Implementation Timeline:	One to five years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors.
Benefits:	Added storage and source development capacity adds reliability and redundancy to the water system, allowing for the mitigation of drought-related water shortages and protection against wildfire. Action will provide a long-term reduction of risk for life and property.
Mitigation Category	Structure and Infrastructure Project
CRS Category	Preventive Activities
Priority	Medium

41. Upcountry Emergency Waterline

Lead Agency:	Department of Water Supply
Supporting Agencies:	Office of Recovery
Hazards of Concern:	Drought, Wildfire, Tsunami, Landslides
Description of the Problem:	Isolated water systems are vulnerable to outages due to hazards.
Description of the Solution:	Project constructs a waterline and booster pump stations to connect the Upcountry Maui Water System and the Central Maui Water System for use only during emergencies. Project is at Conceptual design stage. A phased Hazard Mitigation Grant Program sub-application was submitted for Hazard Mitigation Grant Program funding in 2025, showing phased project eligibility, cost effectiveness, and environmental and historic preservation considerations.
Estimated Cost:	High
Potential Funding Source:	FEMA Hazard Mitigation Grant Program; FEMA Pre-Disaster Mitigation Grant Program; Drinking Water State Revolving Fund, Maui Department of Water Supply Capital Revolving Fund, and U.S. Bureau of Reclamation WaterSMART
Implementation Timeline:	One to five years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors.
Benefits:	Action will provide a long-term reduction of risk for life and property.
Mitigation Category	Structure and Infrastructure Project
CRS Category	Emergency Services
Priority	Medium

42. Floodplain Training and Certification

Lead Agency:	Department of Public Works
Supporting Agencies:	Department of Planning, Mayor's Office, FEMA Training Center, Association of State Floodplain Managers
Hazards of Concern:	Flood
Description of the Problem:	The County identified a gap in NFIP and Floodplain Management expertise among County staff and officials. As a result, County personnel and decision makers are ill-equipped to make decisions about floodplain regulations, plans, and procedures.
Description of the Solution:	Encourage the integration of floodplain best practices across county agencies, including, but not limited to: • Provide floodplain training to County staff who are working to support the County's floodplain management program to build administrative capacity and increase performance efficiencies. Have each plan reviewer and building inspector attend a training or workshop related to floodplain management. • Sponsor a periodic NFIP workshop for local surveyors and builders. • Encourage or require more County staff positions to obtain and maintain Certified Floodplain Manager (CFM) certification, ideally having 2-3 dedicated CFMs optimizing the flood program. • Conduct information sessions regarding the NFIP for public officials and appointees of the Flood Management Program with an emphasis on the importance of the County's participation in the NFIP and the impact of failing to enforce requirements.
Estimated Cost:	Low
Potential Funding Source:	County Budget; FEMA Emergency Management Institute
Implementation Timeline:	One to five years
Goals Met:	Goal 2: Promote the long-term resilience of the County's economic, environmental, historical and cultural resources. Goal 4: Improve awareness and mitigation of risks associated with natural hazards and climate change.
Benefits:	Action will provide a long-term reduction of risk for life and property.
Mitigation Category	Education and Awareness Programs
CRS Category	Public Information Activities
Priority	Low

43. Substantial Damage Estimator

Lead Agency:	Maui Department of Public Works
Supporting Agencies:	Maui Emergency Management Agency
Hazards of Concern:	Earthquake, Flood, High Windstorm, Hurricane, Tsunamis, Wildfire
Description of the Problem:	To be considered "substantially damaged," a building in a flood hazard area must meet a set of criteria and comply with certain requirements. FEMA uses the term "substantial damage" to trigger a review of compliance with building code requirements applied to damaged buildings in flood hazard areas. FEMA developed the tool to assist state and local officials in estimating substantial damage for residential and non-residential structures per the National Flood Insurance Program requirements adopted by the communities. The tool assesses damage caused by flood, wind, wildfire, seismic and other events.
Description of the Solution:	Obtain FEMA's Substantial Damage Estimator and attend training to be prepared to use it when damage occurs; and develop mutual aid agreements with other jurisdictions to augment local inspection personnel after major disasters.
Estimated Cost:	Low
Potential Funding Source:	County budget and staff time; FEMA Hazard Mitigation Grant Program; FEMA Flood Mitigation Assistance; FEMA Pre-Disaster Mitigation Grant Program
Implementation Timeline:	One to five years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors. Goal 2: Promote the long-term resilience of the County's economic, environmental, historical and cultural resources. Goal 3: Protect and adapt property and infrastructure from the impacts of natural hazards and climate change. Goal 4: Improve awareness and mitigation of risks associated with natural hazards and climate change. Goal 5: Enhance the implementation of this Hazard Mitigation Plan through active involvement and Plan integration across all County Departments.
Benefits:	Long-term benefits of the action are difficult to quantify in the short term.
Mitigation Category	Local Plans and Regulations
CRS Category	Preventive Measures
Priority	Low

44. Drainage Plan Implementation

Lead Agency:	Department of Public Works
Supporting Agencies:	Department of Planning
Hazards of Concern:	Flood
Description of the Problem:	DPW completed the Kīhei Drainage Master Plan in 2022 and an Ecological Alternatives Analysis in 2023. DPW is underway with a coastal engineering analysis of the Kīhei Drainage Master Plan starting in 2025. The EPA began an update to the Lahaina Drainage Master Plan in 2025 to recommend nature-based solutions.
Description of the Solution:	Implement the mitigation actions identified in the existing and future drainage master plans, including, but not limited to, the Kīhei Drainage Master Plan, Ecological Alternatives Analysis, Coastal Engineering Analysis, and Lahaina Drainage Master Plan.
Estimated Cost:	High
Potential Funding Source:	EPA Clean Water State Revolving Fund; FEMA Hazard Mitigation Grant Program; USDA Natural Resources Conservation Service Emergency Watershed Program; FEMA Flood Mitigation Assistance; FEMA Pre-Disaster Mitigation Grant Program
Implementation Timeline:	One to ten years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors. Goal 2: Promote the long-term resilience of the County's economic, environmental, historical and cultural resources. Goal 3: Protect and adapt property and infrastructure from the impacts of natural hazards and climate change. Goal 4: Improve awareness and mitigation of risks associated with natural hazards and climate change. Goal 5: Enhance the implementation of this Hazard Mitigation Plan through active involvement and Plan integration across all County Departments.
Benefits:	Action will provide a long-term reduction of risk for life and property.
Mitigation Category	Local Plans and Regulations, Structure and Infrastructure Projects, Natural Systems Protection
CRS Category	Preventive Activities, Property Protection, Natural Resource Protection, Emergency Services, Structural Projects
Priority	Low

45. Saltwater Intrusion Mitigation

Lead Agency:	Mayor's Office
Supporting Agencies:	Maui Emergency Management Agency, Maui Planning Department
Hazards of Concern:	Coastal Erosion, Flood
Description of the Problem:	Saltwater intrusion, exacerbated by coastal flooding and erosion of natural coastal systems, presents a threat to the utilities, infrastructure, and ecosystems located along County coastlines.
Description of the Solution:	Mitigate the impacts of saltwater intrusion, exacerbated by flooding and/or erosion from Sea Level Rise, on utilities, ecosystems and other public facilities.
Estimated Cost:	High
Potential Funding Source:	County budget and staff time; FEMA Hazard Mitigation Grant Program; FEMA Pre-Disaster Mitigation Grant Program
Implementation Timeline:	One to five years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors. Goal 2: Promote the long-term resilience of the County's economic, environmental, historical and cultural resources. Goal 3: Protect and adapt property and infrastructure from the impacts of natural hazards and climate change. Goal 4: Improve awareness and mitigation of risks associated with natural hazards and climate change. Goal 5: Enhance the implementation of this Hazard Mitigation Plan through active involvement and Plan integration across all County Departments.
Benefits:	Long-term benefits of the action are difficult to quantify in the short term.
Mitigation Category	Local Plans and Regulations, Structure and Infrastructure Project, Natural Systems Protection
CRS Category	Preventive Measures, Property Protection, Natural Resource Protection, Structural Flood Control Projects
Priority	Low

46. Community Resilience Hubs

Lead Agency:	Mayor's Office
Supporting Agencies:	Maui Emergency Management Agency, Maui Planning Department
Hazards of Concern:	All Hazards
Description of the Problem:	The 2023 Lahaina Wildfires highlighted the need for disaster-impacted communities to have a single point of reference for emergency supply distribution, disaster information, and reunification.
Description of the Solution:	Support the development of a network of community resilience hubs across Maui County that complements the emergency preparedness, response and recovery efforts of the MEMA.
Estimated Cost:	High
Potential Funding Source:	County budget and staff time; FEMA Hazard Mitigation Grant Program; FEMA Pre-Disaster Mitigation Grant Program
Implementation Timeline:	One to five years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors. Goal 2: Promote the long-term resilience of the County's economic, environmental, historical and cultural resources. Goal 3: Protect and adapt property and infrastructure from the impacts of natural hazards and climate change. Goal 4: Improve awareness and mitigation of risks associated with natural hazards and climate change. Goal 5: Enhance the implementation of this Hazard Mitigation Plan through active involvement and Plan integration across all County Departments.
Benefits:	Long-term benefits of the action are difficult to quantify in the short term.
Mitigation Category	Local Plans and Regulations, Structure and Infrastructure Project, Education and Awareness Program
CRS Category	Preventive Measures, Property Protection, Public Information, Emergency Services
Priority	Low

47. Shoreline Erosion Studies

Lead Agency:	Department of Planning
Supporting Agencies:	Emergency Management Agency
Hazards of Concern:	Coastal Erosion
Description of the Problem:	Coastal erosion is already having widespread impacts on Maui, and these conditions are expanding and worsening in the face of sea level rise. UH has conducted detailed studies of historic and future erosion, but these studies have so far excluded Molokaʻi and Lānaʻi due to data and funding limitations. Updated modeling to include these islands is currently underway if funding remains sufficient.
Description of the Solution:	Support to the joint efforts of the University of Hawaiʻi (Coastal Geology Group) and Planning Department to complete shoreline erosion studies, to include Molokaʻi and Lānaʻi and continue to update studies for Maui.
Estimated Cost:	High
Potential Funding Source:	FEMA Hazard Mitigation Grant Program; FEMA Pre-Disaster Mitigation Grant Program; NOAA Coastal Resilience Grant; USACE; County Budget; FEMA Flood Mitigation Assistance
Implementation Timeline:	One to five years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors. Goal 2: Promote the long-term resilience of the County's economic, environmental, historical and cultural resources. Goal 5: Enhance the implementation of this Hazard Mitigation Plan through active involvement and Plan integration across all County Departments.
Benefits:	Long-term benefits of the action are difficult to quantify in the short term.
Mitigation Category	Local Plans and Regulations
CRS Category	Preventive Activities
Priority	Low

48. Wave-Driven Flooding Tool

Lead Agency:	Department of Planning
Supporting Agencies:	Department of Public Works, Department of Water Supply, Department of Environmental Management, Emergency Management Agency, Department of Parks & Recreation, Division of Forestry and Wildlife, Department of Land and Natural Resources, County GIS
Hazards of Concern:	Coastal Erosion, Flood
Description of the Problem:	Hawai'i is well-known for its seasonal big wave conditions. These seasonal conditions can have major impacts on the shoreline, especially as chronic erosion whittles away at the natural beach buffers and sea level rise leads to more wave energy crossing the barrier reef systems. A pilot project was conducted for West Maui to develop a next generation 2-D wave run-up model, also using photos of high wave events from Maui residents to calibrate the model. This model is now being applied island-wide and statewide if funding remains sufficient.
Description of the Solution:	Continue developing the West Maui Wave-Driven Flooding with Sea Level Rise Tool for other areas of the county, including Moloka'i and Lāna'i. This tool will be used to assess proposed coastal development projects and activities, informing mitigation and adaptation strategies or conditions. Additionally, it will identify major impacts and hotspots, enabling the County to better assess areas affected by coastal erosion and address them through proper mitigation and adaptive measures.
Estimated Cost:	High
Potential Funding Source:	County Budget and Staff Time
Implementation Timeline:	One to five years
Goals Met:	Goal 2: Promote the long-term resilience of the County's economic, environmental, historical and cultural resources. Goal 4: Improve awareness and mitigation of risks associated with natural hazards and climate change. Goal 5: Enhance the implementation of this Hazard Mitigation Plan through active involvement and Plan integration across all County Departments.
Benefits:	Long-term benefits of the action are difficult to quantify in the short term.
Mitigation Category	Local Plans and Regulations
CRS Category	Public Information Activities
Priority	Low

49. County Bridge Inventory

Lead Agency:	Department of Public Works
Supporting Agencies:	Maui Department of Management/GIS, Hawai'i Department of Transportation
Hazards of Concern:	Coastal Erosion, Flood, Tsunami
Description of the Problem:	Evacuation routes and emergency access to private property are inaccessible when bridges are washed away.
Description of the Solution:	Prepare an inventory of non-National Bridge Inspection Standards bridges using GIS and create a framework for an inspections schedule to help ensure that all bridges are assessed for their structural stability during a natural disaster, and to identify and prioritize the implementation of improvements for long-term resiliency, with an emphasis on bridges serving potentially isolated communities (e.g., East Maui).
Estimated Cost:	High
Potential Funding Source:	FEMA Hazard Mitigation Grant Program; FEMA Public Assistance 406; FEMA Pre-Disaster Mitigation Grant Program; Staff Time
Implementation Timeline:	One to five years
Goals Met:	Goal 3: Protect and adapt property and infrastructure from the impacts of natural hazards and climate change. Goal 5: Enhance the implementation of this Hazard Mitigation Plan through active involvement and Plan integration across all County Departments.
Benefits:	Long-term benefits of the action are difficult to quantify in the short term.
Mitigation Category	Local Plans and Regulations
CRS Category	Preventative Activities
Priority	Low

50. Irrigation Water Alternate Sources

Lead Agency:	Department of Water Supply, Department of Environmental Management
Supporting Agencies:	Maui Farm Bureau, Department of Parks & Recreation, Hawai'i Department of Agriculture
Hazards of Concern:	Drought, Wildfire
Description of the Problem:	Drought and periods of reduced rainfall lead to mandatory water restrictions, impacting the community's water supply.
Description of the Solution:	Coordinate with industry stakeholders to develop alternative sources of irrigation water including wastewater reuse, recycled stormwater runoff, and brackish well water. Coordinating priorities with Department of Environmental Management for wastewater reuse. Promoting use of brackish wells where available for developers through discretionary permit consultation. Informing developers of onsite stormwater capture opportunities, such as rain gardens and other best practices through discretionary permit consultation.
Estimated Cost:	High
Potential Funding Source:	EPA Clean Water State Revolving Fund; Staff Time
Implementation Timeline:	One to ten years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors.
Benefits:	Recycled water, brackish wells and stormwater capture adds resiliency and alternative supply in a water shortage due to drought, wildfire or other hazard-related water scarcity. Action will provide a long-term reduction of risk for life and property.
Mitigation Category	Structure and Infrastructure Projects, Natural Systems Protection
CRS Category	Natural Resource Protection
Priority	Low

51. Kamole Water Treatment Plant

Lead Agency:	Department of Water Supply
Supporting Agencies:	Office of Recovery
Hazards of Concern:	Drought, Hurricane
Description of the Problem:	Upcountry's Kamole Water Treatment plant shuts down during heavy rains due to the lack of retention and high turbidity of the water. Additionally, long drought periods and reduced rainfall also lead to shutoffs due to the lack of water storage.
Description of the Solution:	Project will construct two 70-MG reservoirs for retention and storage to mitigate against drought- and storm-related water treatment plant outages. Project is at preliminary design stage. A phased Hazard Mitigation Grant Program sub-application was submitted for Hazard Mitigation Grant Program funding in 2025, showing phased project eligibility, cost effectiveness, and environmental and historic preservation considerations.
Estimated Cost:	High
Potential Funding Source:	FEMA Hazard Mitigation Grant Program; FEMA Pre-Disaster Mitigation Grant Program; Drinking Water State Revolving Fund, Maui Department of Water Supply Capital Revolving Fund, and U.S. Bureau of Reclamation WaterSMART
Implementation Timeline:	One to ten years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors.
Benefits:	Action will provide a long-term reduction of risk for life and property.
Mitigation Category	Structure and Infrastructure Project
CRS Category	Natural Resource Protection, Structural Flood Control Project
Priority	Low

52. HHPD Emergency Actions Plans

Lead Agency:	Department of Water Supply
Supporting Agencies:	Hawaii Department of Land and Natural Resources
Hazards of Concern:	Dam Failure
Description of the Problem:	Of the 53 state-regulated dams in the County, 50 are considered high hazard, two are considered significant hazard, and one is considered low hazard. There are 37 dams assessed as being in poor condition, and 34 of them are high hazard potential dams (HHPDs). Emergency Actions Plans (EAPs) are required for HHPDs, updated every year, and exercised every five years.
Description of the Solution:	Provide technical assistance to dam owners updating their EAPs and help them exercise the plans, prioritizing the plans for HHPDs in poor condition.
Estimated Cost:	Low
Potential Funding Source:	FEMA Hazard Mitigation Grant Program; FEMA Pre-Disaster Mitigation Grant Program; Drinking Water State Revolving Fund, Maui Department of Water Supply Capital Revolving Fund, and U.S. Bureau of Reclamation WaterSMART, Rehabilitation of HHPD Grant Program
Implementation Timeline:	One to five years
Goals Met:	Goal 1: Protect the life, health, safety and welfare of Maui County residents and visitors.
Benefits:	Action will provide both short- and long-term reduction of risk to life and property in the dam failure inundation area. Updated EAPs ensure timely and effective notification and evacuation procedures for downstream communities, reducing the risk of injury or loss of life in the event of dam failure or emergency.
Mitigation Category	Local Plans and Regulations
CRS Category	Preventative Measures
Priority	High

53. HHPD Infrastructure Reinforcement Projects

Lead Agency:	Department of Water Supply
Supporting Agencies:	Hawaii Department of Land and Natural Resources
Hazards of Concern:	Dam Failure
Description of the Problem:	Of the 53 state-regulated dams in the County, 50 are considered high hazard, two are considered significant hazard, and one is considered low hazard. There are 37 dams assessed as being in poor condition, and 34 of them are high hazard dams.
Description of the Solution:	Implement dam infrastructure reinforcement projects for high hazard potential dams in poor condition.
Estimated Cost:	High
Potential Funding Source:	FEMA Hazard Mitigation Grant Program; FEMA Pre-Disaster Mitigation Grant Program; Drinking Water State Revolving Fund, Maui Department of Water Supply Capital Revolving Fund, and U.S. Bureau of Reclamation WaterSMART, Rehabilitation of High Hazard Potential Dam (HHPD) Grant Program
Implementation Timeline:	One to ten years
Goals Met:	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.
Benefits:	Action will provide a long-term reduction of risk to life and property in the dam failure inundation area.
Mitigation Category	Structure and Infrastructure Project
CRS Category	Structural Flood Control Project
Priority	Medium

PART 5: PLAN MAINTENANCE

20. MAINTENANCE AND IMPLEMENTATION PROCEDURES

This chapter details the formal process that will ensure that the hazard mitigation plan remains an active and relevant document and that the County maintains its eligibility for applicable funding sources. The plan maintenance process includes a schedule for monitoring and evaluating the plan annually and producing an updated plan every five years. In addition, this chapter describes how public participation will be integrated throughout the plan maintenance and implementation process. It explains how the mitigation strategy outlined in this plan update will be incorporated into existing planning mechanisms and programs, such as comprehensive land use planning processes, capital improvement planning, and building code enforcement and implementation.

20.1 HMP COORDINATOR

Plan implementation and evaluation will be a shared responsibility among all agencies identified as lead agencies in the mitigation action plan. An HMP Coordinator from MEMA will be designated to assume responsibility for overseeing the plan implementation and maintenance strategy. The HMP Coordinator will manage the maintenance and update of the plan during its approval period (the five-year period between FEMA's approval of the plan and its expiration), with the following responsibilities:

- Convene the HMWG
- Be the prime point of contact for questions regarding the plan and its implementation
- Coordinate the incorporation of additional information into the plan
- Manage the monitoring, evaluation, and updating responsibilities identified in this section

Currently, the Maui County HMP Coordinator is designated as:

Christopher Wegner, Hazard Mitigation Specialist
Maui Emergency Management Agency
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20.2 MAINTENANCE AND IMPLEMENTATION TASKS

The procedures for monitoring, evaluating, and updating the plan are provided below. The plan maintenance matrix shown in Table 20-1 provides a synopsis of responsibilities for plan monitoring, integration, evaluation, and update, which are discussed in further detail in the sections below.

Table 20-1. Plan Maintenance Matrix

Task	Approach	Timeline	Lead Responsibility	Support Responsibility
Monitoring	Lead agencies to recommend updates of the mitigation strategy, report progress toward implementation of actions, identify new actions, and update information on funding opportunities.	Each June or after the occurrence of a federally declared disaster	County agencies identified as lead agencies in mitigation strategy	HMP Coordinator
Integrating	Distribute the safe growth worksheet (see Table 20-2) for annual review and update by all participating agencies.	June each year with interim email reminders to address integration in county activities	HMP Coordinator	MEMA Administrator
Evaluating	Review the status of previous actions, as submitted by the monitoring task lead, and assess the effectiveness of the plan; compile and finalize update of mitigation strategy.	Updated progress report completed by September 30 of each year	HMP Coordinator	MEMA Administrator
Updating	Reconvene the HMWG to guide a comprehensive update to review and revise the plan.	Every 5 years or upon major update to General Plan or after the occurrence of a major disaster	HMP Coordinator	MEMA Administrator
Grant Monitoring	Notify lead agencies about grant opportunities, maintain a list of eligible agency-specific projects for funding consideration, and notify lead agencies of fiscal year mitigation priorities.	Continuously and as grant opportunities are identified	HMP Coordinator	MEMA Administrator
Public Involvement	Inform the public of hazard events via social media outlets, promote educational workshops on hazard topics, and track and file public comments received regarding the HMP.	Continuously	MEMA PIO	HMP Coordinator

20.2.1 Monitoring

The HMP Coordinator will be responsible for monitoring and documenting annual progress on the plan. Each year, beginning one year after plan development, the HMP Coordinator will collect and process information from the persons responsible for initiating or overseeing the mitigation projects in each department, agency, and organization involved in implementing mitigation actions. This will be accomplished using an online performance progress reporting system (the BATool^{SM}), which will enable the County to:

- Directly access mitigation actions
- Easily update the status of each project
- Document successes or obstacles to implementation
- Add or delete projects to maintain mitigation strategy implementation

Staff will be prompted by the tool to update progress on a quarterly basis, encouraging them to refresh the mitigation strategy and to continue the implementation of actions. This reporting system facilitates the sorting and prioritization of projects and will support the submittal of an increased number of project grant fund applications. Designated staff will be expected to document the following:

- Progress on the implementation of mitigation actions
- Obstacles or impediments to the implementation of actions
- Any grant applications filed
- Hazard events and losses occurring in the community
- Additional mitigation actions believed to be appropriate and feasible
- Public and stakeholder input.

20.2.2 Integrating the HMP into Local Planning Mechanisms

Hazard mitigation is sustained action taken to reduce or eliminate the long-term risk to human life and property from natural hazards. Integrating hazard mitigation into a community's existing plans, policies, codes, and programs leads to development patterns or redevelopment that reduce risk from known hazards. During the HMP update, the County recognized the importance and benefits of incorporating hazard mitigation into future local planning and regulatory processes.

Effective mitigation is achieved when hazard awareness and risk management approaches and strategies become an integral part of public activities and decision-making. Within the County, there are many existing plans and programs that support hazard risk management, and it is critical that this HMP integrate with and complement those existing plans and programs.

The Capability Assessment (Chapter 18) provides a summary and description of the existing plans, programs, and regulatory mechanisms at all levels of government (federal, state, county, and local) that support hazard mitigation within the County. In addition, the County identified how it has integrated hazard risk management into its existing planning, regulatory, and administrative framework ("existing integration") and how it intends to promote this integration further ("opportunities for future integration").

It is the intention of the County to incorporate mitigation planning as an integral component of daily government operations. County staff will integrate the newly adopted hazard mitigation goals and actions into the general operations of government and partner organizations. The sample adoption resolution (Appendix A) includes a resolution item stating the intent of the County's governing body to incorporate mitigation planning as an integral component of government operations. By doing so, the County anticipates that:

- Hazard mitigation planning will be formally recognized as an integral part of overall emergency management efforts.
- The HMP, comprehensive plans, emergency management plans and other relevant planning mechanisms will become mutually supportive documents that work in concert to meet the goals and needs of county residents.

Other planning processes and programs to be coordinated with the recommendations of the HMP include the following:

- Emergency response plans
- Training and exercise of emergency response plans
- Debris management plans
- Recovery plans
- Capital improvement programs
- County codes
- Community design guidelines
- Water-efficient landscape design guidelines
- Stormwater management programs
- Water system vulnerability assessments
- Community wildfire protection plans
- Comprehensive flood hazard management plans
- Resiliency plans
- Community Development Block Grant Disaster Recovery action plans
- Public information and improved public participation
- Educational programs
- Continued interagency coordination

During the HMP annual review process, the County will document how it has incorporated the HMP into day-to-day operations and planning and regulatory processes. Each agency will identify additional policies, programs, practices, and procedures that could be modified to accommodate hazard mitigation actions and include these findings and recommendations in the annual HMP progress report. The checklist in Table 20-2, adapted from FEMA's 2013 Local Mitigation Handbook, will help to analyze how hazard mitigation is integrated into local plans, ordinances, regulations, and policies. Completing the checklist will help identify areas that currently integrate hazard mitigation and where to make improvements and reduce vulnerability to future development.

Table 20-2. Safe Growth Check List

Planning Mechanisms	Yes	No	How is it being done or how will this be utilized in the future?
Operating and Capital Improvement Program Budgets			
When constructing upcoming budgets, are hazard mitigation actions funded as budget allows?			
Are construction projects evaluated to see if they meet the hazard mitigation goals?			
Does the community review mitigation actions when allocating funding during annual budget adoption processes?			
Do budgets limit expenditures on projects that would encourage development in areas vulnerable to natural hazards?			
Do infrastructure policies limit extension of existing facilities and services that would encourage development in areas vulnerable to natural hazards?			
Do budgets provide funding for hazard mitigation projects identified in the HMP?			
Human Resource Manual			
Do any job descriptions specifically include identifying and/or implementing mitigation projects/actions or other efforts to reduce natural hazard risk?			
Building and Zoning Ordinances			
Prior to zoning changes or development permitting, does the community review the HMP and other hazard analyses to ensure consistent and compatible land use?			
Does the zoning ordinance discourage development or redevelopment within natural areas, including wetlands, floodways, and floodplains?			
Does the zoning ordinance contain natural overlay zones that set conditions			
Does the zoning ordinance require developers to take additional actions to mitigate natural hazard risk?			
Do rezoning procedures recognize natural hazard areas as limits on zoning changes that allow greater intensity or density of use?			
Does the zoning ordinance prohibit development within or filling of wetlands, floodways, and floodplains?			
Subdivision Regulations			
Do the subdivision regulations restrict the subdivision of land within or adjacent to natural hazard areas?			
Do the regulations provide for conservation subdivisions or cluster subdivisions in order to conserve environmental resources?			
Do the regulations allow density transfers where hazard areas exist?			

Planning Mechanisms	Yes	No	How is it being done or how will this be utilized in the future?
Comprehensive Plan			
Are the goals and policies of the plan related to those of the HMP?			
Does the future land use map clearly identify natural hazard areas?			
Does the plan provide adequate space for expected future growth in areas located outside natural hazard areas?			
Land Use			
Does the future land use map clearly identify natural hazard areas?			
Do the land use policies discourage development or redevelopment in natural hazard areas?			
Transportation Plan			
Does the transportation plan limit access to hazard areas?			
Is transportation policy used to guide growth to safe locations?			
Are transportation systems designed to function under disaster conditions (e.g., evacuation)?			
Environmental Management			
Are environmental systems that protect development from hazards identified and mapped?			
Do environmental policies maintain and restore protective ecosystems?			
Do environmental policies provide incentives to development located outside protective ecosystems?			
Grant Applications			
Are data and maps used as supporting documentation in grant applications?			
Local Ordinances			
Is hazard mitigation a priority when updating local ordinances?			
Economic Development			
Does the local economic development group take into account information regarding identified hazard areas when assisting new businesses in finding a location?			
Public Education and Outreach			
Does the community have any public outreach mechanisms/ programs in place to inform citizens on natural hazards, risk, and ways to protect themselves during such events?			

20.2.3 Evaluating

Evaluation of the mitigation plan is an assessment of whether the planning process and actions have been effective, whether the HMP goals are being achieved, and whether changes are needed. The

HMP Coordinator will consult with the lead agencies to evaluate the effectiveness of the plan implementation and to reflect changes that could affect mitigation priorities or available funding.

The status of the HMP will be discussed and documented at an annual plan review meeting to be held either in person or via teleconference approximately one year from the date of local adoption of this update and successively thereafter. The HMP Coordinator will be responsible for calling participants, coordinating the annual plan review meeting, and soliciting input regarding progress toward meeting plan goals. At least two weeks before the annual plan review meeting, the HMP Coordinator will advise lead agencies of the meeting date, agenda, and expectations of the members. These evaluations will assess whether:

- Goals address current and expected conditions
- The nature or magnitude of the risks has changed
- Current resources are appropriate for implementing the HMP and if different or additional resources are now available
- Actions were cost-effective
- Schedules and budgets are feasible
- Implementation problems are present, such as technical, political, legal, or coordination issues with other agencies
- Outcomes have occurred as expected
- Changes in local resources impacted plan implementation (e.g., funding, personnel, and equipment)
- New agencies, departments, and staff are included, involving other local governments as defined under 44 CFR 201.6.

Specifically, the agencies will review the mitigation goals and activities using performance-based indicators, including:

- New agencies/departments
- Project completion
- Underspending/overspending
- Achievement of the goals
- Resource allocation
- Timeframes
- Budgets
- Lead/support agency commitment
- Resources
- Feasibility

Finally, the agencies will evaluate how other programs and policies have conflicted with or augmented planned or implemented mitigation actions and will identify policies, programs, practices, and

procedures that could be modified to accommodate hazard mitigation actions. Other programs and policies can include those that address:

- Economic development
- Environmental preservation
- Historic preservation
- Redevelopment
- Health and safety
- Recreation
- Land use and zoning
- Public education and outreach
- Transportation

The agencies should refer to evaluation forms in the FEMA 386-4 guidance document to assist in the evaluation process. Further, the agencies should refer to any process and plan review deliverables developed by the County as a part of the plan review processes established for prior or existing local HMPs within the county.

The HMP Coordinator will be responsible for preparing an annual HMP progress report for each year of the approval period based on the information provided by County agencies. These annual reports will provide data for the five-year update of this HMP and will assist in pinpointing any implementation challenges. By monitoring the implementation of the HMP, the agencies will be able to assess which actions are completed, which are no longer feasible, and which require additional funding.

Following any major disasters, the HMP will be evaluated and revised to determine if the recommended actions remain relevant and appropriate. The risk assessment will also be revisited to see if any changes are necessary based on the pattern of disaster damage or if data listed in the hazard profiles of this plan has been collected to facilitate the risk assessment. This is an opportunity to increase the community's disaster resistance and build a better and stronger community.

20.2.4 Updating

44 CFR 201.6.d.3 requires that local hazard mitigation plans be reviewed, revised as appropriate, and resubmitted for approval to remain eligible for benefits awarded under DMA 2000. It is the intent of MEMA to update this plan on a five-year cycle from the date of initial plan adoption.

To facilitate the update process, the HMP Coordinator will use the second annual HMP Update meeting to develop and commence the implementation of a detailed plan update program. Prior to the five-year update, the HMP Coordinator will invite representatives from HI-EMA to provide guidance on plan update procedures. At a minimum, this will establish who will be responsible for managing and completing the plan update effort, items that need to be included in the updated plan, and a detailed timeline with milestones to ensure that the update is completed according to regulatory requirements.

At this meeting, the project team will determine what resources will be needed to complete the update and seek to secure these resources.

Following each 5-year update of the HMP, the updated plan will be distributed for public comment. After all comments are addressed, the HMP will be revised and distributed to all lead agencies.

20.2.5 Grant Monitoring and Coordination

Maui County intends to be a resource to the lead agencies in the support of project grant writing and development. The degree of this support will depend on the level of assistance requested by the agencies during openings for grant applications. As part of grant monitoring and coordination, Maui County intends to provide the following:

- Notification to lead agencies about impending grant opportunities
- A current list of eligible projects for funding pursuit consideration
- Notification about mitigation priorities for the fiscal year to assist the agencies in the selection of appropriate projects.

20.2.6 Continued Public Involvement

The County is committed to the continued involvement of the public in the hazard mitigation process. This HMP update will continue to be posted online at the following link: https://www.mauicounty.gov/1832/Hazard-Mitigation. In addition, public outreach and dissemination of the HMP will include the following:

- Continued utilization of existing social media outlets (Facebook, X, Instagram) to inform the public of natural hazard events, such as floods and severe storms; the public can be educated via the County website on how these applications can be used in an emergency situation
- Promotion of articles or workshops on hazards to educate the public and keep them aware of the dangers of hazards

The HMP Coordinator will be responsible for receiving, tracking, and filing public comments regarding this HMP. The public will have an opportunity to comment on the plan via the hazard mitigation website at any time. The HMP Coordinator will ensure that:

- Public and stakeholder comments and input on the plan, and hazard mitigation in general, are collected, recorded, and addressed as appropriate.
- The Maui County HMP website is maintained and updated as appropriate.
- Copies of the latest approved plan are available for review at appropriate county facilities, along with instructions to facilitate public input and comment on the plan.
- Public notices, including media releases, are made (as appropriate) to inform the public of the availability of the plan, particularly during plan update cycles.

Communities likely to experience isolation, such as Molokaʻi, Hāna, and Lānaʻi will continue to hold public disaster preparedness meetings. The HMP Coordinator will support public meetings in all

Community Plan Areas that relate to hazard mitigation, such as the development of community plans, by providing meeting leaders with hazard mitigation information and attending meetings whenever possible. HMWG meetings will provide an opportunity for the HMP Coordinator and key County stakeholders to determine how best to support common goals. These meetings also provide a chance to facilitate the integration of the Hazard Mitigation Plan into other planning mechanisms and County programs.

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APPENDIX A. HMP ADOPTION RESOLUTION

To Be Provided With Final Draft

APPENDIX B. DEFINITION OF TERMS AND ACRONYMS

Acronyms

%g—percent acceleration force of gravity

44 CFR—Code of Federal Regulations, Title 44

ACS—U.S. Census American Community Survey

APA—approvable pending adoption

ASCE—American Society of Civil Engineers

BFE—base flood elevation

CERT—Community Emergency Response Team

CFM—certified floodplain manager

CFR—Code of Federal Regulations

CIP—capital improvement plan

CRS—Community Rating System

CWPP—Community Wildfire Protection Plan

DART—Deep-ocean Assessment and Reporting of Tsunami

DBEDT—Hawai'i Department of Business, Economic Development, and Tourism

DEM—digital elevation model

DFIRM—Digital Flood Insurance Rate Maps

DHS—U.S. Department of Homeland Security

DLNR—Hawai'i Department of Land and Natural Resources

DMA—Disaster Mitigation Act

DOFAW—Division of Forestry and Wildlife Management

EAP—education and awareness program

EAP—emergency action plan

ENSO—El Niño–Southern Oscillation

EOC—emergency operations center

EPA—U.S. Environmental Protection Agency

FEMA—Federal Emergency Management Agency

FERC—Federal Energy Regulatory Commission

FIRM—Flood Insurance Rate Map

FIS—Flood Insurance Study

FMA—Flood Mitigation Assistance

FSA—USDA Farm Service Agencye

GAT—Great Aleutian Tsunami

GIS—geographic information system

HHARP—Hawai'i Hazards Awareness and Resilience Program

HI-EMA—Hawai'i Emergency Management Agency

HMA—Hazard Mitigation Assistance

HMGP—Hazard Mitigation Grant Program

HMP—hazard mitigation plan

HMWG—Hazard Mitigation Working Group

HWMO—Hawai'i Wildfire Management Organization

IBC—International Building Code

IPCC—Intergovernmental Panel on Climate Change

IRC—International Residential Code

LiMWA—limit of moderate wave action

LTRP—Long Term Recovery Plan

MEMA—Maui Emergency Management Agency

MMI—Modified Mercalli Intensity

mph—miles per hour

MRP—mean return period

NAICS—North American Industry Classification System

NBI—National Bridge Inventory

NCEI—National Centers for Environmental Information

NDMC—National Drought Mitigation Center

NEHRP—National Earthquake Hazards Reduction Program

NFIP—National Flood Insurance Program

NHC—National Hurricane Center

NOAA—National Oceanic and Atmospheric Administration

NPS—National Park Service

NRCS—Natural Resource Conservation Service

NSI—USACE National Structure Inventory

NWS—National Weather Service

PacIOOS—Pacific Islands Ocean Observing System

PDC—Pacific Disaster Center

PGA—peak ground acceleration

RCV—replacement cost value

RL—repetitive loss

SA—spectral acceleration

SFHA—Special Flood Hazard Areas

SO_2—sulfur dioxide

SOEST—University of Hawai'i School of Ocean and Earth Science and Technology

SPC—Storm Prediction Center

SPI—Standardized Precipitation Index

SRL—severe repetitive loss

THIRA—Threat & Hazard Identification & Risk Assessment

USACE—U.S. Army Corps of Engineers

USDA—U.S. Department of Agriculture

USDM—U.S. Drought Monitor

USGS—U.S. Geological Survey

VOAD—Voluntary Organizations Active in Disaster

WUI—wildland-urban interface

Definitions

Asset: An asset is any man-made or natural feature that has value, including, but not limited to, people; buildings; infrastructure, such as bridges, roads, sewers, and water systems; lifelines, such as electricity and communication resources; and environmental, cultural, or recreational features such as parks, wetlands, and landmarks.

Base Flood: The flood having a 1-percent chance of being equaled or exceeded in any given year, also known as the "100-year" or "1-percent chance" flood. The base flood is a statistical concept used to ensure that all properties subject to the National Flood Insurance Program (NFIP) are protected to the same degree against flooding.

Benefit: A benefit is a net project outcome and is usually defined in monetary terms. Benefits may include direct and indirect effects. For the purposes of benefit-cost analysis of proposed mitigation measures, benefits are limited to specific, measurable, risk reduction factors, including reduction in expected property losses (buildings, contents, and functions) and protection of human life.

Benefit/Cost Analysis: A benefit/cost analysis is a systematic, quantitative method of comparing projected benefits to projected costs of a project or policy. It is used as a measure of cost effectiveness.

Capability Assessment: A capability assessment provides a description and analysis of a community's current capacity to address threats associated with hazards. The assessment includes two components: an inventory of an agency's mission, programs, and policies, and an analysis of its capacity to carry them out. A capability assessment is an integral part of the planning process in which a community's actions to reduce losses are identified, reviewed, and analyzed, and the framework for implementation is identified.

Community Rating System (CRS): The CRS is a voluntary program under the NFIP that rewards participating communities (provides incentives) for exceeding the minimum requirements of the NFIP and completing activities that reduce flood hazard risk by providing flood insurance premium discounts.

Critical Facility: Facilities and infrastructure that are critical to the health and welfare of the population. These become especially important after any hazard event occurs.

Dam: Any artificial barrier or controlling mechanism that can or does impound 10 acre-feet or more of water.

Dam Failure: Dam failure refers to a partial or complete breach in a dam (or levee) that impacts its integrity. Dam failures occur for a number of reasons, such as flash flooding, inadequate spillway size, mechanical failure of valves or other equipment, freezing and thawing cycles, earthquakes, and intentional destruction.

Debris Flow: Dense mixtures of water-saturated debris that move down-valley; looking and behaving much like flowing concrete. They form when loose masses of unconsolidated material are saturated, become unstable, and move down slope.

Disaster Mitigation Act of 2000 (DMA): The DMA is Public Law 106-390 and is the latest federal legislation enacted to encourage and promote proactive, pre-disaster planning as a condition of receiving financial assistance under the Robert T. Stafford Act. The DMA emphasizes planning for disasters before they occur. Under the DMA, a pre-disaster hazard mitigation program and new requirements for the national post-disaster hazard mitigation grant program (HMGP) were established.

Drought: Drought is a period of time without substantial precipitation from one year to the next. Drought can also be defined as the cumulative impacts of several dry years or a deficiency of precipitation over an extended period of time, which in turn results in water shortages for some activity, group, or environmental function. A hydrological drought is caused by deficiencies in surface and subsurface water supplies. A socioeconomic drought impacts the health, well being, and quality of life or starts to have an adverse impact on a region. Drought is a normal, recurrent feature of climate and occurs almost everywhere.

Earthquake: An earthquake is defined as a sudden slip on a fault, volcanic or magmatic activity, and sudden stress changes in the earth that result in ground shaking and radiated seismic energy. Earthquakes can last from a few seconds to over 5 minutes, and have been known to occur as a series of tremors over a period of several days. The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Casualties may result from falling objects and debris as shocks shake, damage, or demolish buildings and other structures.

Exposure: Exposure is defined as the number and dollar value of assets considered to be at risk during the occurrence of a specific hazard.

Extent: The extent is the severity of a hazard event measured against some quantitative scale.

Fire Behavior: Fire behavior refers to the physical characteristics of a fire and is a function of the interaction between the fuel characteristics (such as type of vegetation and structures that could burn), topography, and weather. Variables that affect fire behavior include the rate of spread, intensity, fuel consumption, and fire type (such as underbrush versus crown fire).

Flash Flood: A flash flood occurs with little or no warning when water levels rise at an extremely fast rate

Flood Insurance Rate Map (FIRM): FIRMs are the official maps on which the Federal Emergency Management Agency (FEMA) has delineated the Special Flood Hazard Area (SFHA).

Flood Insurance Study: A report published by the Federal Insurance and Mitigation Administration for a community in conjunction with the community's Flood Insurance rate Map. The study contains such background data as the base flood discharges and water surface elevations that were used to prepare the FIRM. In most cases, a community FIRM with detailed mapping will have a corresponding flood insurance study.

Floodplain: Any land area susceptible to being inundated by flood waters from any source. A flood insurance rate map identifies most, but not necessarily all, of a community's floodplain as the Special Flood Hazard Area (SFHA).

Floodway: Floodways are areas within a floodplain that are reserved for the purpose of conveying flood discharge without increasing the base flood elevation more than 1 foot. Generally speaking, no development is allowed in floodways, as any structures located there would block the flow of floodwaters.

Freeboard: Freeboard is the margin of safety added to the base flood elevation.

Frequency: For the purposes of this plan, frequency refers to how often a hazard of specific magnitude, duration, and/or extent is expected to occur on average. Statistically, a hazard with a 100-year frequency is expected to occur about once every 100 years on average and has a 1 percent chance of occurring any given year. Frequency reliability varies depending on the type of hazard considered.

Geographic Information System (GIS): GIS is a computer software application that relates data regarding physical and other features on the earth to a database for mapping and analysis.

Hazard Mitigation Grant Program (HMGP): Authorized under Section 202 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, the HMGP is administered by FEMA and provides grants to states, tribes, and local governments to implement hazard mitigation actions after a major disaster declaration. The purpose of the program is to reduce the loss of life and property due to disasters and to enable mitigation activities to be implemented as a community recovers from a disaster

Hazus: Hazus is a GIS-based program used to support the development of risk assessments as required under the DMA. The Hazus software assesses risk in a quantitative manner to estimate damages and losses associated with natural hazards. Hazus is FEMA's nationally applicable, standardized methodology and software program and contains modules for estimating potential losses from earthquakes, floods, and wind hazards. Hazus has also been used to assess vulnerability (exposure) for other hazards.

Hydrology: Hydrology is the analysis of waters of the earth. For example, a flood discharge estimate is developed by conducting a hydrologic study.

Intensity: For the purposes of this plan, intensity refers to the measure of the effects of a hazard.

Inventory: The assets identified in a study region comprise an inventory. Inventories include assets that could be lost when a disaster occurs and community resources are at risk. Assets include people, buildings, transportation, and other valued community resources.

Liquefaction: Liquefaction is the complete failure of soils, occurring when soils lose shear strength and flow horizontally. It is most likely to occur in fine grain sands and silts, which behave like viscous fluids when liquefaction occurs. This situation is extremely hazardous to development on the soils that liquefy, and generally results in extreme property damage and threats to life and safety.

Local Government: Any county, municipality, city, town, township, public authority, school district, special district, intrastate district, council of governments (regardless of whether the council of governments is incorporated as a nonprofit corporation under State law), regional or interstate

government entity, or agency or instrumentality of a local government; any Indian tribe or authorized tribal organization, or Alaska Native village or organization; and any rural community, unincorporated town or village, or other public entity.

Magnitude: Magnitude is the measure of the strength of an earthquake, and is typically measured by the Richter scale. As an estimate of energy, each whole number step in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number value.

Mitigation: A preventive action that can be taken in advance of an event that will reduce or eliminate the risk to life or property.

Mitigation Actions: Mitigation actions are specific actions to achieve goals that minimize the effects from a disaster and reduce the loss of life and property.

Peak Ground Acceleration: Peak Ground Acceleration (PGA) is a measure of the highest amplitude of ground shaking that accompanies an earthquake, based on a percentage of the force of gravity.

Preparedness: Preparedness refers to actions that strengthen the capability of government, citizens, and communities to respond to disasters.

Probability of Occurrence: The probability of occurrence is a statistical measure or estimate of the likelihood that a hazard will occur. This probability is generally based on past hazard events in the area and a forecast of events that could occur in the future. A probability factor based on yearly values of occurrence is used to estimate probability of occurrence.

Repetitive Loss Property: Any NFIP-insured property that, since 1978 and regardless of any changes of ownership during that period, has experienced one of the following:

- Four or more paid flood losses in excess of $1000.00
- Two paid flood losses in excess of $1000.00 within any 10-year period since 1978
- Three or more paid losses that equal or exceed the current value of the insured property.

Return Period (or Mean Return Period): This term refers to the average period of time in years between occurrences of a particular hazard (equal to the inverse of the annual frequency of occurrence).

Riverine: Of or produced by a river. Riverine floodplains have readily identifiable channels. Floodway maps can only be prepared for riverine floodplains.

Risk: Risk is the estimated impact that a hazard would have on people, services, facilities, and structures in a community. Risk measures the likelihood of a hazard occurring and resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms such as a high, moderate, or low likelihood of sustaining damage above a particular threshold due to occurrence of a specific type of hazard. Risk also can be expressed in terms of potential monetary losses associated with the intensity of the hazard.

Risk Assessment: Risk assessment is the process of measuring potential loss of life, personal injury, economic injury, and property damage resulting from hazards. This process assesses the vulnerability of people, buildings, and infrastructure to hazards and focuses on (1) hazard identification; (2) impacts of hazards on physical, social, and economic assets; (3) vulnerability identification; and (4) estimates of the cost of damage or costs that could be avoided through mitigation.

Risk Ranking: This ranking serves two purposes: (1) to describe the probability that a hazard will occur, and (2) to describe the impact a hazard will have on people, property, and the economy. Risk estimates are based on the methodology used to prepare the risk assessment for this plan.

Robert T. Stafford Act: The Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 100-107, was signed into law on November 23, 1988. This law amended the Disaster Relief Act of 1974, Public Law 93-288. The Stafford Act is the statutory authority for most federal disaster response activities, especially as they pertain to FEMA and its programs.

Sinkhole: A collapse depression in the ground with no visible outlet. Its drainage is subterranean. It is commonly vertical-sided or funnel-shaped.

Special Flood Hazard Area: The base floodplain delineated on a Flood Insurance Rate Map. The SFHA is mapped as a Zone A in riverine situations and zone V in coastal situations. The SFHA may or may not encompass all of a community's flood problems

Stakeholder: Business leaders, civic groups, academia, non-profit organizations, major employers, managers of critical facilities, farmers, developers, special purpose districts, and others whose actions could impact hazard mitigation.

Vulnerability: Vulnerability describes how exposed or susceptible an asset is to damage. Vulnerability depends on an asset's construction, contents, and the economic value of its functions.

Vog: Volcanic gas

Watershed: A watershed is an area that drains downgradient from areas of higher land to areas of lower land to the lowest point.

Zoning Ordinance: The zoning ordinance designates allowable land use and intensities for a local jurisdiction. Zoning ordinances consist of two components: a zoning text and a zoning map.

APPENDIX C. PUBLIC OUTREACH

County Press Release December 12, 2024:

Home › News Flash

Press Releases

Posted on: December 12, 2024

Public invited to join virtual kickoff for Maui County Hazard Mitigation Plan Update working group

Maui Emergency Management Agency to host virtual meetings on risks and impacts, mitigation strategies

The Maui Emergency Management Agency (MEMA) invites residents to join the virtual kickoff meeting for the Maui County Hazard Mitigation Plan Update (HMPU) working group on Tuesday, Dec. 17, from noon to 1 p.m.

The HMPU update is essential for maintaining eligibility for FEMA's Hazard Mitigation Assistance grants, which providing funding for community needs including hazard mitigation funds, resilient infrastructure, post-fire needs and flood mitigation assistance.

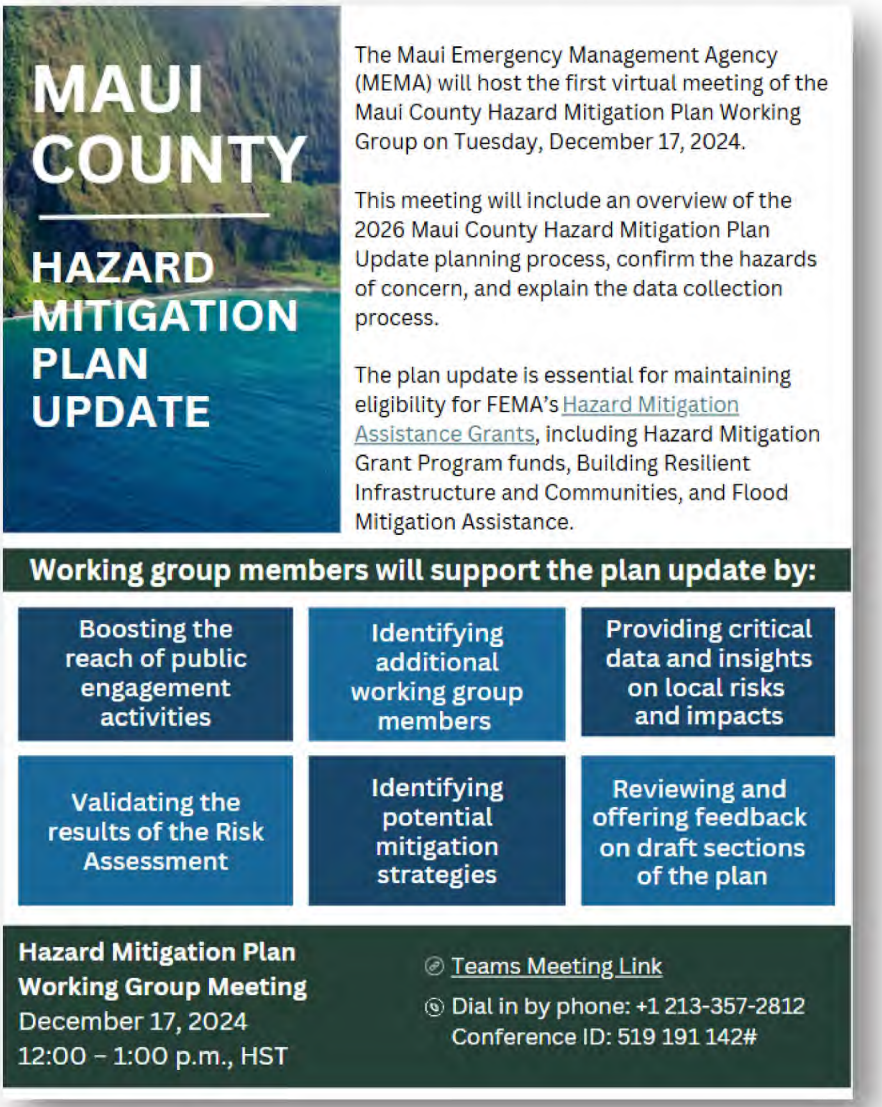
Over the next eight months, HMPU working group members will conduct public engagement outreach, provide critical data and insights on local risks and impacts, recommend mitigation strategies, review and offer feedback on the draft plan, and identify additional stakeholders for plan review.

To join the online meeting at noon on Dec.17, visit https://tinyurl.com/HazardMitigationWGmeeting or join by phone by calling (213) 357-2812, and entering phone conference ID: 519 191 142#.

To learn more about Maui County's Multi-Hazard Mitigation Plan, visit www.mauicounty.gov/1832 or call MEMA at (808) 270-7285.

Click here to join kickoff mtg at noon on 12-17-24

Hazard Mitigation Working Group Kickoff Flyer for December 17, 2024 meeting:



Social Media Posts to advertise HMWG Meetings:

County of Maui's Post

County of Maui
December 14, 2024 ·

The Maui Emergency Management Agency (MEMA) invites residents to join the virtual kickoff meeting for the Maui County Hazard Mitigation Plan Update (HMPU) working group on Tuesday, Dec. 17 from noon to 1 p.m.

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MEMA Alerts news bulletin December 12, 2024:

MEMA ALERTS

December 12, 2024

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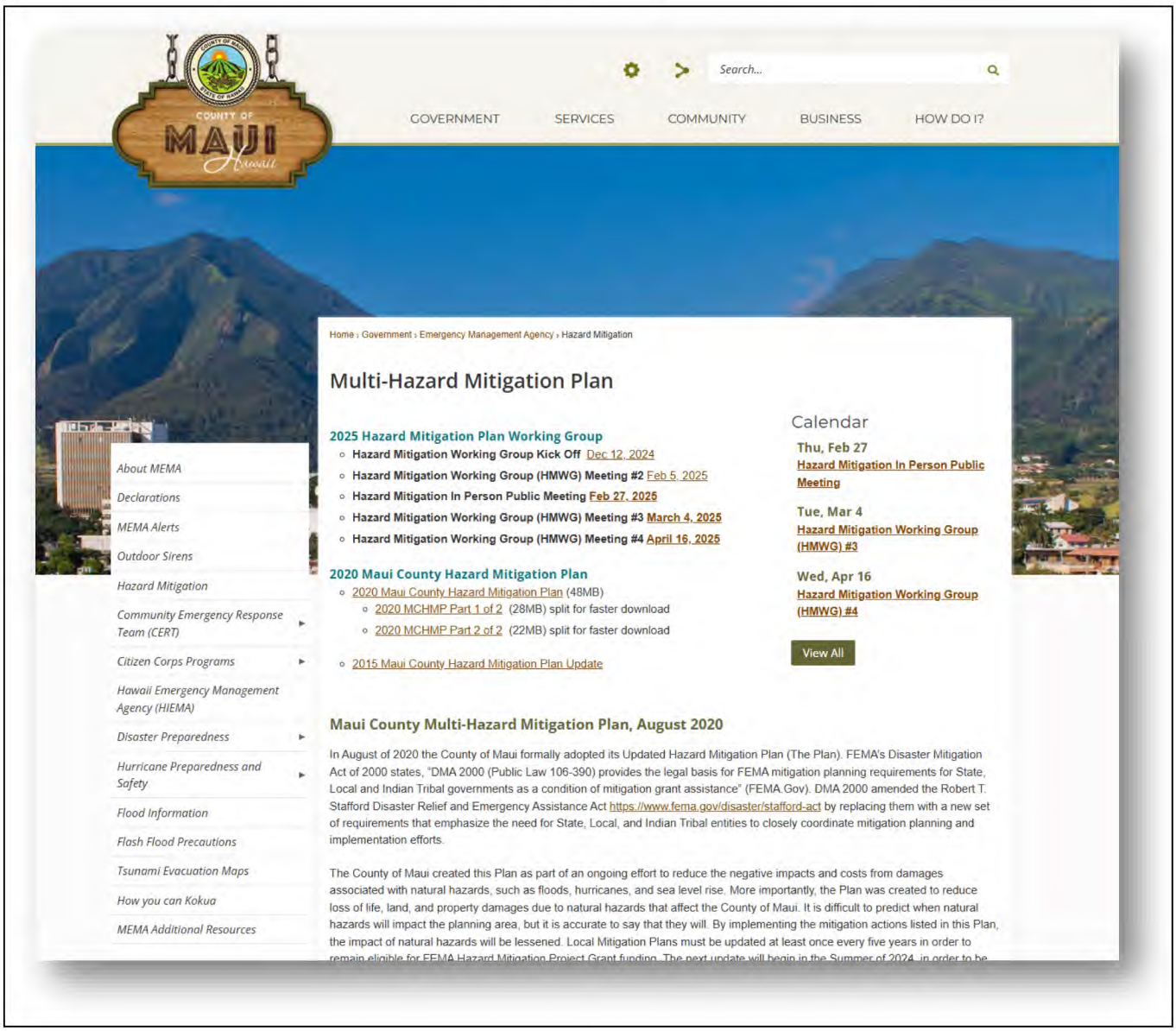
MEMA Hazard Mitigation Website with 2024-2025 meeting schedule and agendas:



Hazard Mitigation Brochure (provided in electronic format to stakeholders and in paper format at outreach events):

Hazard Mitigation Handout (provided in electronic format to stakeholders and in paper format at outreach events):

2025 Maui County Hazard Mitigation Plan

What is Hazard Mitigation?

The term "hazard mitigation" describes actions that can reduce or eliminate long-term risks caused by hazards or disasters, such as floods, hurricanes, and wildfires. As the costs of disasters continue to rise, governments and citizens must find ways to reduce hazard risks in their communities. As communities plan for new development and improvements to existing infrastructure, mitigation can and should be an important component of the planning effort. Often after disasters, repairs and reconstruction are completed in such a way as to simply restore damaged property to pre-disaster conditions. The implementation of hazard mitigation actions during reconstruction leads to stronger, safer, and smarter communities.

What is a Hazard Mitigation Plan?

A hazard mitigation plan is the representation of the jurisdiction's commitment to reduce risks from natural hazards, serving as a guide for decision makers as they commit resources to reducing the effects of natural hazards. Hazard mitigation planning can significantly reduce the physical, financial, and emotional losses caused by disasters. FEMA encourages and rewards local pre-disaster planning by making it a requirement to access certain grant programs. A hazard mitigation plan includes a community risk assessment, community capability assessment, and prioritized mitigation action plan.

Mitigation Project Types

Local Plans and Regulations
These actions include government authorities, policies or codes that influence the way land and buildings are being developed and built.

Structure and Infrastructure
These actions involve modifying existing structures and infrastructure to protect them from a hazard or remove them from a hazard area.

Natural Systems Protection
These are actions that minimize damage and losses, and also preserve or restore the functions of natural systems.

Education and Awareness Programs
These are actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them.

Popular Mitigation Actions

- Enforcement of building codes, floodplain management codes, and environmental regulations
- Public safety measures such as continual maintenance of roadways, culverts, and dams
- Acquisition or relocation of structures, such as purchasing buildings located in a floodplain
- Acquisition of hazard prone lands in their undeveloped state to ensure they remain so
- Retrofitting structures and design of new construction such as elevating a home or building
- Protecting critical facilities and infrastructure from future hazard events
- Development and distribution of outreach materials related to hazard mitigation
- Deployment of warning systems
- Drainage system upgrades

Actions from 2020 Maui County Hazard Mitigation Plan

- Adopt the most current building codes to mitigate risk associated with flooding
- Support Emergency Preparedness Working Groups to form and hold annual preparedness workshops for families in Moloka'i, Lāna'i and Hāna
- Support the revitalization and expansion of the Firewise USA program to additional communities
- Encourage low impact development approach to site development and stormwater management through development of best practices guide
- Improve drainage and slope stabilization along steeps areas that are prone to fail due to soil saturation, including the Kahekili Slope Repair project and other locations identified as priorities for hazard risk reduction
- Conduct a detailed needs assessment and capital planning/feasibility study for additional emergency shelters for both residents and visitors

MEMA Hazard Mitigation

MEMA website:

Follow the progress of the 2025 Maui Hazard Mitigation Plan on the MEMA website and on social media.

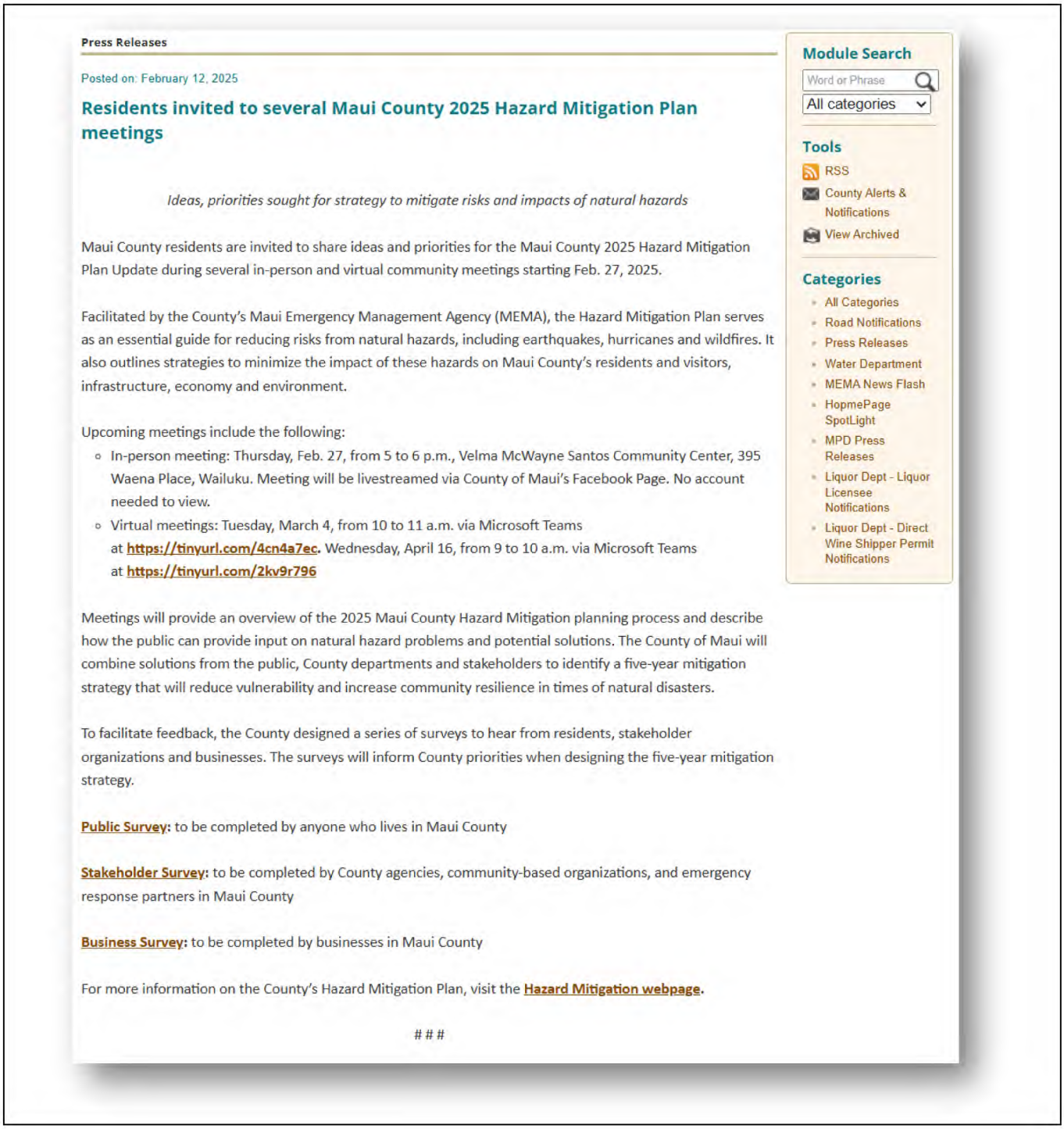
www.MauiCounty.gov/1832/Hazard-Mitigation

MauiEMA

Maui_EMA

Public Meeting announcement for the February 27, 2025, Velma McWayne Santos Community Center in Wailuku:

County Press Release February 12, 2025:



Press Releases

Posted on: February 12, 2025

Residents invited to several Maui County 2025 Hazard Mitigation Plan meetings

Ideas, priorities sought for strategy to mitigate risks and impacts of natural hazards

Maui County residents are invited to share ideas and priorities for the Maui County 2025 Hazard Mitigation Plan Update during several in-person and virtual community meetings starting Feb. 27, 2025.

Facilitated by the County's Maui Emergency Management Agency (MEMA), the Hazard Mitigation Plan serves as an essential guide for reducing risks from natural hazards, including earthquakes, hurricanes and wildfires. It also outlines strategies to minimize the impact of these hazards on Maui County's residents and visitors, infrastructure, economy and environment.

Upcoming meetings include the following:

- In-person meeting: Thursday, Feb. 27, from 5 to 6 p.m., Velma McWayne Santos Community Center, 395 Waena Place, Wailuku. Meeting will be livestreamed via County of Maui's Facebook Page. No account needed to view.
- Virtual meetings: Tuesday, March 4, from 10 to 11 a.m. via Microsoft Teams at **https://tinyurl.com/4cn4a7ec**. Wednesday, April 16, from 9 to 10 a.m. via Microsoft Teams at **https://tinyurl.com/2kv9r796**

Meetings will provide an overview of the 2025 Maui County Hazard Mitigation planning process and describe how the public can provide input on natural hazard problems and potential solutions. The County of Maui will combine solutions from the public, County departments and stakeholders to identify a five-year mitigation strategy that will reduce vulnerability and increase community resilience in times of natural disasters.

To facilitate feedback, the County designed a series of surveys to hear from residents, stakeholder organizations and businesses. The surveys will inform County priorities when designing the five-year mitigation strategy.

Public Survey: to be completed by anyone who lives in Maui County

Stakeholder Survey: to be completed by County agencies, community-based organizations, and emergency response partners in Maui County

Business Survey: to be completed by businesses in Maui County

For more information on the County's Hazard Mitigation Plan, visit the **Hazard Mitigation webpage**.

###

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- Liquor Dept - Direct Wine Shipper Permit Notifications

MEMA Alerts news bulletin February 12, 2025:

MEMA ALERTS

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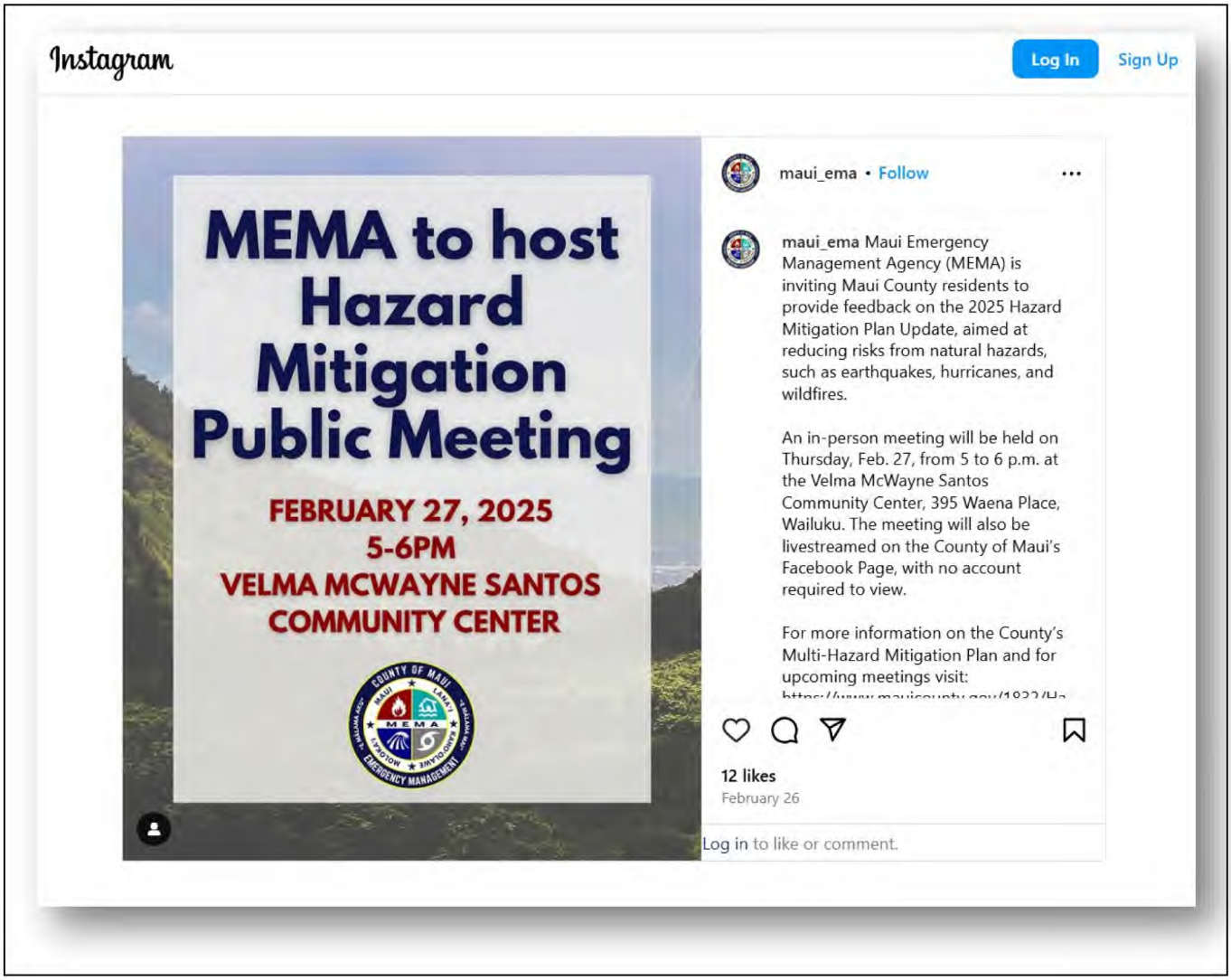
Social media to advertise February 2025 public meeting: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MEMA to host Hazard Mitigation Public Meeting
FEBRUARY 27, 2025
5-6PM
VELMA MCWAYNE SANTOS COMMUNITY CENTER
maui_ema • Follow
maui_ema Maui Emergency Management Agency (MEMA) is inviting Maui County residents to provide feedback on the 2025 Hazard Mitigation Plan Update, aimed at reducing risks from natural hazards, such as earthquakes, hurricanes, and wildfires.
An in-person meeting will be held on Thursday, Feb. 27, from 5 to 6 p.m. at the Velma McWayne Santos Community Center, 395 Waena Place, Wailuku. The meeting will also be livestreamed on the County of Maui's Facebook Page, with no account required to view.
For more information on the County's Multi-Hazard Mitigation Plan and for upcoming meetings visit:
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Residents invited to several Maui County 2025 Hazard Mitigation Plan meetings

February 12, 2025 · 5:00 PM PDT

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1 minute

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The first community meeting about the 2025 Hazard Mitigation Plan will take place at the Velma McWayne Community Center in Wailuku on Thursday, Feb. 27, 2025. Maui County photo

Maui County residents are invited to share ideas and priorities for the Maui County 2025 Hazard Mitigation Plan Update during several in-person and virtual community meetings starting Thursday, Feb. 27, 2025.

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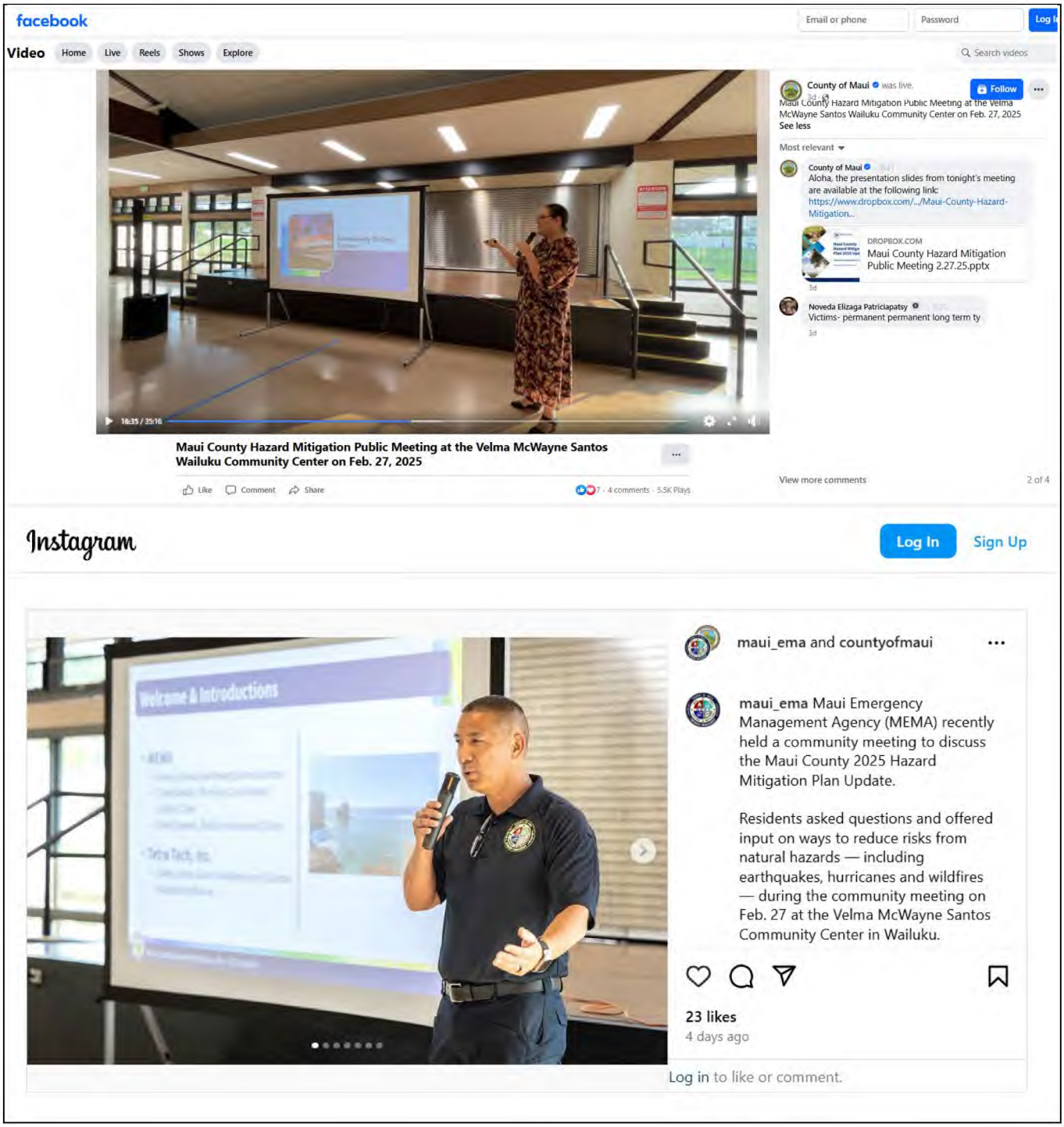
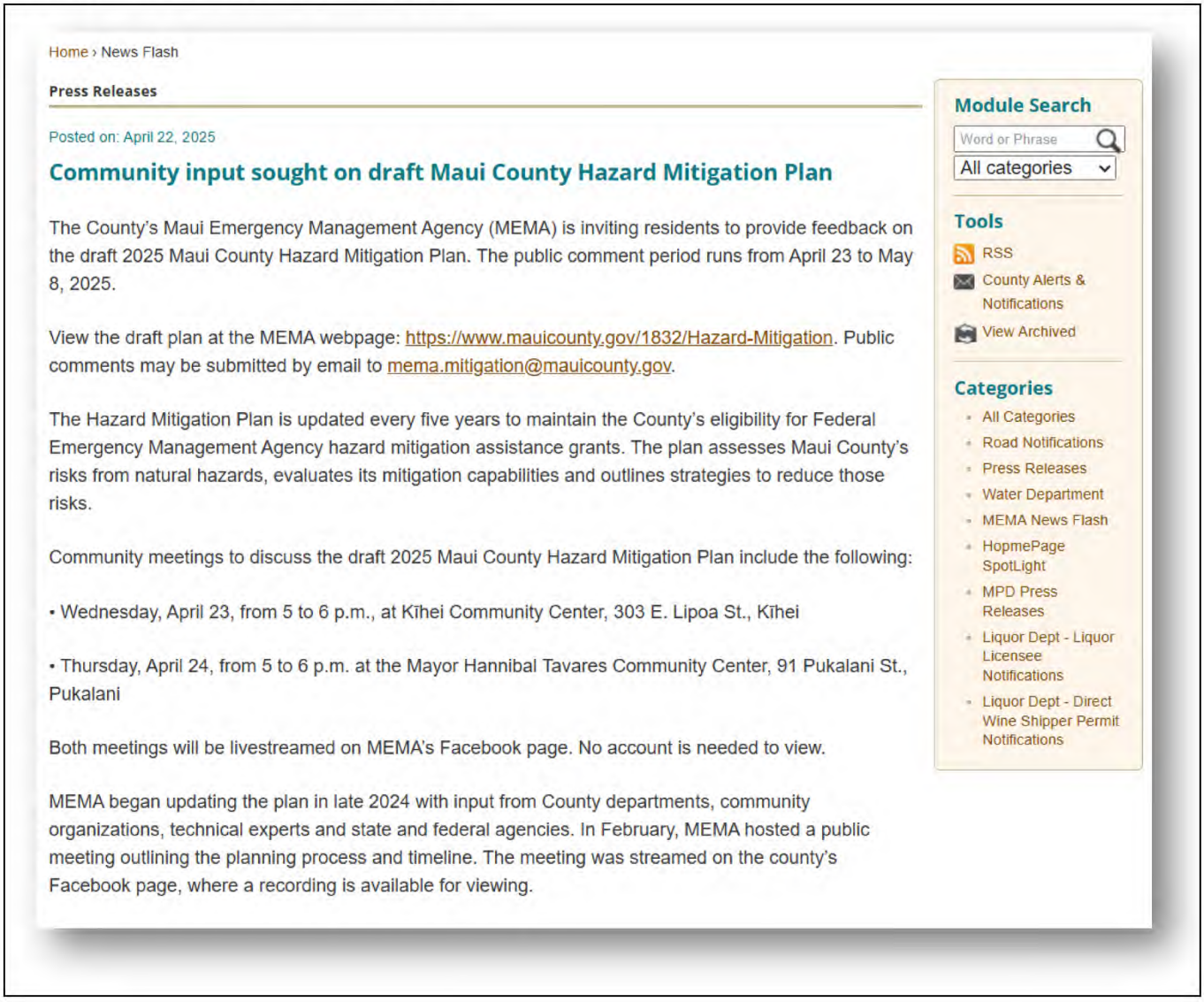


County Press Release April 22, 2025:



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Press Releases

Posted on: April 22, 2025

Community input sought on draft Maui County Hazard Mitigation Plan

The County's Maui Emergency Management Agency (MEMA) is inviting residents to provide feedback on the draft 2025 Maui County Hazard Mitigation Plan. The public comment period runs from April 23 to May 8, 2025.

View the draft plan at the MEMA webpage: https://www.mauicounty.gov/1832/Hazard-Mitigation. Public comments may be submitted by email to mema.mitigation@mauicounty.gov.

The Hazard Mitigation Plan is updated every five years to maintain the County's eligibility for Federal Emergency Management Agency hazard mitigation assistance grants. The plan assesses Maui County's risks from natural hazards, evaluates its mitigation capabilities and outlines strategies to reduce those risks.

Community meetings to discuss the draft 2025 Maui County Hazard Mitigation Plan include the following:

- Wednesday, April 23, from 5 to 6 p.m., at Kīhei Community Center, 303 E. Lipoa St., Kīhei

- Thursday, April 24, from 5 to 6 p.m. at the Mayor Hannibal Tavares Community Center, 91 Pukalani St., Pukalani

Both meetings will be livestreamed on MEMA's Facebook page. No account is needed to view.

MEMA began updating the plan in late 2024 with input from County departments, community organizations, technical experts and state and federal agencies. In February, MEMA hosted a public meeting outlining the planning process and timeline. The meeting was streamed on the county's Facebook page, where a recording is available for viewing.

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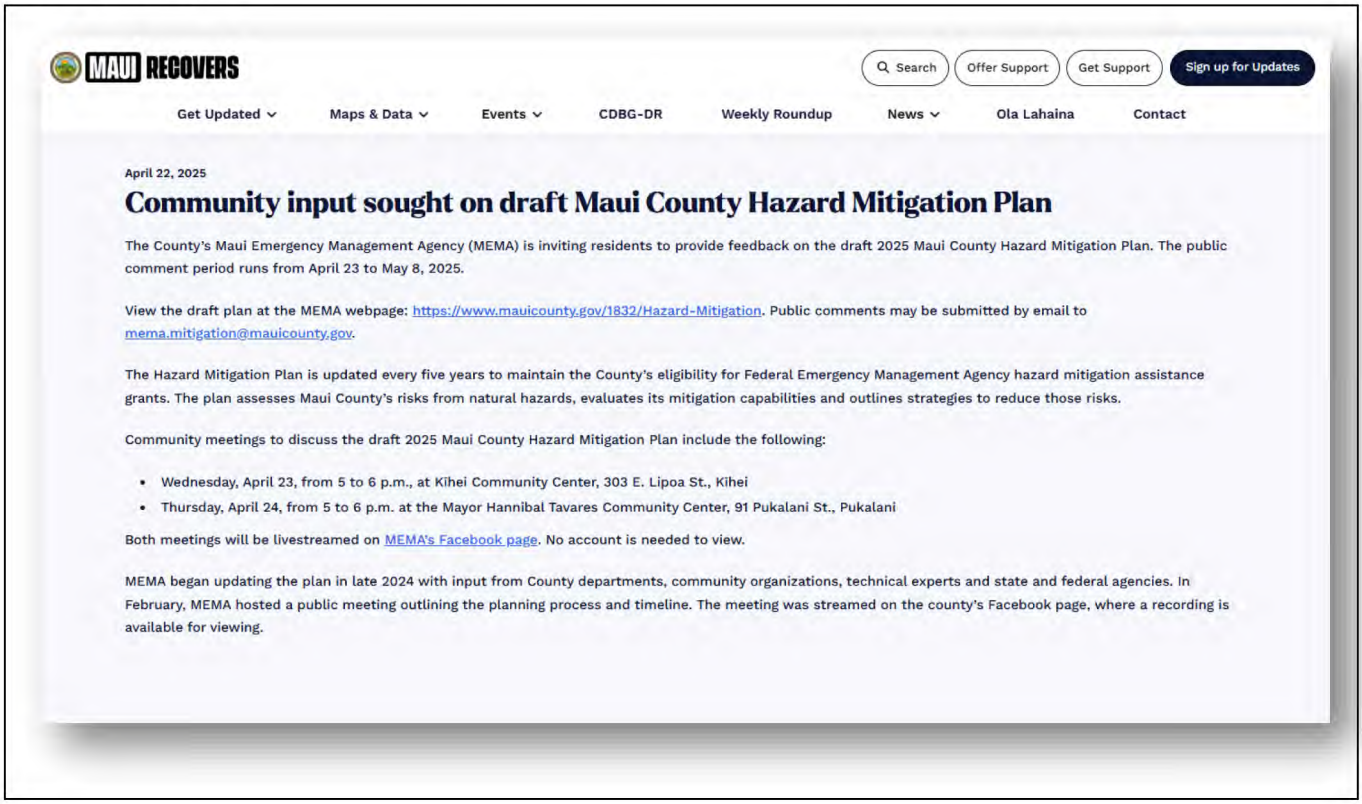
- HopmePage SpotLight
- MPD Press Releases
- Liquor Dept - Liquor Licensee Notifications
- Liquor Dept - Direct Wine Shipper Permit Notifications

Public outreach efforts by County, community-based organizations, and media outlets for April public meetings:



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Maui County Emergency Management Agency's Post

Maui County Emergency Management Agency
April 22 at 6:47 PM ·

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MEMA began updating the plan in late 2024 with input from County departments, community organizations, technical experts and state and federal agencies. In February, MEMA hosted a public meeting outlining the planning process and timeline. The meeting was streamed on the county's Facebook page, where a recording is available for viewing.

MAUI COUNTY HAZARD MITIGATION PLAN NEEDS COMMUNITY INPUT

Posted by Isaac Roosa & Olena Kagui | Apr 23, 2025 | Fire Prevention, Flooding, Government | 0 |

4/23/25 #kihei #emergency #fireprevention

Maui County residents are invited to provide feedback on County's Maui Emergency Management Agency's (MEMA) draft of the 2025 Maui County Hazard Mitigation Plan. The Hazard Mitigation Plan is updated every five years to maintain the County's eligibility for Federal Emergency Management Agency hazard mitigation assistance grants. The plan assesses Maui County's risks from natural hazards, evaluates its mitigation capabilities and outlines strategies to reduce those risks.

View the draft plan at the MEMA webpage: https://www.mauicounty.gov/1832/Hazard-Mitigation. Public comments may be submitted by email to mema.mitigation@mauicounty.gov.

There will be community meetings to discuss the draft 2025 Maui County Hazard Mitigation Plan:

- **Wednesday, April 23, from 5 to 6 p.m.**, at Kīhei Community Center, 303 E. Lipoa St., Kīhei
- **Thursday, April 24, from 5 to 6 p.m.** at the Mayor Hannibal Tavares Community Center, 91 Pukalani St., Pukalani

Both meetings will be livestreamed on MEMA's Facebook page. No account is needed to view.

MEMA began updating the plan in late 2024 with input from County departments, community organizations, technical experts and state and federal agencies. In February, MEMA hosted a public meeting outlining the

MAUINOW ☰ Sections Maui News Wildfires Business Weather Surf Enterta

Maui News

Community input sought on draft Maui County Hazard Mitigation Plan

April 23, 2025 · 12:00 PM PDT

Listen to this Article
1 minute

A A A

The County's Maui Emergency Management Agency (MEMA) is inviting residents to provide feedback on the draft 2025 Maui County Hazard Mitigation Plan. The public comment period runs from April 23 to May 8, 2025.

View the draft plan at the MEMA webpage: https://www.mauicounty.gov/1832/Hazard-Mitigation. Public comments may be submitted by email to mema.mitigation@mauicounty.gov.

The Hazard Mitigation Plan is updated every five years to maintain the County's eligibility for Federal Emergency Management Agency hazard mitigation assistance grants. The plan assesses Maui County's risks from natural hazards, evaluates its mitigation capabilities and outlines strategies to reduce those risks.

Maui

Maui Looks Elsewhere To Fund Fire Prevention Projects After Trump Cuts

Wildfire is the biggest threat facing Maui, according to the county's draft Hazard Mitigation Plan but FEMA cuts could require a pivot to other funding sources.

By Caitlin Thompson / May 13, 2025
Reading time: 6 minutes.

Share Article 9

The risk of wildfires is so high in Maui that the county is now deemed to have a 100% chance of facing a blaze in any given year, according to a recent analysis of environmental threats facing residents.

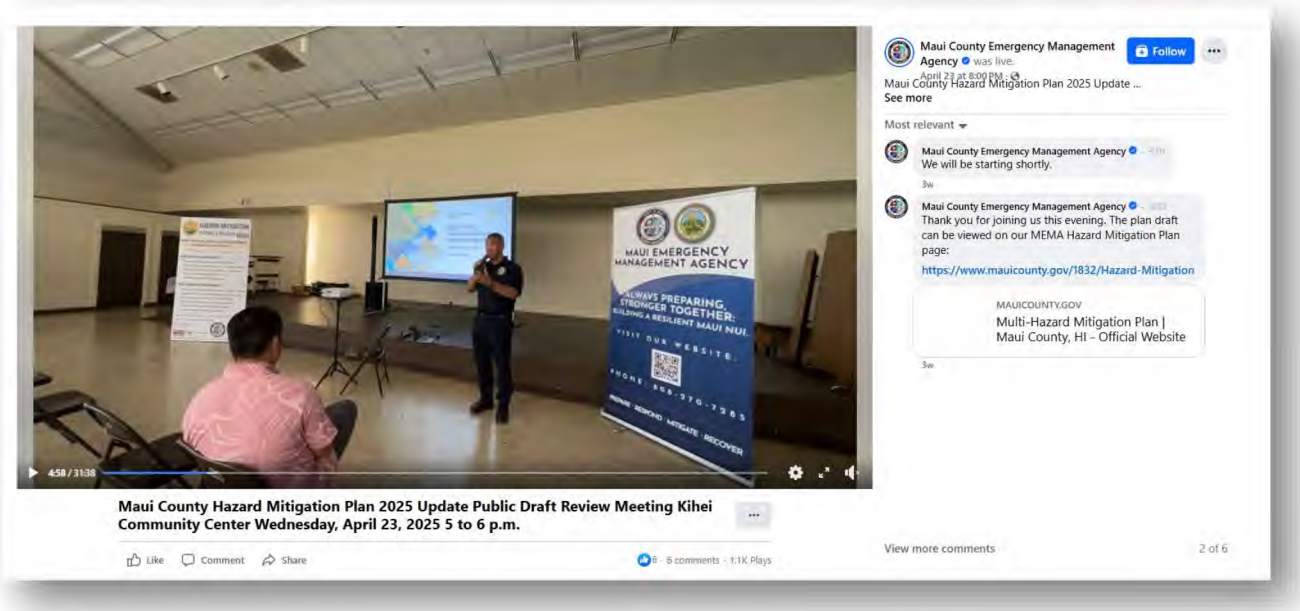
The county's new draft Hazard Mitigation Plan — its first since the 2023 fire that destroyed much of Lahaina town — lists fire as the Valley Isle's biggest threat. Following close behind are drought and high windstorms, both factors that can exacerbate wildfires.

More than half of the county's population lives in a wildfire hazard area, according to the report compiled by Tetra Tech for the county, in consultation with community groups and county agencies.

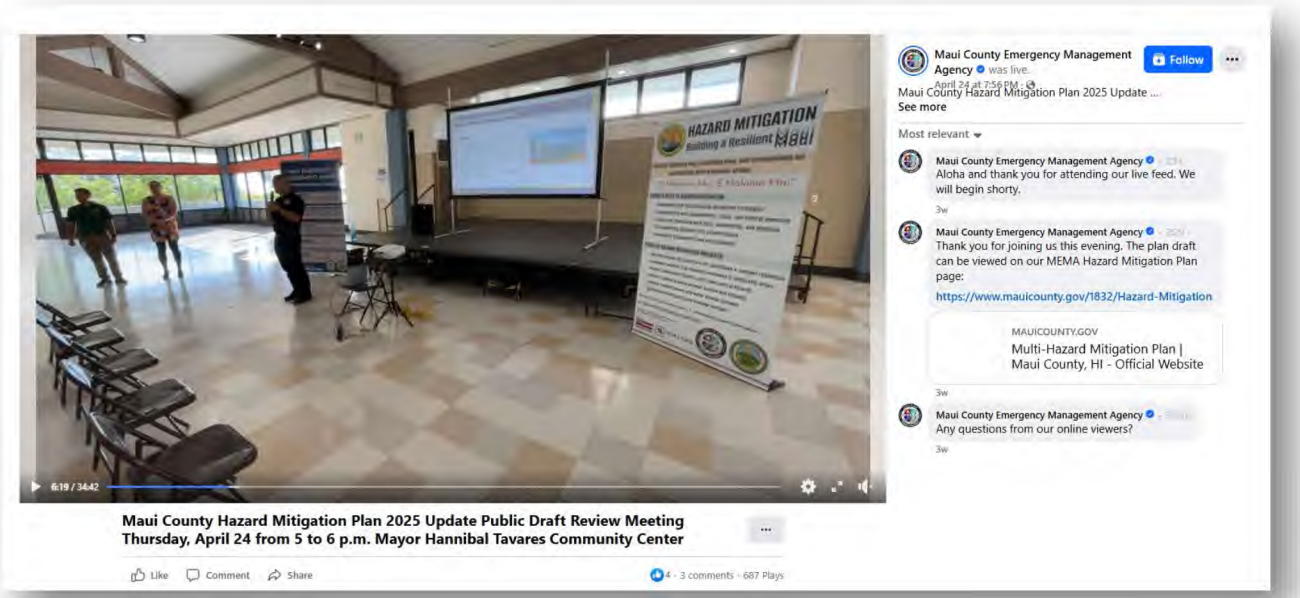
But how to pay for projects to reduce the risk of wildfires and other natural disasters — such as establishing fuel breaks on unmaintained land or expanding wildfire safety education programs — is uncertain, especially as the Trump administration makes cuts to emergency grant funds.

"We're going to have to pivot those conversations about the funding that typically comes from FEMA being

The April 23, 2025, Public Meeting at the Kīhei Community Center was livestreamed on the MEMA Facebook page and the recording was posted:



The April 24, 2025, Public Meeting at the Mayor Hannibal Tavares Community Center was livestreamed on the MEMA Facebook page and the recording was posted:



APPENDIX D. CRS STAKEHOLDER OUTREACH

Insert Appendix Content

PDF File saved:
https://tetratechinc.sharepoint.com/:b:/r/teams/MauiHMP/Shared%20Documents/Working/2.%20Working/CRS/Appendix%20-%20CRS%20Stakeholder%20Invites.pdf?csf=1&web=1&e=o2OcRa

APPENDIX E. CRS STAKEHOLDER MEETINGS

Insert Appendix Content

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https://tetratechinc.sharepoint.com/:b:/r/teams/MauiHMP/Shared%20Documents/Working/2.%20Working/Meetings/Stakeholder%20Meetings/Appendix%20-%20CRS%20Stakeholder%20Meetings.pdf?csf=1&web=1&e=RbKcf6

APPENDIX F. MEETING MATERIALS

The following pages include meeting agendas, sign-in sheets, and minutes (where appliable and available) for meetings convened as part of the planning process for the

Insert Appendix Content

PDF Link:
https://tetratechinc.sharepoint.com/:b:/r/teams/MauiHMP/Shared%20Documents/Working/2.%20Working/Meetings/Maui%20Meeting%20materials.pdf?csf=1&web=1&e=HOmxCy

Still need to add April public meetings

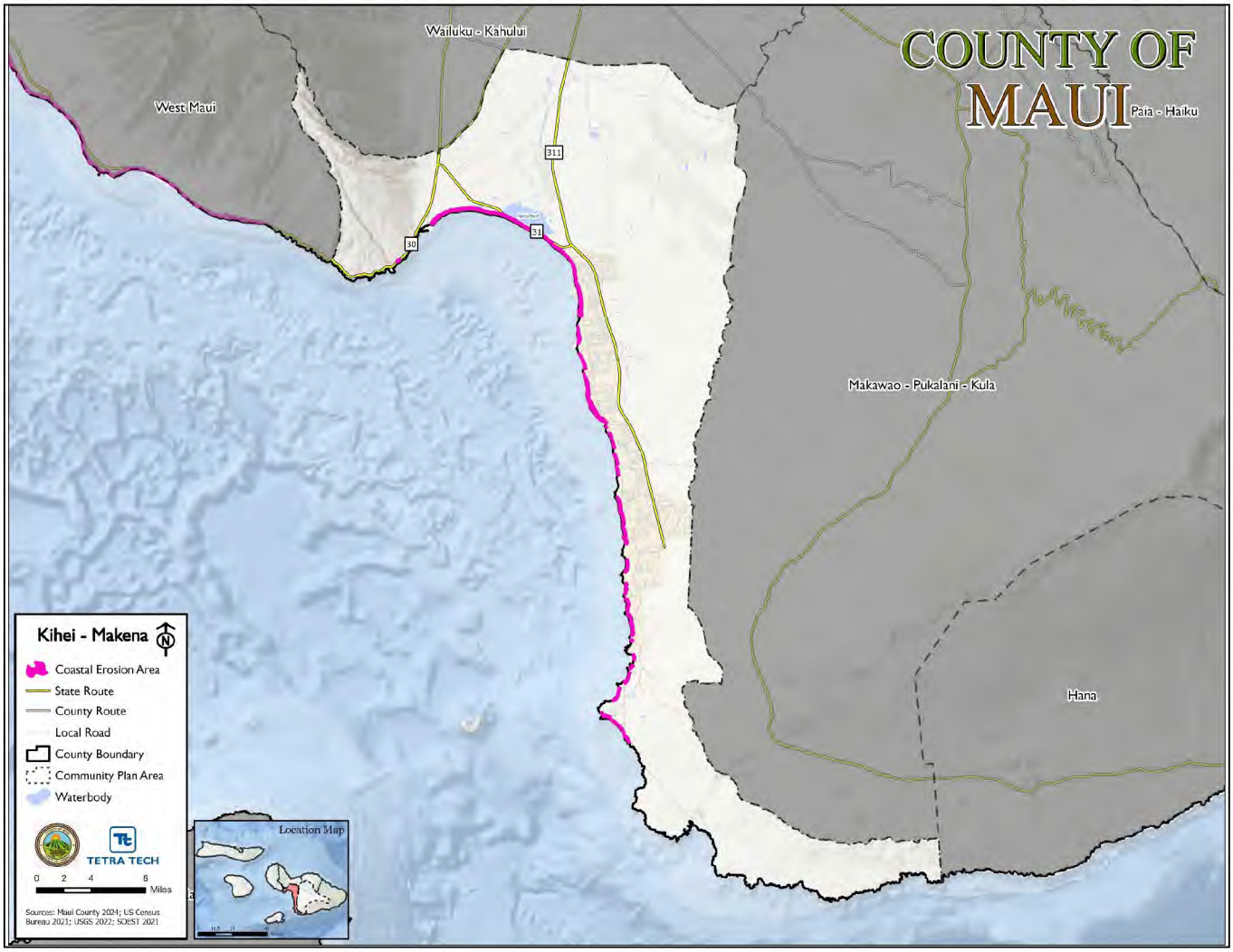
APPENDIX G. SURVEY RESULTS

PDF file:
https://tetratechinc.sharepoint.com/:b:/r/teams/MauiHMP/Shared%20Documents/Working/2.%20Working/1.%20Draft%20Plan/Maui%20All%20Surveys.pdf?csf=1&web=1&e=xFGfX6

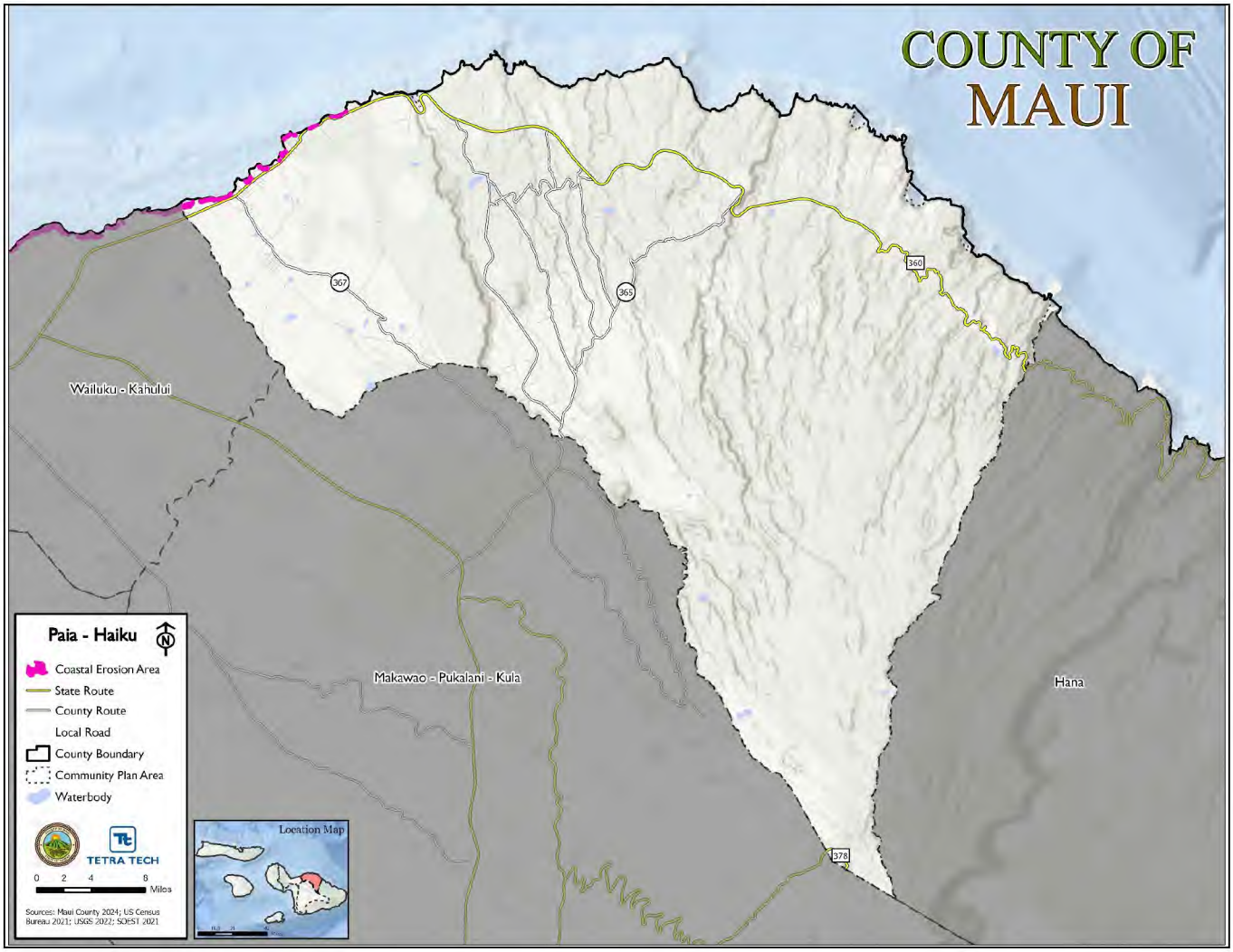
APPENDIX H. HAZARD MAPS FOR COMMUNITY PLAN AREAS

Coastal Erosion

Coastal Erosion Area, Kīhei-Mākena

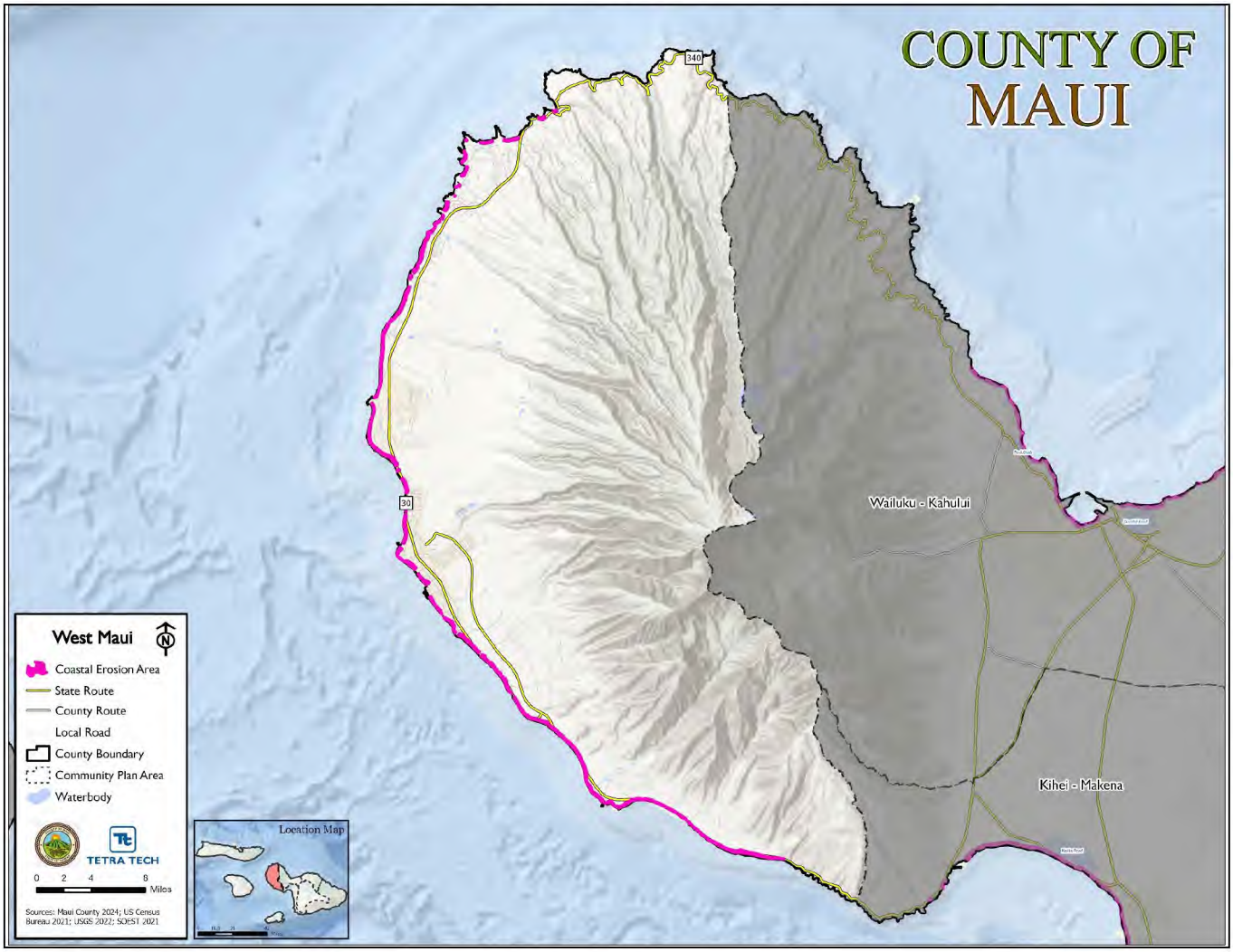


Coastal Erosion Area, Pāʻia-Haʻikū



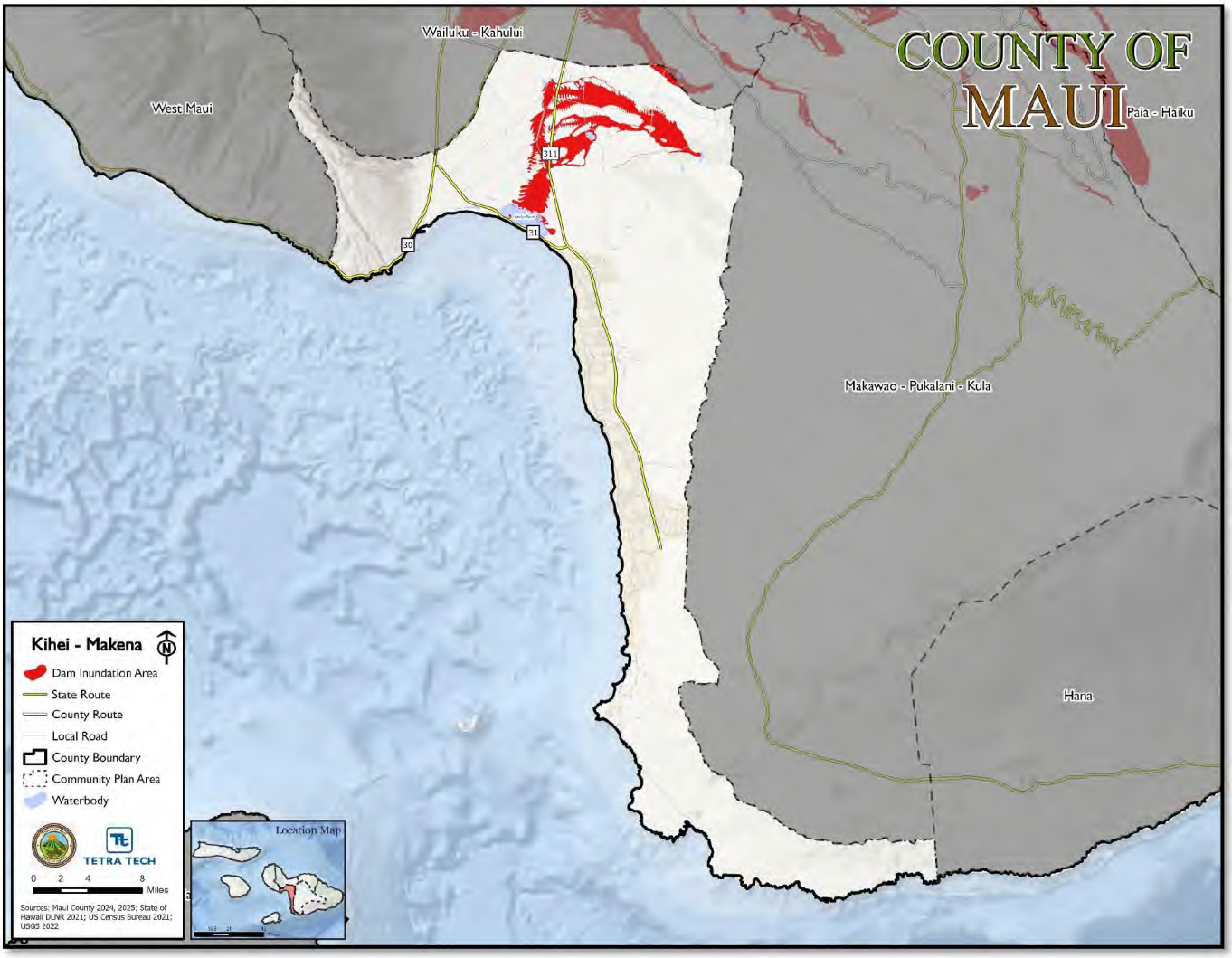
Coastal Erosion Area, Wailuku-Kahului

Coastal Erosion Area, West Maui

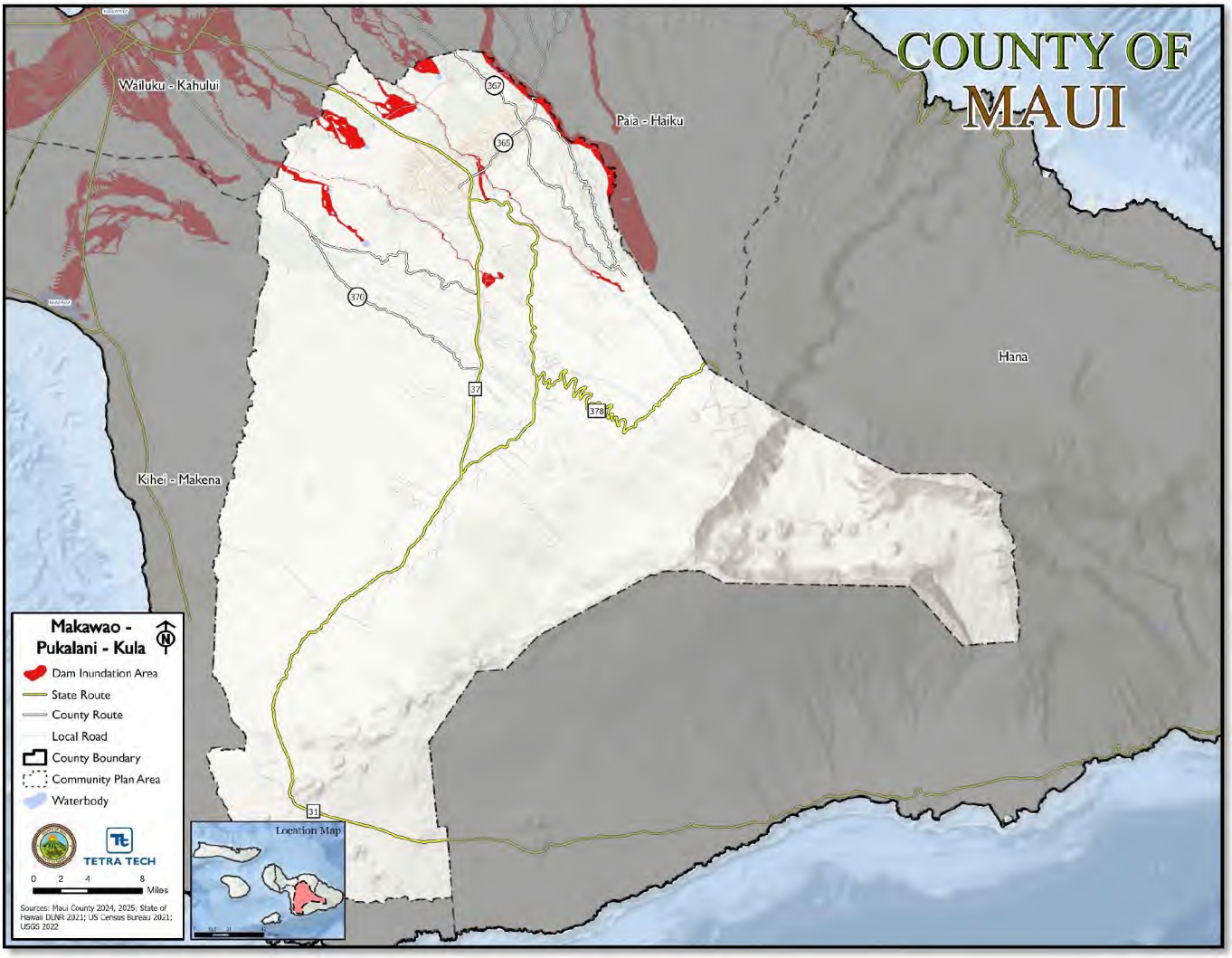


Dam Failure Inundation

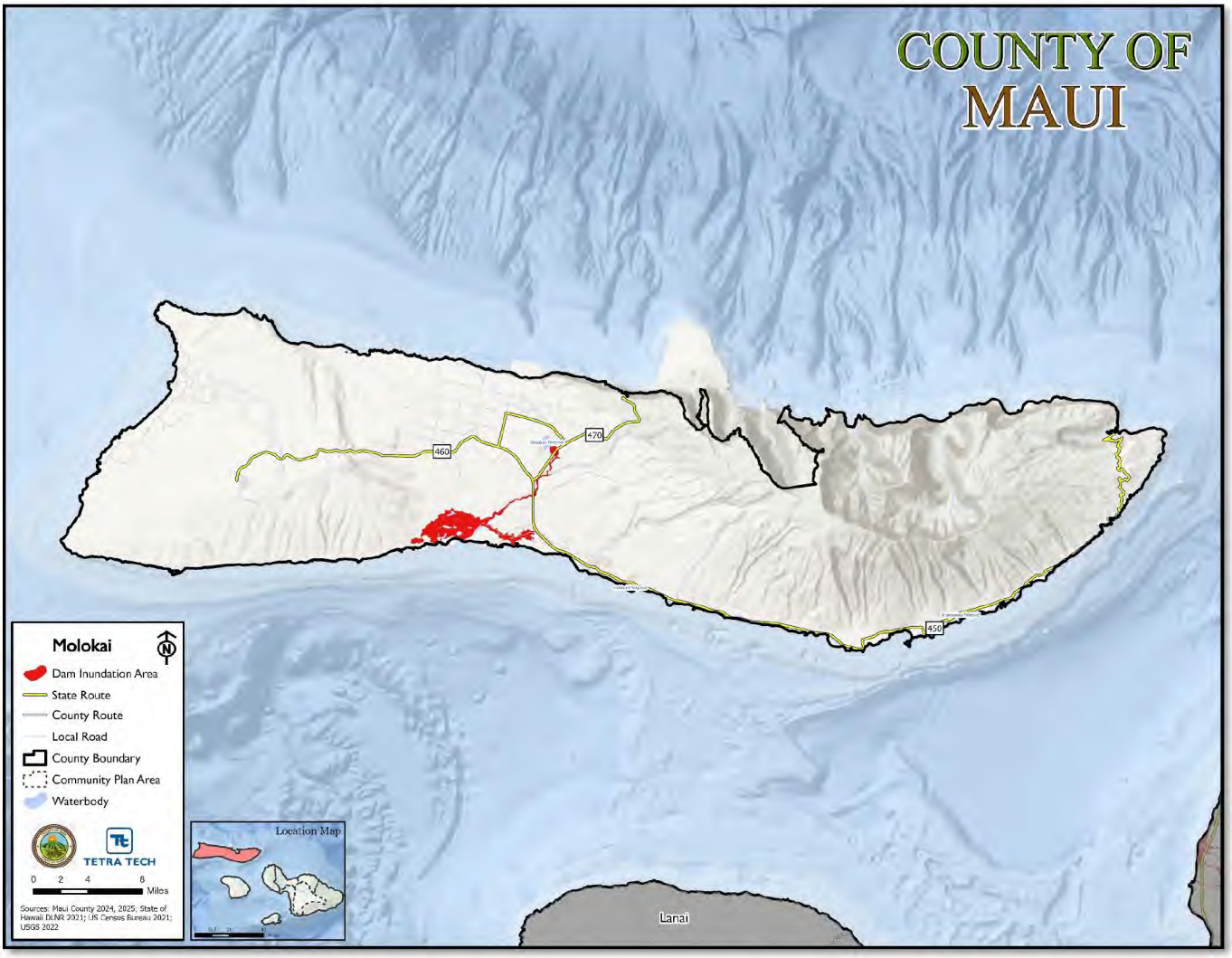
Dam-Failure Inundation Areas in Kīhei-Mākena



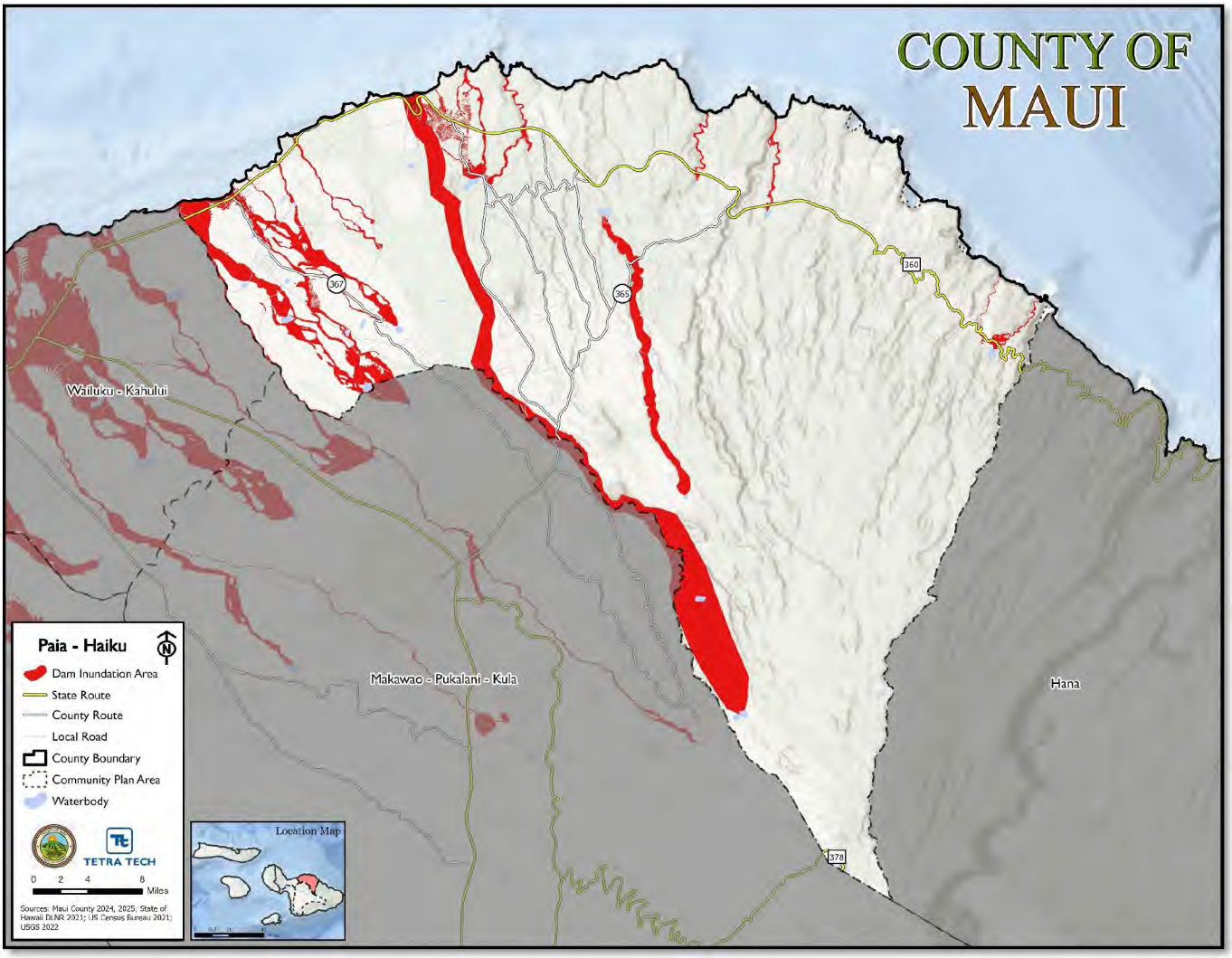
Dam-Failure Inundation Areas in Makawao-Pukalani-Kula



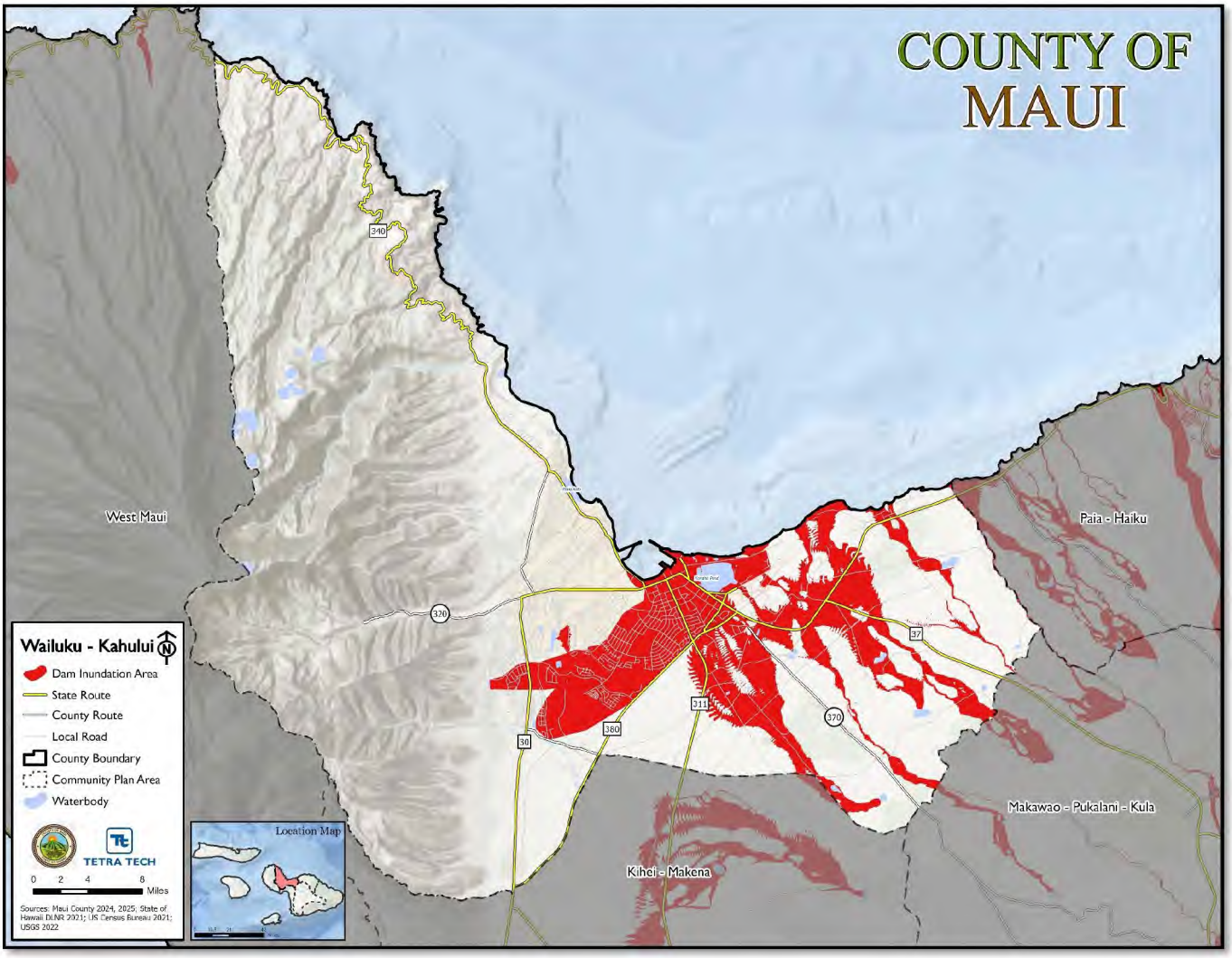
Dam-Failure Inundation Areas in Moloka‘i



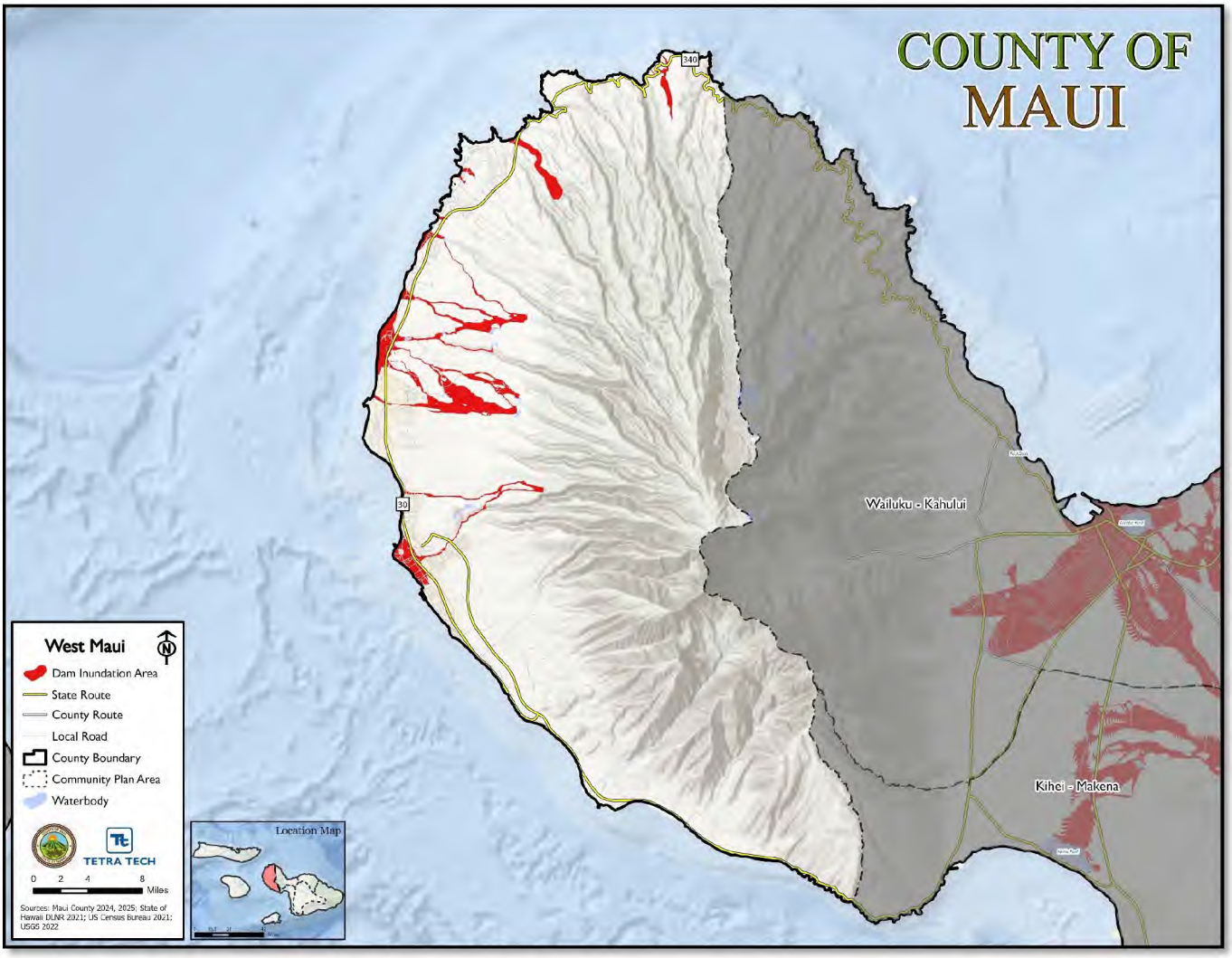
Dam-Failure Inundation Areas in Pāʻia-Haʻikū



Dam-Failure Inundation Areas in Wailuku-Kahului

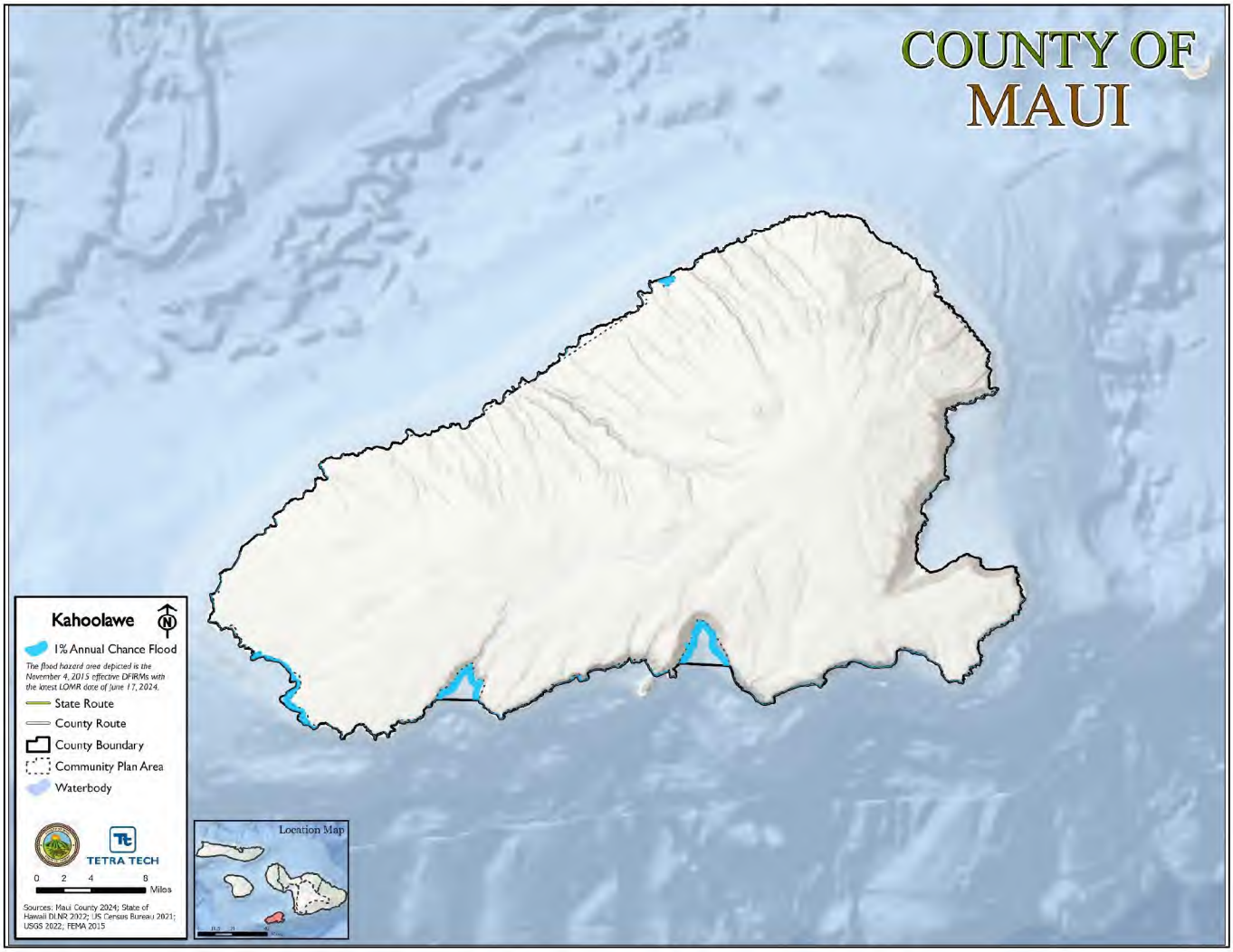


Dam-Failure Inundation Areas in West Maui

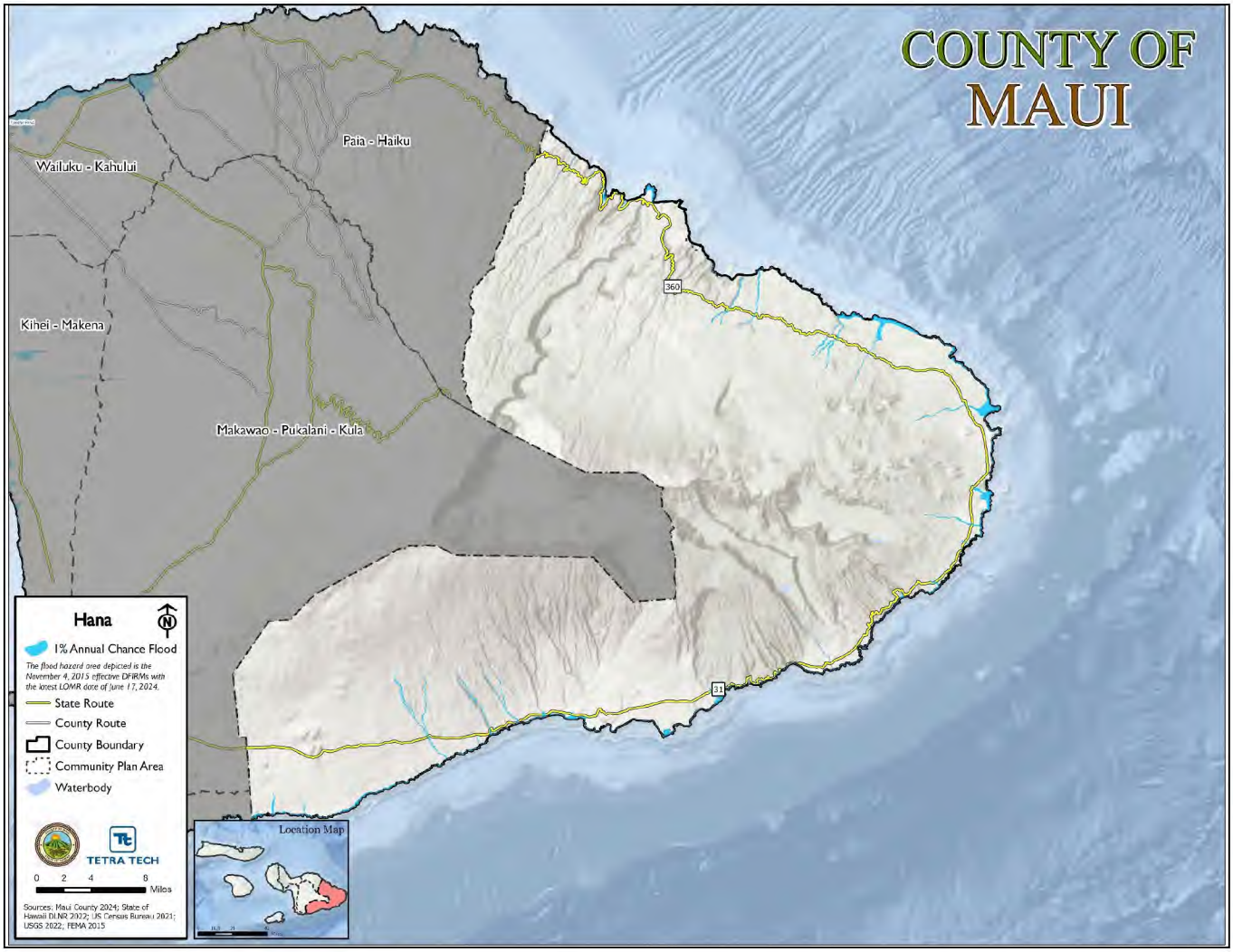


Flood Hazard Area

Flood Hazard Area, Kaho‘olawe

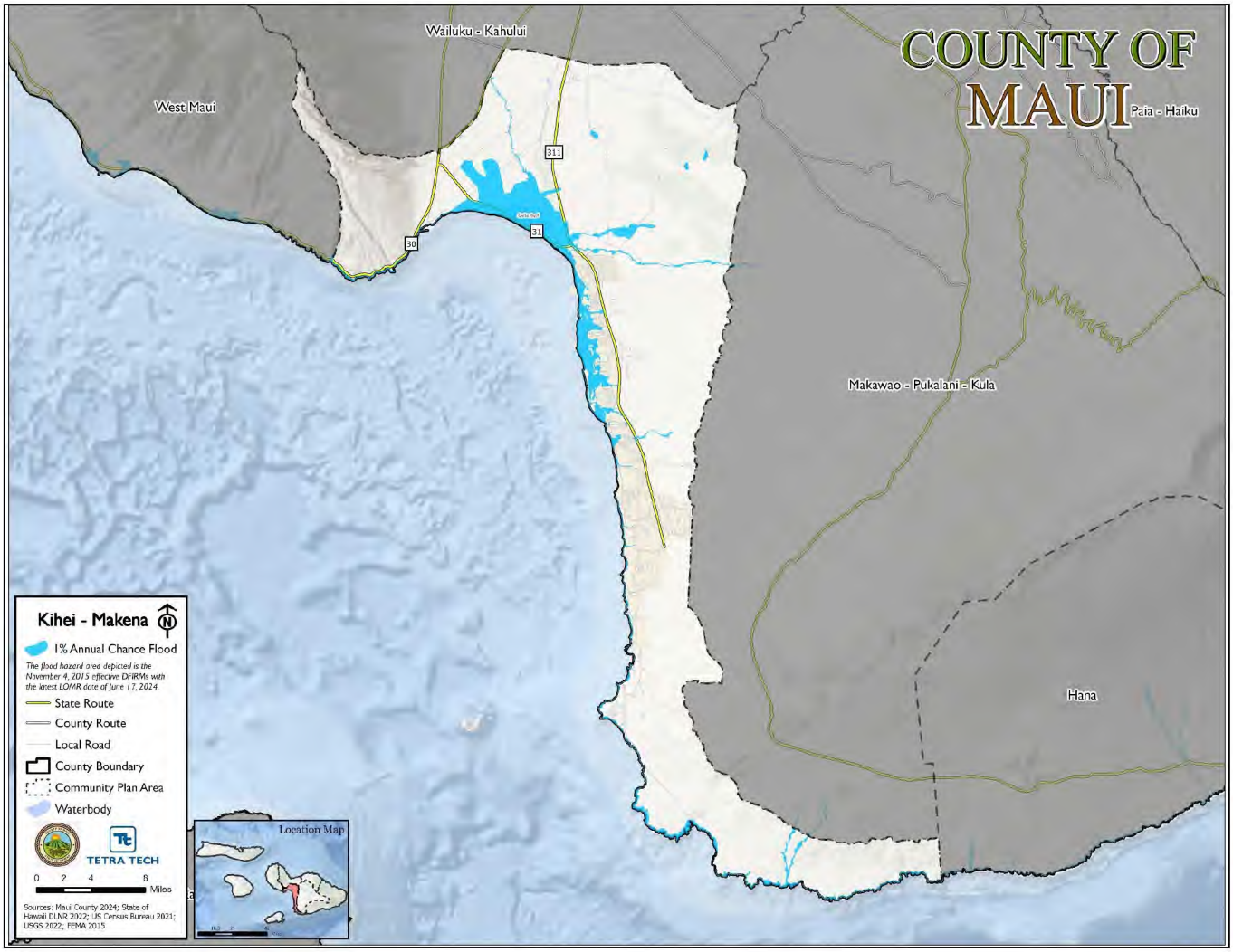


Flood Hazard Area, Hāna



Flood Hazard Area, Wailuku-Kahului

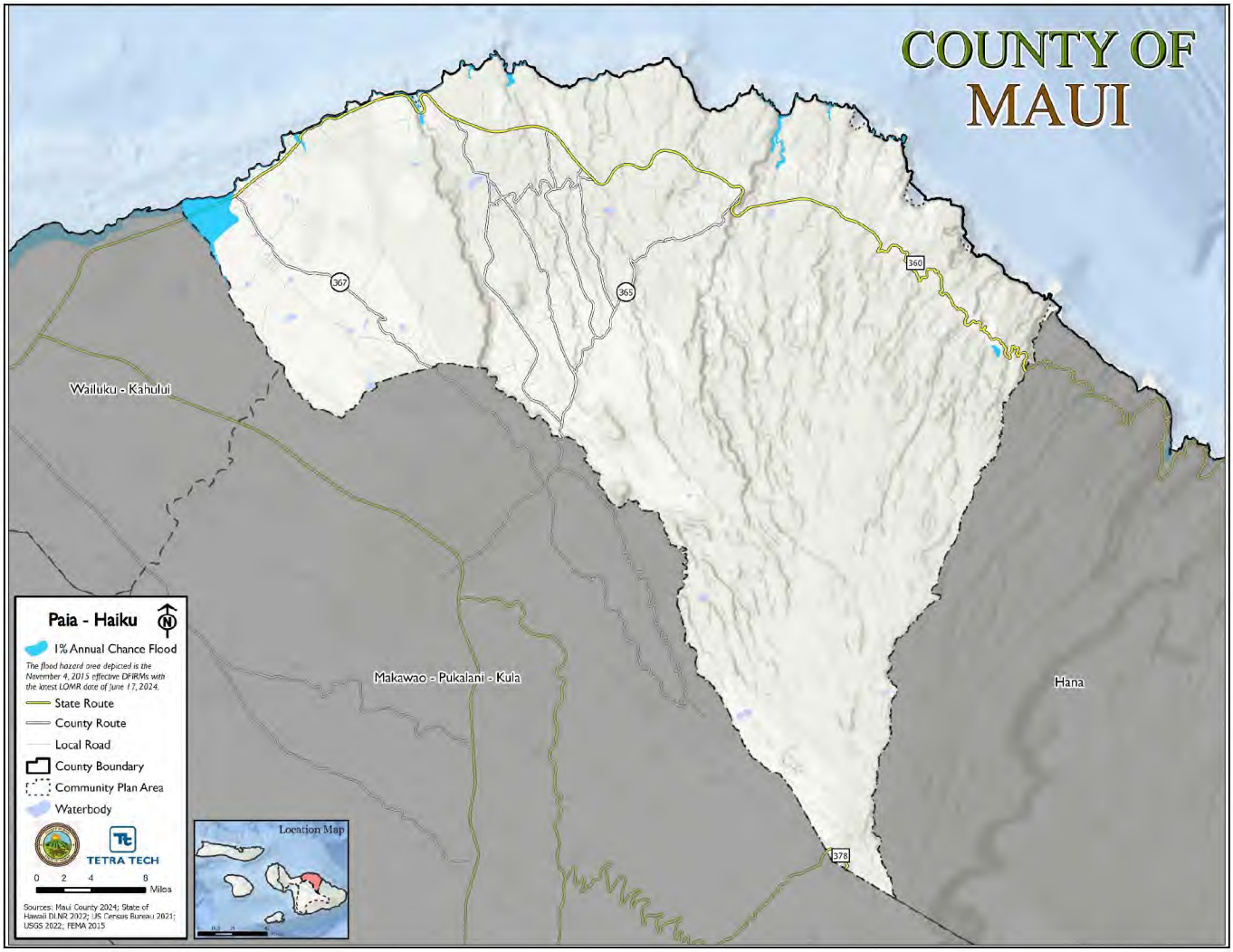
Flood Hazard Area, Kīhei-Mākena



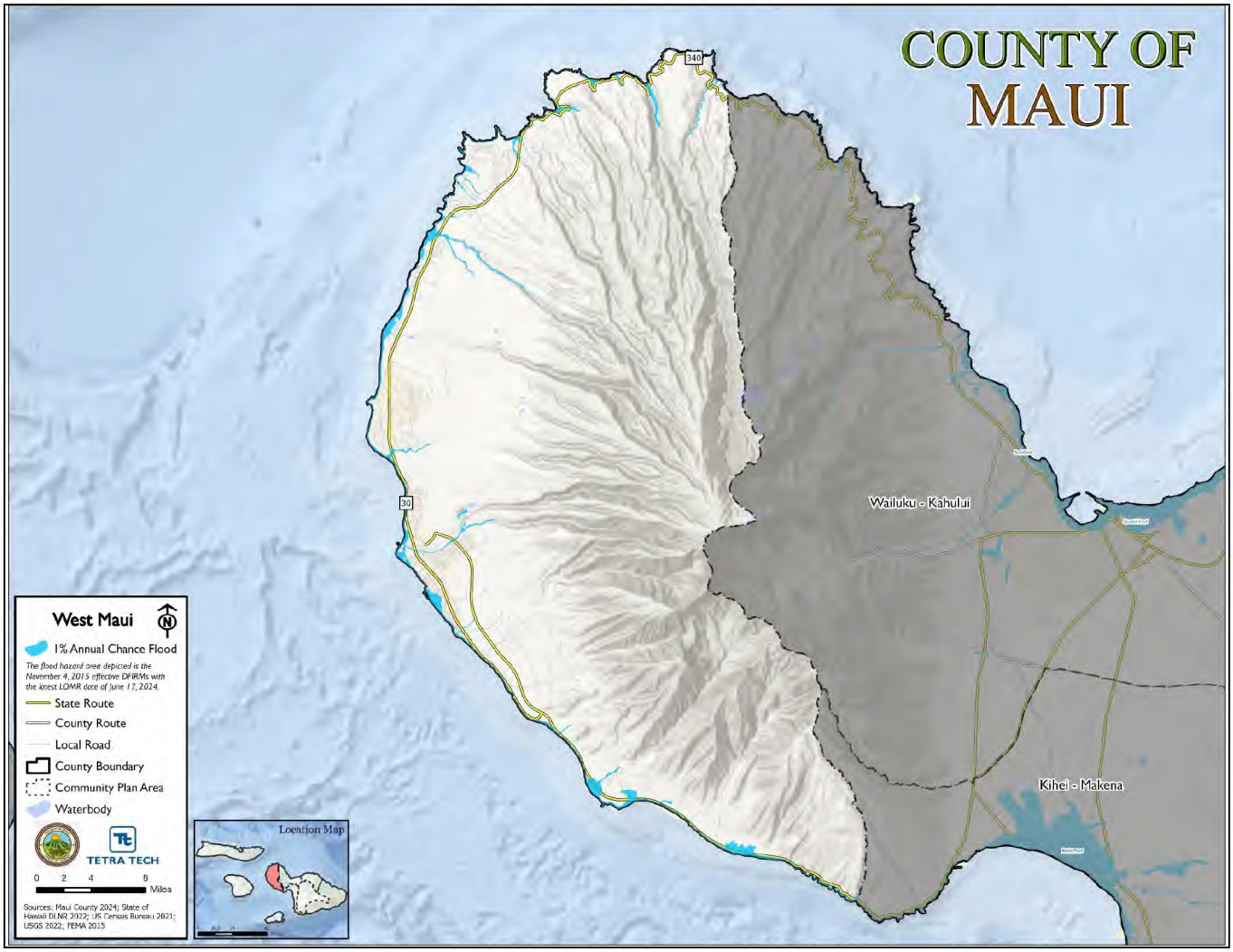
Flood Hazard Area, Lānaʻi

Flood Hazard Area, Moloka‘i

Flood Hazard Area, Pāʻia-Haʻikū

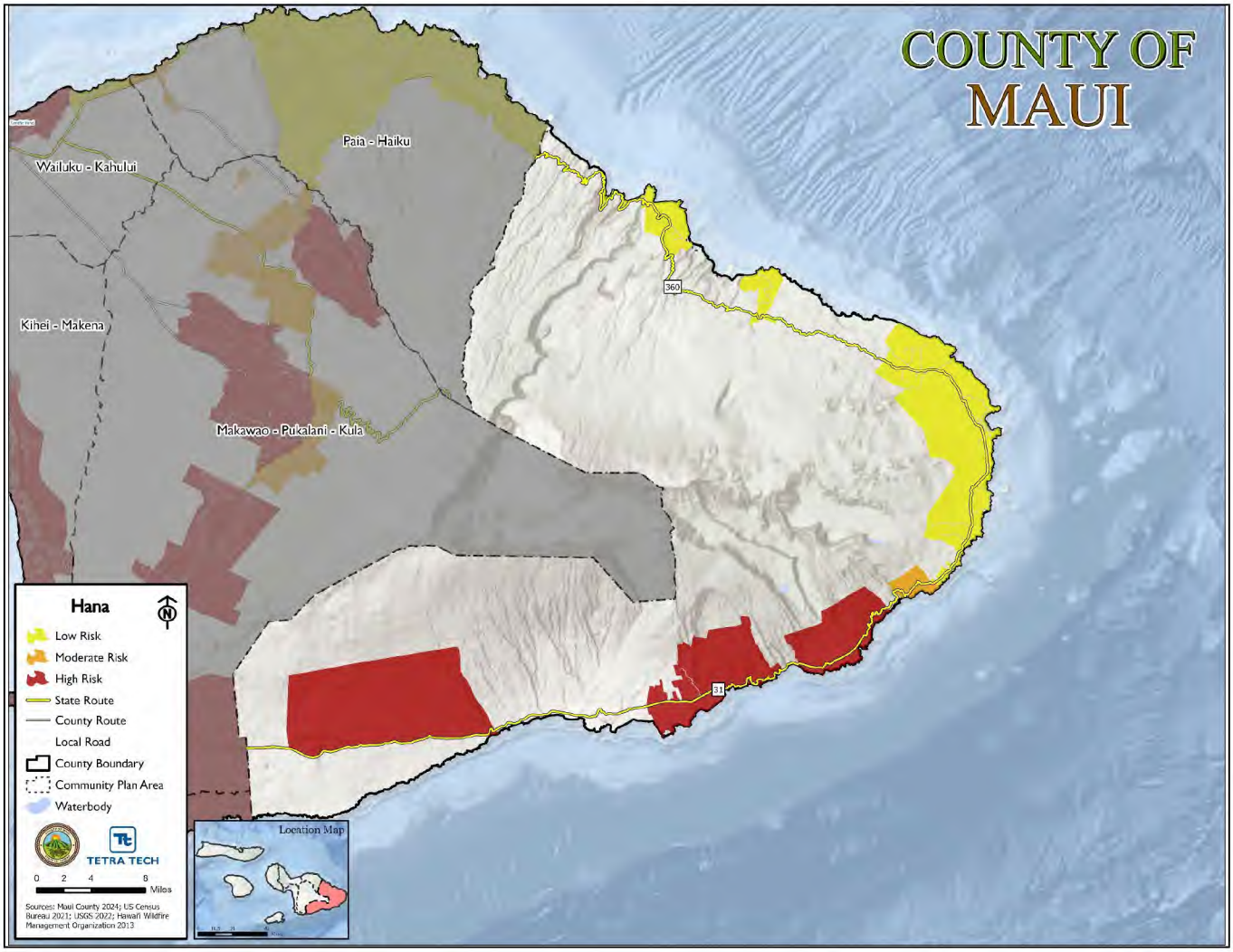


Flood Hazard Area, West Maui

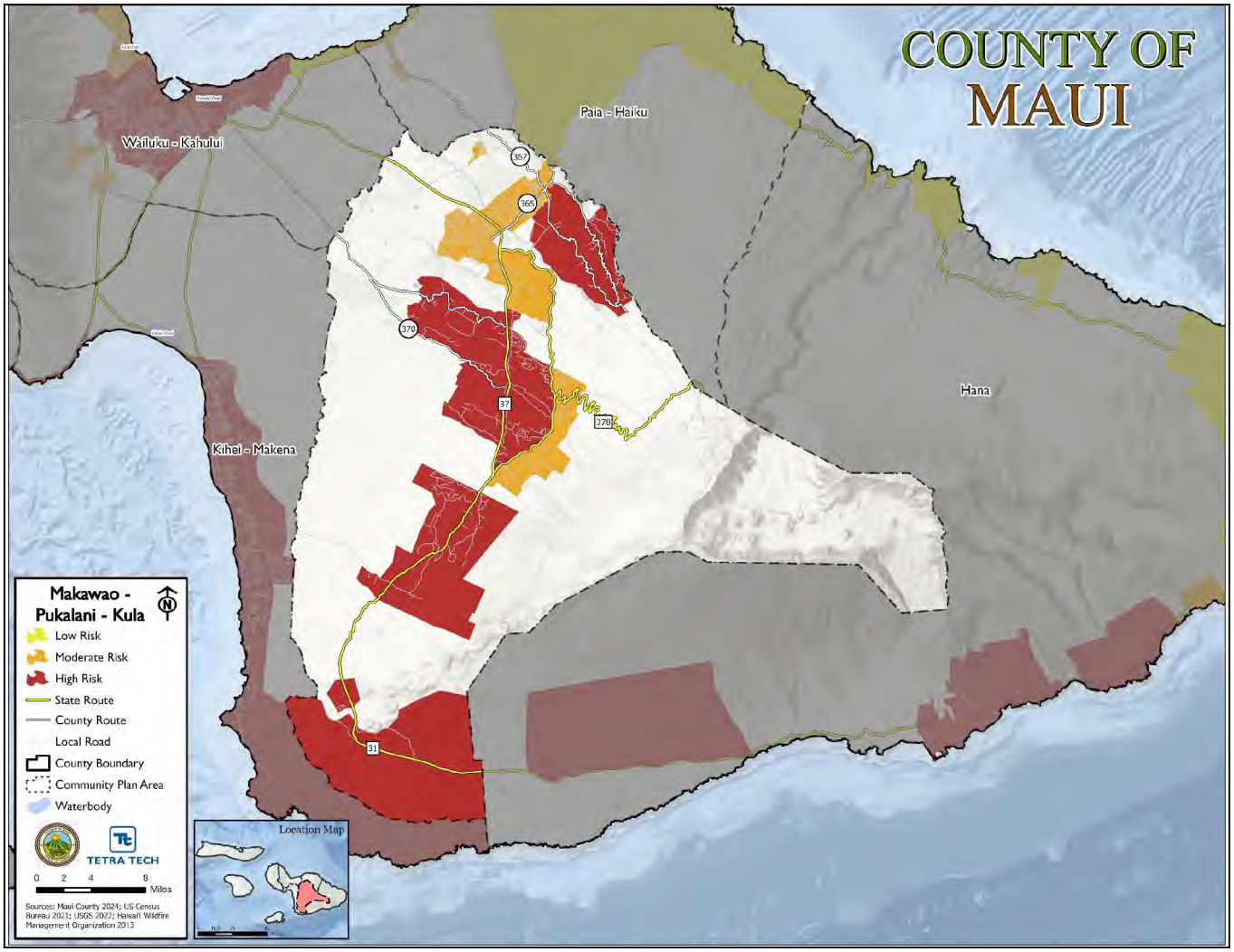


Wildfire Risk

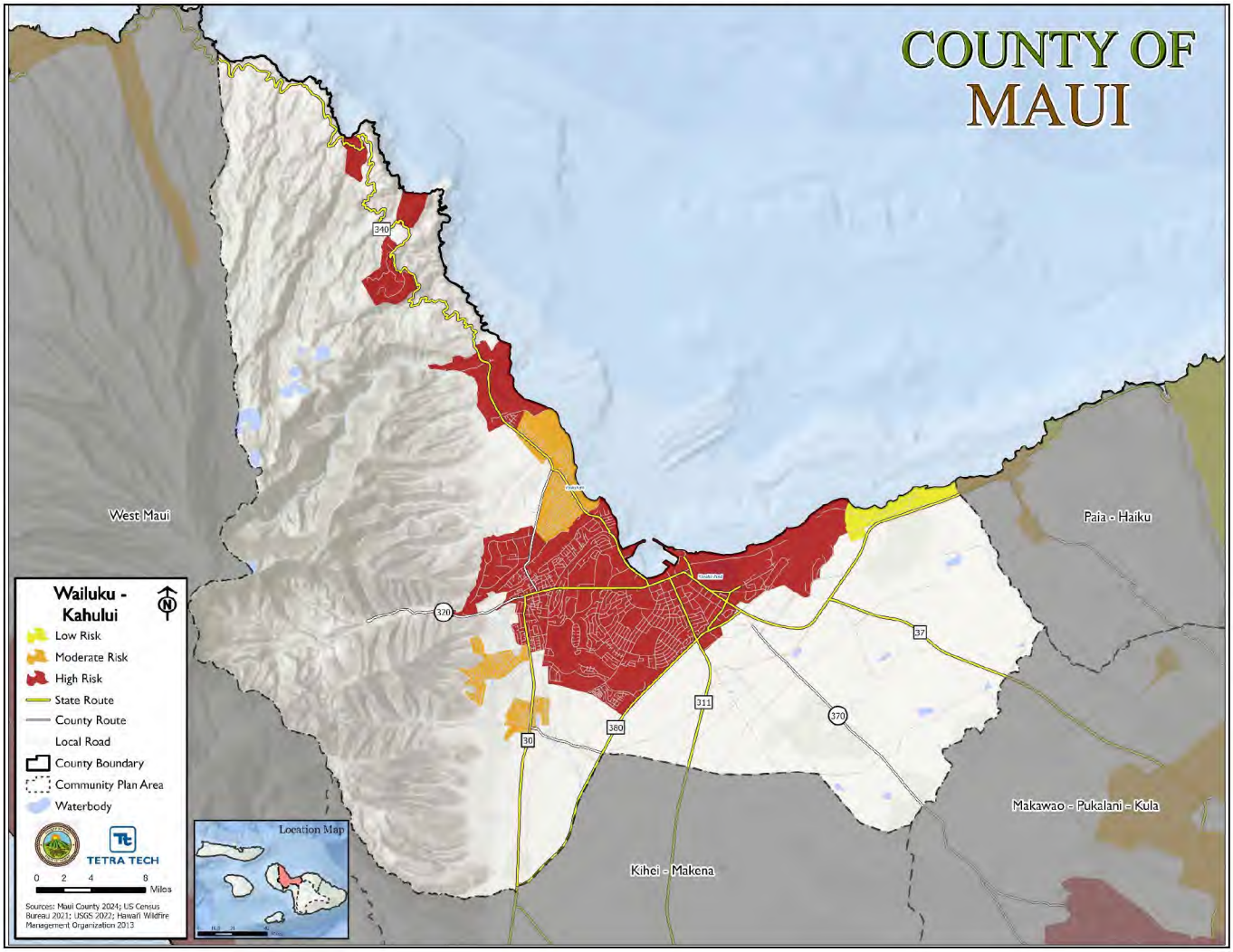
Wildfire Risk, Hāna



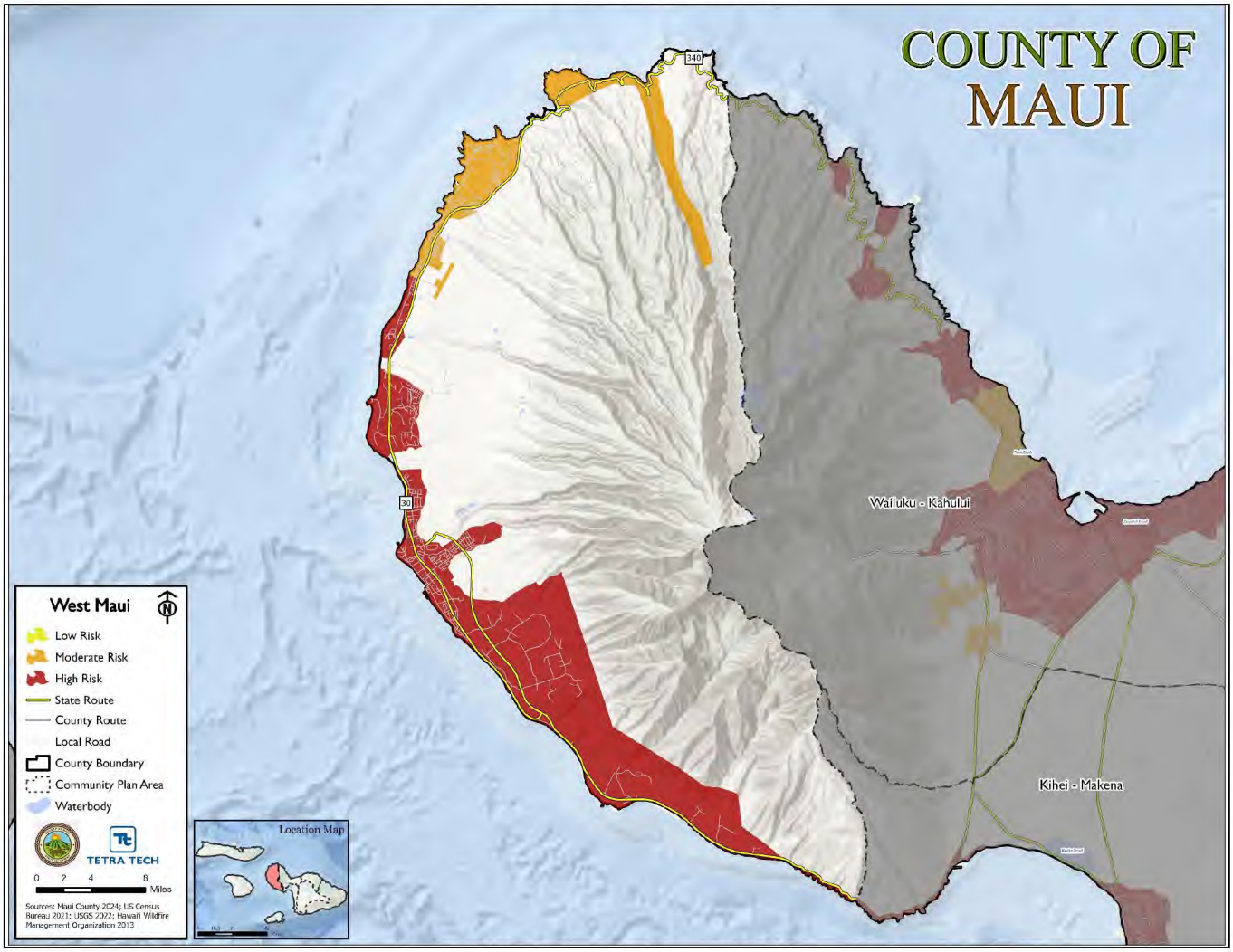
Wildfire Risk, Makawao-Pukalani-Kula



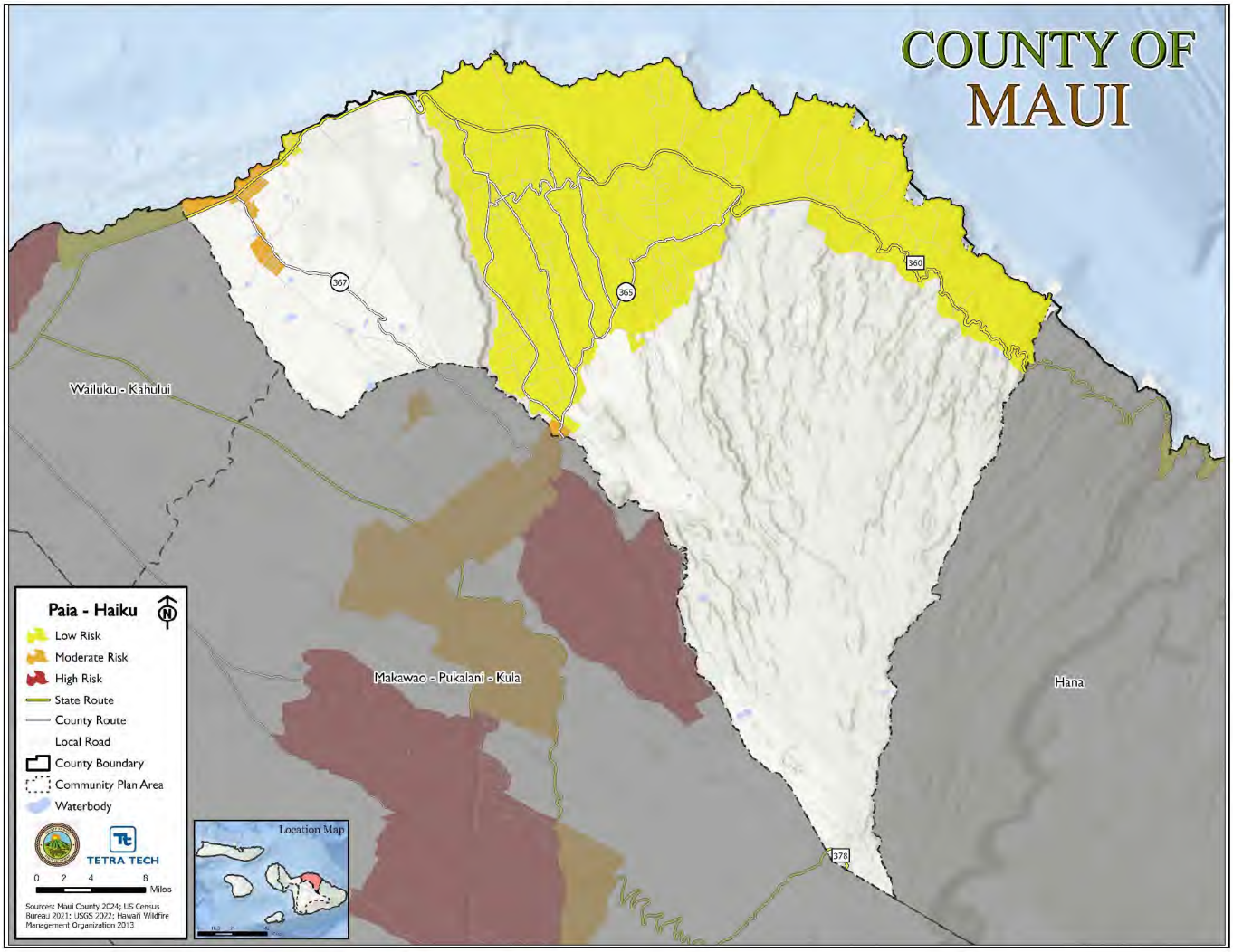
Wildfire Risk, Wailuku-Kahului



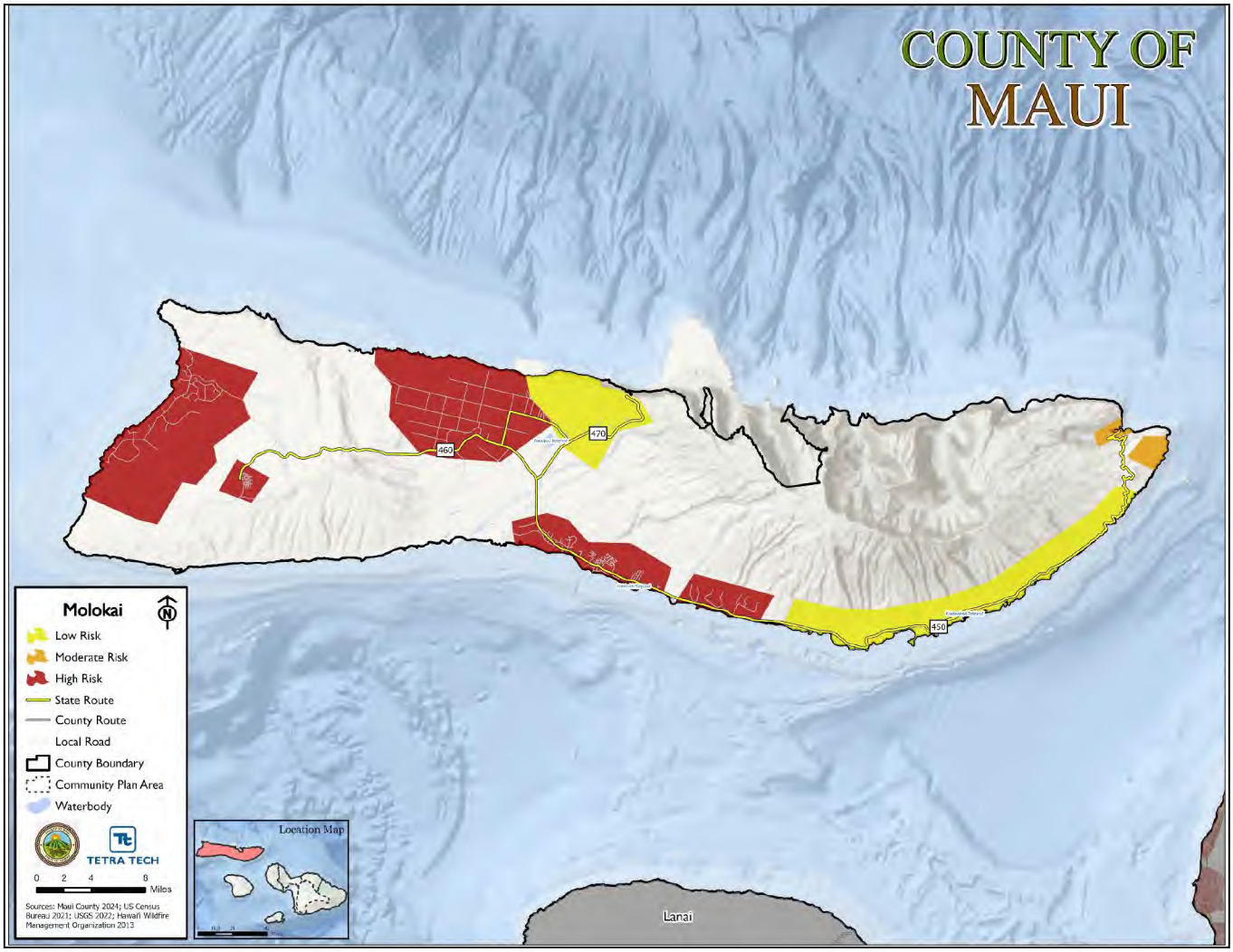
Wildfire Risk, West Maui



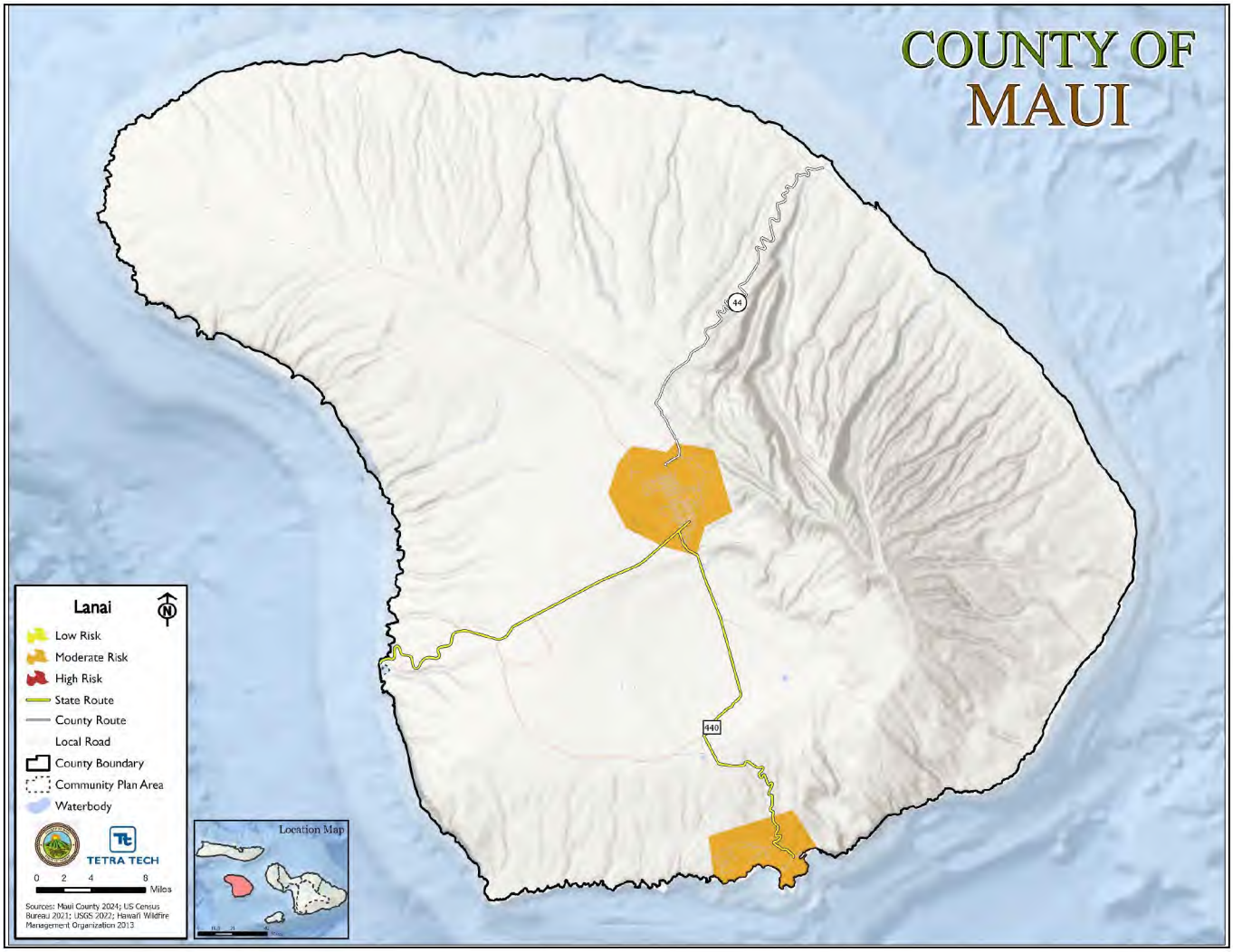
Wildfire Risk, Pāʻia-Haʻikū



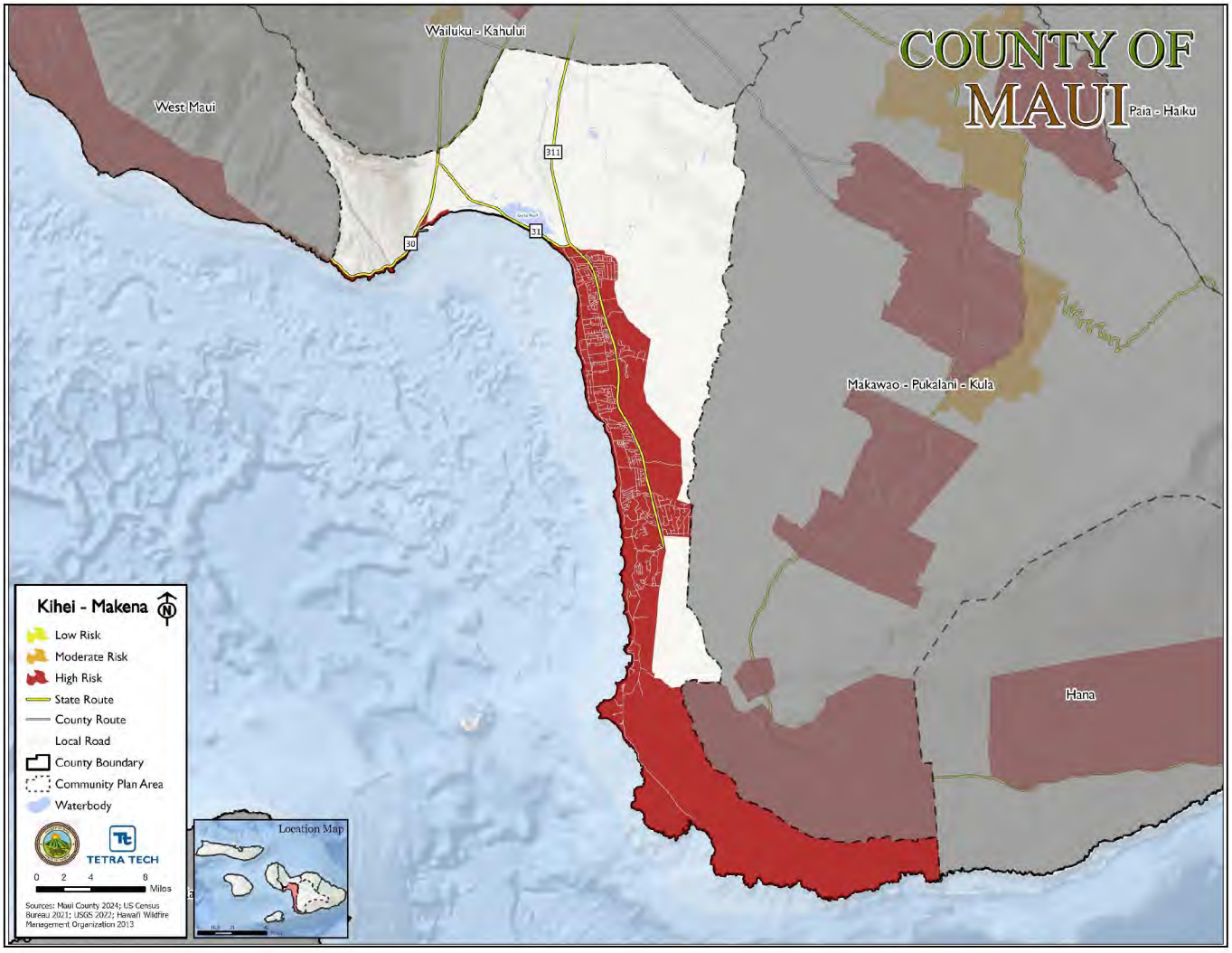
Wildfire Risk, Moloka‘i



Wildfire Risk, Lāna‘i



Wildfire Risk, Kīhei-Mākena



APPENDIX I. MITIGATION CATALOG

Mitigation Action Catalog

2025 Maui County Hazard Mitigation Plan

Coastal Erosion

Mitigation Action Catalog

Personal Scale	Organizational Scale	Government Scale
Reduce the probability of hazard events: ❖ Voluntary retreat ❖ Plant trees and shrubs that reinforce soil and sand integrity **Limit risk to people or structures:** ❖ Protect, preserve, and restore beaches and dunes ❖ Elevate structures and utilities above base flood elevation ❖ Use low-impact development ❖ Floodproof property and structures **Increase ability to respond to or be prepared for the hazard:** ❖ Purchase flood insurance ❖ Develop household mitigation plan ❖ Develop a disaster survival kit for 72-hour self-sufficiency after a natural disaster ❖ Keep cash reserves for reconstruction ❖ Become informed on the hazard and risk reduction alternatives available.	**Reduce the probability of hazard events:** ❖ Voluntary retreat ❖ Plant trees and shrubs that reinforce soil and sand integrity **Limit risk to people or structures:** ❖ Protect, preserve, and restore beaches and dunes ❖ Elevate structures and utilities above base flood elevation ❖ Use low-impact development ❖ Floodproof property and facilities **Increase ability to respond to or be prepared for hazard:** ❖ Keep cash reserves for reconstruction ❖ Develop a continuity of operations plan ❖ Purchase business interruption insurance	**Reduce the probability of hazard events:** ❖ Voluntary retreat ❖ Plant trees and shrubs that reinforce soil and sand integrity **Limit risk to people or structures:** ❖ Implement a property buyout or relocation program ❖ Promote open space uses in identified high-hazard areas via techniques such as: planned unit developments, easements, setbacks, greenways, sensitive area tracks ❖ Adopt land development criteria such as planned unit developments, density transfers, clustering ❖ Institute low impact development techniques ❖ Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff ❖ Harden infrastructure ❖ Provide redundancy for critical infrastructure nodes and systems ❖ Higher regulatory standards in sea-level rise zones ❖ Facilitate managed retreat from, or upgrade of, the most at-risk areas ❖ Implement tree management programs ❖ Elevate roads that are vital/critical to evacuation and local community operations ❖ Include nature-based elements in infrastructure adaptation projects (e.g., roads) such as living shorelines, ecotone levees, and habitat restoration to increase resilience ❖ Design or enhance existing drainage systems for higher design storms to provide increased capacity of the drainage system ❖ Maintain the drainage infrastructure to levels that equal or exceed their design specifications ❖ Require accounting of sea-level rise in all applications for new development in shoreline areas **Increase ability to respond to or be prepared for hazard:** ❖ Provide technical information and guidance ❖ Promote the purchase of flood insurance ❖ Enact tools to help manage development in hazard areas (stronger controls, tax incentives, information) ❖ Incorporate retrofitting or replacement of critical system elements in capital improvement plan ❖ Develop strategy to take advantage of post-disaster opportunities ❖ Provide incentives to guide development away from hazard areas or to retrofit in place ❖ Provide residents with sea-level rise inundation maps Develop non-English and culturally sensitive educational materials

Nature-based opportunities

- ❖ *Restore wetlands, marshes, mudflats, oyster reefs, dunes, beaches, eelgrass, kelp forests, living shorelines and other coastal habitats to enhance resilience and reduce wave impacts during storms*
- ❖ *Preserve/restore tidal marshes to enhance resilience and provide multiple benefits, including absorbing floodwaters and reducing wave impacts during storms*

- *Conserve and protect coastal habitat and non-habitat areas suitable for habitat restoration*
- *Establish living shorelines (natural elements including plants, reefs, and oyster beds) to prevent erosion*
- *Incentivize voluntary retreat from coastal hazard areas*
- *Preserve floodplain storage capacity by limiting or prohibiting the use of fill within the floodplain*

Dam and Reservoir Failure

Mitigation Action Catalog

Personal Scale	Organizational Scale	Government Scale
Reduce the probability of hazard events: ❖ None **Limit risk to people or structures:** ❖ Relocate out of dam failure inundation areas ❖ Elevate home to appropriate levels **Increase ability to respond to or be prepared for hazard:** ❖ Learn about risk reduction for the dam failure hazard ❖ Learn the evacuation routes for a dam failure ❖ Educate yourself on early warning systems ❖ Know evacuation routes ❖ Educate yourself on where the inundation areas are and if you are located within them	**Reduce the probability of hazard events:** ❖ Remove dams ❖ Harden dams **Limit risk to people or structures:** ❖ Replace earthen dams with hardened structures ❖ Flood-proof facilities in dam failure inundation areas **Increase ability to respond to or be prepared for hazard:** ❖ Educate employees on the probable effects of a dam failure ❖ Develop a continuity of operations plan	**Reduce the probability of hazard events:** ❖ Remove dams ❖ Harden dams **Limit risk to people or structures:** ❖ Replace earthen dams with hardened structures ❖ Relocate community lifelines out of dam failure inundation areas ❖ Consider open space land use in designated dam failure inundation areas ❖ Adopt higher floodplain standards in mapped dam failure inundation areas ❖ Retrofit community lifelines in dam failure inundation areas **Increase ability to respond to or be prepared for hazard:** ❖ Map dam failure inundation areas ❖ Enhance emergency operations plan to include a dam failure component ❖ Institute monthly communications checks with dam operators ❖ Inform the public on risk reduction techniques ❖ Adopt real-estate disclosure requirements for the sale of property located in dam failure inundation areas ❖ Consider the probable effects of climate in assessing the risk associated with dam failure ❖ Establish early warning capability downstream of listed high hazard dams ❖ Consider the residual risk associated with protection provided by dams in future land use decisions ❖ Develop non-English and culturally sensitive educational materials

Nature-based opportunities

- ❖ *Restore and reconnect floodplains that intersect dam failure inundation areas that have been degraded by development and structural flood control.*
- ❖ *Use soft approaches for stream bank restoration and hardening. Soft approaches can include but are not limited to the introduction of large woody debris into a system.*
- ❖ *Set back levees on systems that rely on levee protection to allow the river channel to meander, which reduces erosion and scour potential.*
- ❖ *Acquire property within dam failure inundation areas, remove or relocate structures, and preserve these areas as open space in perpetuity.*
- ❖ *Preserve floodplain storage capacity by limiting or prohibiting the use of fill within the floodplain.*

Drought

Mitigation Action Catalog

Personal Scale	Organizational Scale	Government Scale
Reduce the probability of hazard events: ❖ Recycle gray water **Limit risk to people or structures:** ❖ Drought-resistant native landscapes ❖ Reduce water system losses ❖ Modify plumbing systems (through water saving kits) **Increase ability to respond to or be prepared for hazard:** ❖ Practice active water conservation ❖ Increased access to water testing ❖ For homes with on-site water systems: increase storage and utilize rainwater catchment	**Reduce the probability of hazard events:** ❖ Recycle gray water **Limit risk to people or structures:** ❖ Support alternative irrigation techniques to reduce water use and use climate-sensitive water supplies ❖ Drought-resistant landscapes ❖ Reduce private water system losses ❖ For businesses with on-site water systems, increase storage and utilize rainwater catchment **Increase ability to respond to or be prepared for hazard:** ❖ Practice active water conservation ❖ Participate in the Integrated Regional Water Management Program	**Reduce the probability of hazard events:** ❖ Groundwater recharge through stormwater management **Limit risk to people or structures:** ❖ Identify and create groundwater backup sources ❖ Water use conflict regulations ❖ Reduce water system losses ❖ Distribute water saving kits **Increase ability to respond to or be prepared for hazard:** ❖ Public education on drought resistance ❖ Encourage water recycling ❖ Identify alternative water supplies for times of drought; mutual aid agreements with alternative suppliers ❖ Develop drought contingency plan ❖ Develop criteria “triggers” for drought-related actions ❖ Improve accuracy of water supply forecasts ❖ Modify rate structure to influence active water conservation techniques ❖ Consider the probable impacts of climate change on the risk associated with the drought hazard ❖ Support, participate in and advocate for funding for the Integrated Regional Water Management Program ❖ Develop non-English and culturally sensitive educational materials

Nature-based opportunities

- ❖ *Promote and use reclaimed water supplies*
- ❖ *Increase capacity for stored surface water to create habitats and ecosystems for aquatic species.*
- ❖ *Promote and use active groundwater recharge*

Earthquake

Mitigation Action Catalog

Personal Scale	Organizational Scale	Government Scale
Reduce the probability of hazard events: ❖ None **Limit risk to people or structures:** ❖ Locate outside of hazard area (off soft soils) ❖ Apply engineering solutions to reduce the hazard ❖ Retrofit structure (anchor house structure to foundation) ❖ Secure household items that can cause injury or damage (such as water heaters, bookcases, and other appliances) ❖ Build to higher design **Increase ability to respond to or be prepared for the hazard:** ❖ Practice drop, cover, and hold ❖ Develop household mitigation plan, such as a retrofit savings account, communication capability with outside, 72-hour self-sufficiency during an event ❖ Keep cash reserves for reconstruction ❖ Become informed on the hazard and risk reduction alternatives available. ❖ Develop a post-disaster action plan for your household	**Reduce the probability of hazard events:** ❖ None **Limit risk to people or structures:** ❖ Locate or relocate mission-critical functions outside hazard area ❖ Apply engineering solutions that minimize or eliminate the hazard ❖ Build redundancy for critical functions and facilities ❖ Retrofit critical buildings and areas housing mission-critical functions **Increase ability to respond to or be prepared for hazard:** ❖ Adopt higher standard for new construction; consider "performance-based design" when building new structures ❖ Keep cash reserves for reconstruction ❖ Inform your employees on the possible effects of earthquake and how to deal with them at your work facility. ❖ Develop a continuity of operations plan	**Reduce the probability of hazard events:** ❖ None **Limit risk to people or structures:** ❖ Locate community lifelines or functions outside hazard area ❖ Apply engineering solutions that minimize or eliminate the hazard ❖ Harden infrastructure ❖ Provide redundancy for critical functions ❖ Adopt higher regulatory standards **Increase ability to respond to or be prepared for hazard:** ❖ Provide better hazard maps ❖ Provide technical information and guidance ❖ Enact tools to help manage development in hazard areas (e.g., tax incentives, information) ❖ Include retrofitting and replacement of critical system elements in capital improvement plan ❖ Develop strategy to take advantage of post-disaster opportunities ❖ Warehouse critical infrastructure components such as pipe, power line, and road repair materials ❖ Develop and adopt a continuity of operations plan ❖ Initiate triggers guiding improvements (such as <50% substantial damage or improvements) ❖ Further enhance seismic risk assessment to target high hazard buildings for mitigation opportunities. ❖ Develop a post-disaster action plan that includes grant funding and debris removal components. ❖ Develop non-English and culturally sensitive educational materials.

Nature-based opportunities

❖ *None identified*

Flood

Mitigation Action Catalog

Personal Scale	Organizational Scale	Government Scale
Reduce the probability of hazard events: ❖ Clear storm drains and culverts ❖ Use green infrastructure **Limit risk to people or structures:** ❖ Locate outside of hazard area ❖ Elevate utilities above base flood elevation ❖ Use low-impact development techniques ❖ Raise structures above base flood elevation ❖ Elevate items within house above base flood elevation ❖ Build new homes above base flood elevation ❖ Flood-proof structures **Increase ability to respond to or be prepared for hazard:** ❖ Buy flood insurance ❖ Develop household plan, such as retrofit savings, communication with outside, 72-hour self-sufficiency during and after an event	**Reduce the probability of hazard events:** ❖ Clear storm drains and culverts ❖ Use low-impact development techniques **Limit risk to people or structures:** ❖ Locate community lifelines or functions outside hazard area ❖ Use low-impact development techniques ❖ Build redundancy for critical functions or retrofit critical buildings ❖ Provide flood-proofing when new critical infrastructure must be located in floodplains **Increase ability to respond to or be prepared for hazard:** ❖ Keep cash reserves for reconstruction ❖ Support and implement hazard disclosure for sale of property in risk zones. ❖ Solicit cost-sharing through partnerships with others on projects with multiple benefits.	**Reduce the probability of hazard events:** ❖ Maintain drainage system ❖ Institute low-impact development techniques on property ❖ Dredging, levee construction, and providing regional retention areas ❖ Structural flood control, levees, channelization, or revetments. ❖ Stormwater management regulations and master planning ❖ Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff **Limit risk to people or structures:** ❖ Locate or relocate community lifelines outside of hazard area ❖ Acquire or relocate identified repetitive loss properties ❖ Promote open space uses in identified high hazard areas via techniques such as: planned unit developments, easements, setbacks, greenways, sensitive area tracks. ❖ Adopt land development criteria such as planned unit developments, density transfers, clustering ❖ Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff ❖ Harden infrastructure, bridge replacement program ❖ Provide redundancy for critical functions and infrastructure ❖ Adopt regulatory standards such as freeboard standards, cumulative substantial improvement or damage, lower substantial damage threshold; compensatory storage, non-conversion deed restrictions. ❖ Stormwater management regulations and master planning. ❖ Adopt “no-adverse impact” floodplain management policies that strive to not increase the flood risk on downstream communities. ❖ Expand the Stormwater Capture Parks Program to collect rainwater and urban runoff. ❖ Create Tree Canopy neighborhoods to reduce stormwater runoff by catching rainfall on branches and leaves and increasing evapotranspiration. **Increase ability to respond to or be prepared for hazard:** ❖ Produce better hazard maps ❖ Provide technical information and guidance ❖ Enact tools to help manage development in hazard areas (stronger controls, tax incentives, and information) ❖ Incorporate retrofitting or replacement of critical system elements in capital improvement plan ❖ Develop strategy to take advantage of post-disaster opportunities ❖ Warehouse critical infrastructure components ❖ Develop and adopt a continuity of operations plan ❖ Maintain and collect data to define vulnerability and potential impacts ❖ Train emergency responders ❖ Create an elevation inventory of structures in the floodplain

Personal Scale	Organizational Scale	Government Scale
		❖ Develop and implement a public information strategy ❖ Charge a hazard mitigation fee ❖ Integrate floodplain management policies into other planning mechanisms within the planning area. ❖ Consider the probable effects of climate change on the risk associated with the flood hazard ❖ Consider the residual risk associated with structural flood control in future land use decisions ❖ Enforce National Flood Insurance Program ❖ Adopt a Stormwater Management Master Plan ❖ Develop non-English and culturally sensitive educational materials

Nature-based opportunities

- ❖ *Restore and reconnect floodplains that have been degraded by development and structural flood control.*
- ❖ *Use soft approaches for stream bank restoration and hardening (e.g., introducing large woody debris into a system).*
- ❖ *Set back levees on systems that rely on levee protection to allow the river channel to meander, which reduces erosion and scour potential.*
- ❖ *Acquire property within the floodplain, remove or relocate structures, and preserve these areas as open space in perpetuity.*
- ❖ *Preserve floodplain storage capacity by limiting or prohibiting the use of fill in the floodplain.*
- ❖ *Incorporate green infrastructure into stormwater management facilities*
- ❖ *Protect and/or restore riparian buffers*

High Windstorms

Mitigation Action Catalog

Personal Scale	Organizational Scale	Government Scale
Reduce the probability of hazard events: ❖ None **Limit risk to people or structures:** ❖ Contact municipality or utilities to trim or remove trees that could affect power lines. ❖ Plant appropriate trees near home and power lines ("Right tree, right place" National Arbor Day Foundation Program. **Increase ability to respond to or be prepared for the hazard:** ❖ Improve awareness of impending severe weather (e.g. obtain a NOAA weather radio). ❖ Promote 72-hour self-sufficiency.	**Reduce the probability of hazard events:** ❖ None **Limit risk to people or structures:** ❖ Locate or relocate mission-critical functions outside hazard area ❖ Apply engineering solutions that minimize or eliminate the hazard ❖ Build redundancy for critical functions and facilities ❖ Retrofit critical buildings and areas housing mission-critical functions **Increase ability to respond to or be prepared for hazard:** ❖ Adopt higher standard for new construction; consider "performance-based design" when building new structures ❖ Keep cash reserves for reconstruction ❖ Inform your employees on the possible effects of earthquake and how to deal with them at your work facility. ❖ Develop a continuity of operations plan	**Reduce the probability of hazard events:** ❖ Increase tree plantings. ❖ Encourage installation of green roofs to provide shade. ❖ Encourage the use of cool roofing products that reflect sunlight and heat away from a building. **Limit risk to people or structures:** ❖ Harden infrastructure such as locating utilities underground. ❖ Trimming trees back from power lines. ❖ Designate and strengthen critical road sections and bridges. ❖ Adopt ordinances that regulate the type and quantity of trees planted near utility lines. ❖ Relocate critical infrastructure, such as power lines, underground. ❖ Require minimum temperatures in housing/landlord codes. **Increase ability to respond to or be prepared for hazard:** ❖ Support programs such as "Tree Watch" that proactively manage problem areas by use of selective removal of hazardous trees, tree replacement, etc. ❖ Enforce building codes. ❖ Increase communication alternatives. ❖ Modify land use and environmental regulations to support vegetation management activities that improve reliability in utility corridors. ❖ Modify landscape and other ordinances to encourage appropriate planting near overhead power, cable, and phone lines. ❖ Promote awareness and participation in alert systems. ❖ Provide NOAA weather radios to the public. ❖ Create/Enhance "mutual aid" agreements for response to all emergencies. ❖ Create/identify evacuation routes to be utilized during severe storm events. ❖ Develop debris management plans. ❖ Join "Storm-Ready" program. ❖ Provide early warning of impending severe storm events to identified critical or essential facilities. This would include facilities such as large employments centers, schools, hospitals. ❖ Promote emergency power supplies to private property. ❖ Improve, expand, or harden communications facilities and services. ❖ Recruit additional emergency personnel or use mutual aid agreements. ❖ Increase sheltering capabilities. ❖ Increase capability to respond to power outages and downed power lines. Establish partnerships with utility providers through pro-active planning.

Nature-based opportunities

❖ *None identified*

Hurricane

Mitigation Action Catalog

Personal Scale	Organizational Scale	Government Scale
Reduce the probability of hazard events: ❖ None **Limit risk to people or structures:** ❖ Retrofit structures (improved roofing, glazing, insulation, etc.) ❖ Provide for redundant heat and power ❖ Contact municipality or utilities to trim or remove trees that could affect power lines ❖ Plant appropriate trees near home and power lines ("Right tree, right place" National Arbor Day Foundation Program **Increase ability to respond to or be prepared for hazard:** ❖ Improve awareness of impending severe weather (e.g. obtain a NOAA weather radio) ❖ Promote 72-hour self-sufficiency ❖ Provide for redundant heat and power	**Reduce the probability of hazard events:** ❖ None **Limit risk to people or structures:** ❖ Locate structures outside of hazard area ❖ Retrofit at-risk facilities **Increase ability to respond to or be prepared for hazard:** ❖ Contact municipality or utilities to trim or remove trees that could affect power lines ❖ Create redundancy (e.g. backup generators) ❖ Improve awareness of impending severe weather (e.g. obtain a NOAA weather radio) ❖ Develop a Continuity of Operations Plan (COOP) ❖ Monitor impending storm events so that you can release employees in such a manner as to not negatively impact emergency response personnel/services	**Reduce the probability of hazard events:** ❖ None **Limit risk to people or structures:** ❖ Harden infrastructure such as locating utilities underground ❖ Trimming trees back from power lines ❖ Designate and strengthen critical road sections and bridges ❖ Adopt ordinances that regulate the type and quantity of trees planted near utility lines ❖ Relocate critical infrastructure, such as power lines, underground ❖ Require minimum temperatures in housing/landlord codes **Increase ability to respond to or be prepared for hazard:** ❖ Enforce building codes ❖ Increase communication alternatives ❖ Modify land use and environmental regulations to support vegetation management activities that improve reliability in utility corridors ❖ Modify landscape and other ordinances to encourage appropriate planting near overhead power, cable, and phone lines ❖ Promote awareness and participation in alert systems ❖ Provide NOAA weather radios to the public ❖ Create/Enhance "mutual aid" agreements for response to all emergencies ❖ Create/identify evacuation routes to be utilized during severe storm events ❖ Develop debris management plans ❖ Join "Storm-Ready" program ❖ Provide early warning of impending hurricane events to identified critical or essential facilities. This would include facilities such as large employments centers, schools, hospitals ❖ Promote emergency power supplies to private property ❖ Improve, expand, or harden communications facilities and services ❖ Recruit additional emergency personnel or use mutual aid agreements ❖ Increase sheltering capabilities ❖ Increase capability to respond to power outages and downed power lines ❖ Establish partnerships with utility providers through pro-active planning

Nature-based opportunities

- *Replace or restore native vegetation known to stabilize steep slope areas.*
- *Soil bioengineering can be used to mitigate risk in larger areas that have a potential for shallow, slow-moving landslides or areas abandoned after past landslides that show signs of reactivation and have a high landslide hazard potential*
- *Hybrid solutions refer to conventional engineering solutions that are combined with nature-based solutions using appropriate vegetation.*

Landslide

Mitigation Action Catalog

Personal Scale	Organizational Scale	Government Scale
Reduce the probability of hazard events: ❖ Stabilize slope (dewater, armor toe) ❖ Reduce weight on top of slope ❖ Minimize vegetation removal and the addition of impervious surfaces. ❖ Apply engineering solutions that minimize/eliminate the hazard **Limit risk to people or structures:** ❖ Locate structures outside of hazard area (off unstable land and away from slide-run out area) ❖ Retrofit home **Increase ability to respond to or be prepared for hazard:** ❖ Institute warning system, and develop evacuation plan ❖ Keep cash reserves for reconstruction ❖ Educate yourself on risk reduction techniques for landslide hazards	**Reduce the probability of hazard events:** ❖ Stabilize slope (dewater, armor toe) ❖ Reduce weight on top of slope ❖ Apply engineering solutions that minimize/eliminate the hazard **Limit risk to people or structures:** ❖ Locate structures outside of hazard area (off unstable land and away from slide-run out area) ❖ Retrofit at-risk facilities **Increase ability to respond to or be prepared for hazard:** ❖ Institute warning system, and develop evacuation plan ❖ Keep cash reserves for reconstruction ❖ Develop a continuity of operations plan ❖ Educate employees on the potential vulnerability to landslide hazards and emergency response protocol.	**Reduce the probability of hazard events:** ❖ Stabilize slope (dewater, armor toe) ❖ Reduce weight on top of slope ❖ Apply engineering solutions that minimize/eliminate the hazard **Limit risk to people or structures:** ❖ Acquire properties in high-risk landslide areas. ❖ Adopt land use policies that prohibit the placement of habitable structures in high-risk landslide areas. ❖ Adopt higher regulatory standards for new development within unstable slope areas. ❖ Armor/retrofit critical infrastructure against landslides. **Increase ability to respond to or be prepared for hazard:** ❖ Produce better hazard maps ❖ Provide technical information and guidance ❖ Enact tools to help manage development in hazard areas: better land controls, tax incentives, information ❖ Develop strategy to take advantage of post-disaster opportunities ❖ Warehouse critical infrastructure components ❖ Develop and adopt a continuity of operations plan ❖ Educate the public on the landslide hazard and appropriate risk reduction alternatives ❖ Develop non-English and culturally sensitive educational materials

Nature-based opportunities

- ❖ *Replace or restore native vegetation known to stabilize steep slope areas.*
- ❖ *Soil bioengineering can be used to mitigate risk in larger areas that have a potential for shallow, slow-moving landslides or areas abandoned after past landslides that show signs of reactivation and have a high landslide hazard potential*
- ❖ *Hybrid solutions refer to conventional engineering solutions that are combined with nature-based solutions using appropriate vegetation.*

Tsunami

Mitigation Action Catalog

Personal Scale	Organizational Scale	Government Scale
Reduce the probability of hazard events: ❖ None **Limit risk to people or structures:** ❖ Locate outside of hazard area ❖ Apply personal property mitigation techniques to your home such as anchoring your foundation and foundation openings to allow flow though **Increase ability to respond to or be prepared for hazard:** ❖ Develop and practice a household evacuation plan ❖ Become educated about the risk exposure from the tsunami hazard and ways to minimize that risk ❖ Understand tsunami warning signs and signals	**Reduce the probability of hazard events:** ❖ Implement tsunami construction measures at a project level, including elevated living spaces and debris deflection structures **Limit risk to people or structures:** ❖ Locate structure or mission critical functions outside of hazard area whenever possible ❖ Mitigate property for the impacts of tsunami ❖ Construct vertical evacuation shelters **Increase ability to respond to or be prepared for hazard:** ❖ Develop and practice a corporate response and evacuation plan ❖ Educate employees on the risk exposure from the tsunami hazard and ways to minimize that risk	**Reduce the probability of hazard events:** ❖ Build wave abatement structures (e.g., sea walls and the "jacks- looking structures designed by the Japanese) **Limit risk to people or structures:** ❖ Locate structure or functions outside of hazard area whenever possible ❖ Harden infrastructure for tsunami impacts ❖ Relocate identified critical facilities located in tsunami high hazard areas ❖ Adopt higher regulatory standards that will provide higher levels of protection to structures built in a tsunami inundation area ❖ Use tsunami mapping and land use planning to guide development away from high-risk areas ❖ Construct vertical evacuation shelters **Increase ability to respond to or be prepared for hazard:** ❖ Use probabilistic tsunami mapping and land use guidance from the state ❖ Provide incentives to guide development away from hazard areas ❖ Improve the tsunami warning and response system ❖ Provide residents with updated tsunami hazard and inundation maps for the coast and vulnerable in-land lakes ❖ Join NOAA's Tsunami Ready program ❖ Develop and communicate evacuation time products and routes ❖ Enhance the public information program to include risk reduction options for the tsunami hazard ❖ Develop products useful for tsunami mitigation and recovery ❖ Utilize multi-hazard mitigation strategies that address tsunami hazards and sea-level rise from global climate change ❖ Provide tsunami products useful for the maritime industry

Nature-based opportunities

- ❖ *Restore wetlands, mangroves, marshes, and oyster reefs, and install living shorelines to help reduce wave impacts*
- ❖ *Preserve/restore tidal marshes*
- ❖ *Establish living shorelines (plants and natural elements designed to stabilize and protect coastlines) to prevent erosion*
- ❖ *Incentivize voluntary retreat from coastal hazard areas*

Volcanic Hazards

Mitigation Action Catalog

Personal Scale	Organizational Scale	Government Scale
Reduce the probability of hazard events: ❖ None **Limit risk to people or structures:** ❖ Locate outside of hazard area **Increase ability to respond to or be prepared for hazard:** ❖ Develop and practice a household evacuation plan	**Reduce the probability of hazard events:** ❖ None **Limit risk to people or structures:** ❖ Locate outside of hazard area ❖ Protect corporate critical facilities from potential impacts of severe ash fall (air filtration capability) **Increase ability to respond to or be prepared for hazard:** ❖ Develop and practice a corporate evacuation plan ❖ Inform employees through corporate sponsored outreach	**Reduce the probability of hazard events:** ❖ Limited success has been experienced with lava flow diversion structures **Limit risk to people or structures:** ❖ Locate outside of hazard area ❖ Protect critical facilities and utilities from potential problems associated with ash fall ❖ Build redundancy for critical facilities and functions ❖ Open space preservation **Increase ability to respond to or be prepared for hazard:** ❖ Public outreach, awareness ❖ Tap into state volcano warning system to provide early warning to residents of potential ash fall problems

Nature-based opportunities

❖ *Volcanic ash could be used to supply nutrients and reduce carbon dioxide from the atmosphere*

Wildfire

Mitigation Action Catalog

Personal Scale	Organizational Scale	Government Scale
Reduce the probability of hazard events: ❖ Clear potential fuels on property such as dry overgrown underbrush and diseased trees **Limit risk to people or structures:** ❖ Create and maintain defensible space around structures ❖ Locate outside of hazard area ❖ Mow regularly ❖ Create and maintain defensible space around structures and provide water on site ❖ Use fire-retardant building materials ❖ Create defensible spaces around home **Increase ability to respond to or be prepared for hazard:** ❖ Employ techniques from the National Fire Protection Association's Firewise Communities program to safeguard home ❖ Identify alternative water supplies for fire fighting ❖ Install/replace roofing material with non-combustible roofing materials	**Reduce the probability of hazard events:** ❖ Clear potential fuels on property such as dry underbrush and diseased trees **Limit risk to people or structures:** ❖ Create and maintain defensible space around structures and infrastructure ❖ Locate outside of hazard area ❖ Create and maintain defensible space around structures and infrastructure and provide water on site ❖ Use fire-retardant building materials ❖ Use fire-resistant plantings in buffer areas of high wildland/urban interface fire threat. **Increase ability to respond to or be prepared for hazard:** ❖ Support Firewise community initiatives ❖ Create /establish stored water supplies to be utilized for firefighting	**Reduce the probability of hazard events:** ❖ Clear potential fuels on property such as dry underbrush and diseased trees ❖ Implement best management practices on public lands. ❖ Remove invasive non-native hazardous fuels in riparian areas and restore native habitat **Limit risk to people or structures:** ❖ Create and maintain defensible space around structures and infrastructure ❖ Locate outside of hazard area ❖ Enhance building code to include use of fire resistant materials in high hazard area. ❖ Ensure compliance with State Minimum Fire Safe Regulations ❖ Create and maintain defensible space around structures and infrastructure ❖ Use fire-retardant building materials ❖ Use fire-resistant plantings in buffer areas of high wildland/urban interface fire threat ❖ Consider higher regulatory standards (e.g., Class A roofing) ❖ Establish biomass reclamation activities **Increase ability to respond to or be prepared for hazard:** ❖ More public outreach and education efforts ❖ Possible weapons of mass destruction funds available to enhance fire capability in high-risk areas ❖ Identify fire response and alternative evacuation routes ❖ Seek alternative water supplies ❖ Manage fuel load through thinning and brush removal ❖ Use academia to study impacts/solutions to wildland/urban interface fire risk ❖ Establish/maintain mutual aid agreements between fire service agencies. ❖ Create/implement fire plans ❖ Consider the probable impacts of climate change on the risk associated with the wildland/urban interface fire hazard in future land use decisions ❖ Develop non-English and culturally sensitive educational materials

Nature-based opportunities

- *Manage invasive species (i.e., Pampas Grass) that are susceptible to increased wildfire risk.*
- *Create riparian corridors in wildfire hazard areas as fire breaks*
- *Incorporate nature-based wildfire risk reduction buffers into existing ecosystem-friendly land uses (e.g., green space, trails, or community parklands)*
- *Implement ecological thinning, prescribed fire and cultural fire and manage wildfire for resource benefit where appropriate*

- *Implement ecological restoration programs to convert exotic grasslands to native scrub and chaparral and control invasive species.*