Kaua'i Island Utility Cooperative

Your Touchstone Energy® Cooperative

WILDFIRE MITIGATION PLAN

DATE: MAY, 2024

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BKI ENGINEERING SERVICES

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WILDFIRE MITIGATION PLAN DISCLAIMER

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1 Introduction

The Hawaiian Islands are typically regarded as a tropical paradise due to the lush and green landscapes depicted on film. Contrary to this image, the climate varies across each of the main Hawaiian Islands and is a composite or frequency distribution of various kinds of weather. The outstanding features of Hawaii's climate include mild temperatures throughout the year, moderate humidity, persistence of northeasterly trade winds, significant differences in rainfall within short distances, and infrequent severe storms. Hawaii's mountains significantly influence every aspect of its weather and climate. The endless variety of peaks, valleys, ridges, and broad slopes, gives Hawaii a climate that is different from the surrounding ocean, as well as a climatic variety within the islands. These climatic differences would not exist if the islands were flat and the same size. The mountains obstruct, deflect, and accelerate the flow of air. When warm, moist air rises over windward coasts and slopes, clouds and rainfall are much greater than over the open sea. Leeward areas, where the air descends, tend to be sunny and dry. In places sheltered by terrain, local air movements are significantly different from winds in exposed localities. For most of Hawaii, there are only two seasons: "summer," between May and October, and "winter," between October and April.[1]

Wildfires have increased 400%[2] on this remote archipelago located 2,000 miles from the US mainland. This trend can be attributed to increased drought conditions combined with a long-term trend toward an increased cover of nonnative grasses[3] and those that are highly flammable. A warming, drying climate, as well as increased frequency and strengths of El Niño events have led to drought conditions that are increasing the wildfire problem, especially in leeward areas. Scientists noted that the rainfall has generally been decreasing over time, with the number of consecutive dry days increasing. Historically, wildfires had been associated with volcanic activity or lightning strikes, but 98% of all Hawai`i wildfires are now attributed to human-causes, including electrical distribution lines.

Wildfire Mitigation Plan (WMP) mandates have not yet been enacted in Hawai`i, although several proposals are currently under consideration by the Hawaii State Legislature. Regardless of potential forthcoming mandates, Kaua`i Island Utility Cooperative (KIUC) believes the development of a thorough WMP is a prudent and responsible effort to prepare for increased wildfire conditions on Kaua`i. While an electric utility can never fully eliminate the risk of fire, KIUC is committed to taking all practical actions to reduce the devastation that a wildfire could bring to the people and communities we serve. This Wildfire Mitigation Plan lays out the steps we are taking to do so.

[1] https://www.weather.gov/hfo/climate_summary

[2] https://www.hawaiiwildfire.org/fire-resource-library-blog/wildfire-in-hawaii-factsheet

[3] 25% of the state has been invaded by fire-prone grass and shrub species; Hawai'i Wildfire Management Organization (HWMO)

1.1 Purpose of the Wildfire Mitigation Plan

KIUC believes the strategies and activities described in this WMP, with associated goals and metrics, are an effective approach to reduce risk for KIUC's members/customers in the near-term and will allow for refinement and improvement over time. The plan will be amended as appropriate to ensure alignment with any subsequent legislative mandates. As KIUC gains experience implementing the WMP's mitigation programs, and as new information emerges, KIUC will assess, evaluate, enhance, and refine its practices.

The WMP describes vegetation management, asset inspection and maintenance, recloser setting protocols, restoration of service processes, and community outreach efforts. It also addresses the unique features of KIUC's service area such as topography, weather, infrastructure, grid configuration and potential wildfire risks. Additionally, it spells out plan ownership, performance metrics, deficiency identification, and the plan's audit and approval process.

1.2 Objectives of the WMP

The WMP's main objective is to implement an actionable plan to:

- Create increased reliability and safety
- Prevent, mitigate, respond/assist, and recover from wildfires
- Comply with current Hawai`i Public Utility Commission (HPUC), Hawai`i State law, and National Electric Safety Code (NESC) regulations and guidelines
- Reduce liability

1.3 KIUC Profile and History

Serving the entire Island of Kaua`i since 2002, KIUC is the only not-for-profit public utility in the state and provides electricity to approximately 35,000 commercial and residential member meters. The utility is governed by a nine-member Board of Directors, elected by the members, that determines policy and appoints the CEO who is responsible for KIUC's overall management and operations.

1.4 The Service Area

KIUC serves a population of 73,454 on the 562 square mile island of Kaua`i in the State of Hawai`i (Figure 1). The volcanic origins of the island dates back approximately 5 million years making it the oldest of the main islands in the Hawaiian chain.

The service area spans approximately 30 miles east to west and 25 miles north to south. With a tropical climate, the weather is generally moderately humid and warm with low altitude temperature ranging from 78°F to 85°F. July is the warmest month at 78° on average. Mountainous regions can be cooler with temps ranging from 45° to 65° at 3,200'-4,200' above mean sea level (AMSL).

Precipitation at the low elevation averages ~50″ on the windward side, to less than 20″ on the leeward side of the island with June typically the driest month. The mountains receive much more rain, with Mt. Wai`ale`ale often cited as one of the wettest place on earth. Between 1949 and 2004, the average yearly precipitation was 374″ at 5,074′ AMSL on the mountain.

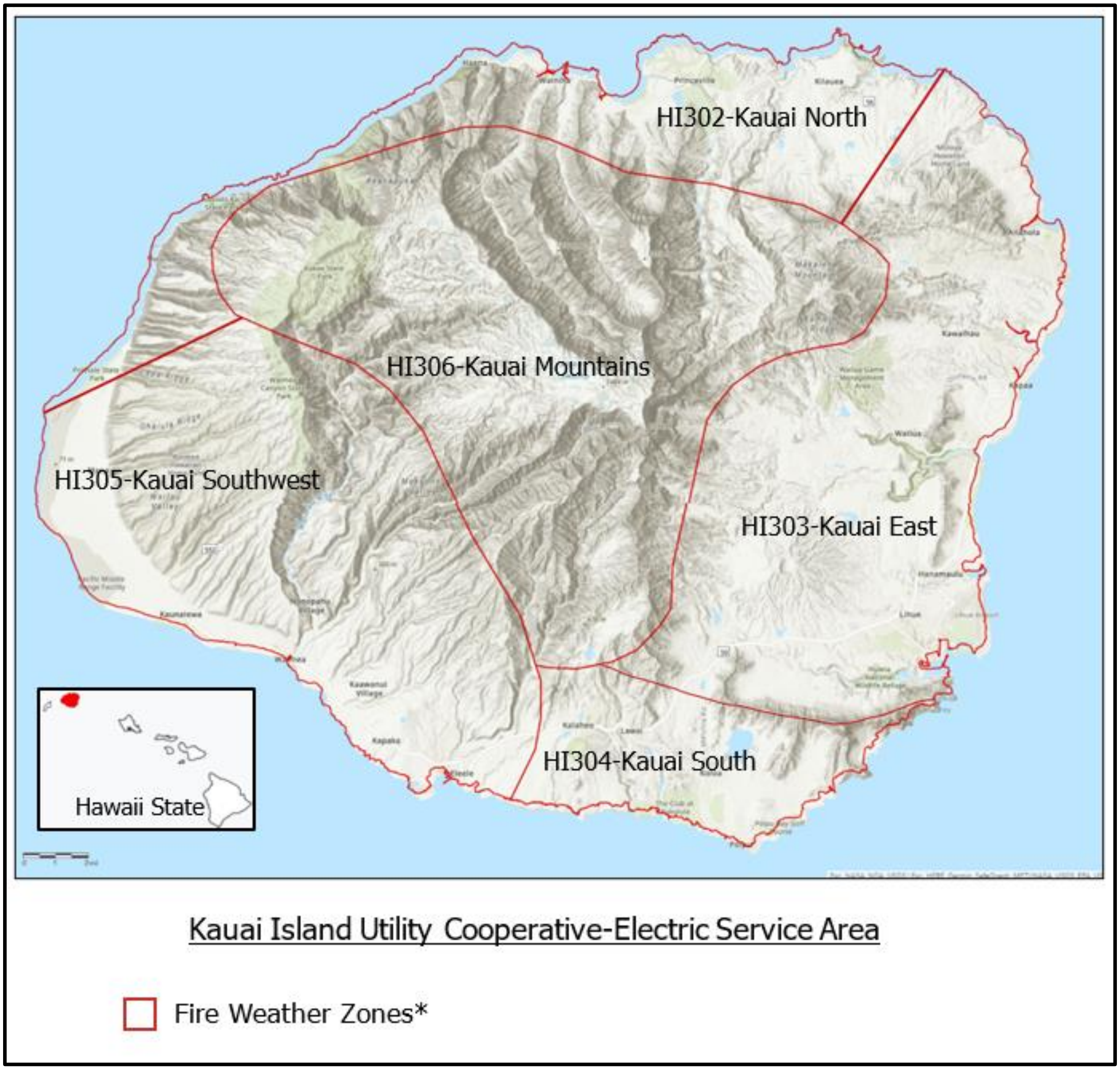
The service territory is made up of agricultural lands interspersed with dense residential developments and towns at the lower elevations, with state parks, forest reserves, and wildlife refuges dominating the undeveloped areas at the upper elevations. Many of the open spaces are deforested and untended agricultural lands taken over by non-native grasses.

There are dramatic variations in altitude with the distribution system serving areas ranging from sea level up to ~3,500 feet AMSL. The highest elevation for the transmission lines is 2,000′ AMSL and most of the distribution system operates at 50′ to 500′ AMSL.

Kaua`i is also full of microclimates thanks to its interior valleys, coastal plains, and mountain peaks. The island is divided into five (5) Fire Weather Zones (FWZs). FWZs are land areas with similar climate, weather, and terrain characteristics. The National Weather Service (NWS) issues Fire Weather Watches (FWW) and Red Flag Warnings (RFW) for critical fire weather patterns that contribute to extreme fire danger and/or fire behavior. In Hawaii, a FWW is issued when there is a high potential for the development of a RFW event. Fire Weather Watches may be issued 12 to 72 hours prior to the expected onset of criteria. The criteria for RFW 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. RFWs alert of the potential for widespread ignitions or control problems with new or existing fires.[4] FWW and RFW are issued for all or selected portions of a FWZ or zone. The NWS has proposed a FWZ map update for 2024; the new configuration (Figure 1) divides the island into five separate zones from three zones.

[4] https://www.weather.gov/hfo/prod_questions

Figure 1. KIUC Service Area



*Proposed 2024 FWZs

1.5 The Electric System

KIUC owns and operates generation, transmission, and distribution systems which are critical to maintaining electric service to its members/customers. The co-op serves light industrial, urban, and suburban residences and businesses throughout Kaua`i Island with a peak load of 80MW. The electric grid is a mix of overhead (OH-71%) and underground (UG-29%) distribution with a nominal operating voltage of 12.47kV. Transmission is a mix of wood poles and steel structures insulated to 69kV OH with just 1 miles of UG construction. The nominal transmission voltage is 57.1kV.

Approximately 60% of the power for the electrical grid comes from renewable generation sources, such as biomass, hydroelectric, customer-owned rooftop solar (some with battery behind the meter), and large-scale solar facilities. The remaining power comes from KIUC's petroleum-fired generating plants. KIUC's strategic plan calls for generating 100% of its power from renewables by 2033. During periods of sunshine, all of KIUC's load can be supplied by clean renewable sources.

KIUC owns, operates, and has equipment in 15 substations and maintains approximately 1,311 circuit miles of overhead T&D right-of-way (ROW). Table 1 below provides a high-level overview of KIUC's assets.

Table 1. Asset Overview

ASSET CLASSIFICATION	ASSET DESCRIPTION
Transmission	Approximately 171 miles of 57.1kV OH and 1 mile UG transmission line ROW, structures, and switches.
Distribution	Approximately 811 miles of primary overhead (OH) and 330 miles of primary underground (UG) ROW, conductor, cabling, transformers, voltage regulators, capacitors, switches, line protective devices operating at 12.47kV.
Substation Assets	Major equipment such as power transformers, voltage regulators, capacitors, reactors, protective devices, relays, open-air structures, switchgear, and control houses in 15 substation facilities.

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2 Risk Analysis and Risk Drivers

To establish a baseline understanding of the risks and risk drivers involved, KIUC examined its exposure to all fire-related hazards. KIUC also examined its asset locations in relation to topographic features, wildfire history and land ownership data to identify risks unique to its service area. This chapter will provide an overview of the service area properties and associated risks, which are factored into the wildfire mitigation strategy. See section 1.4 for a detailed description of the service area.

2.1 Fire Risk Drivers

KIUC staff evaluated its own, as well as other utilities', fire causes in the region and applied its own field experience to determine the key potential risk drivers. Nine categories were identified as contributors for heightened wildfire risk:

- Climate Change
- Fire Weather
- Drought
- Vegetation Encroachment/Non-Native vegetation
- Tree Failure/Tree Mortality
- Wind Loading
- Corrosive Environment
- Aging Equipment
- Pole Degradation
- Joint use/pole loading

2.1.1 Climate Change

The Fourth National Climate Assessment, published in 2018, states that 2015 temperatures were 3.4°F above normal (as compared to the 1970-1999 average) with winter temperatures 6.2°F above normal. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased. These changes may impact Kaua`i through rising sea levels, increasing ocean acidity, changing rainfall patterns, changing wind and wave patterns, changing extremes, changing habitats and species distribution, and wildfire occurrence and intensity.

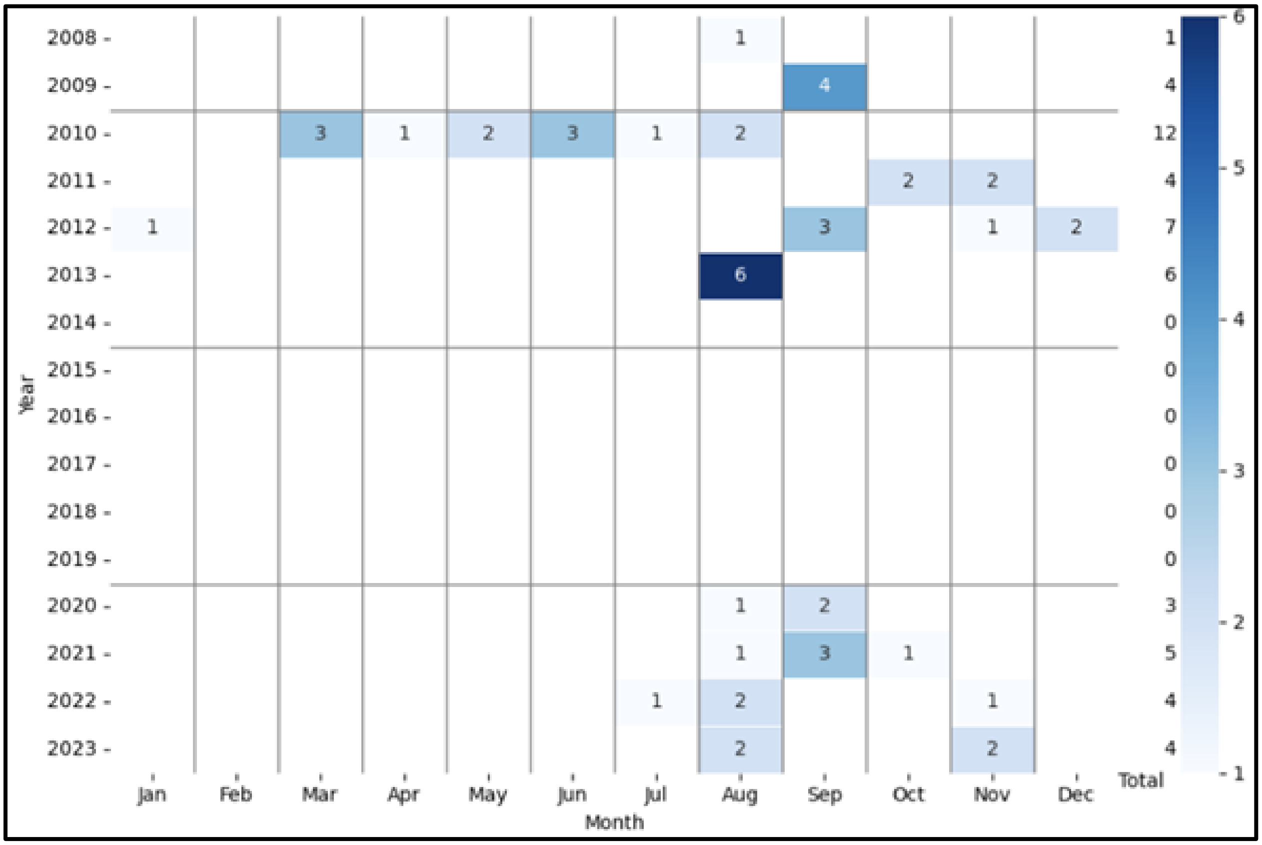
2.1.2 Fire Weather

KIUC notes that one of the three criteria for a RFW in Hawaii is winds greater than or equal to 20 mph[5], which is just above typical trade wind speed. Wind speeds of 20 mph and somewhat higher do not typically result in damage to KIUC's electrical infrastructure, and therefore a RFW being issued does not necessarily result in concern that KIUC infrastructure could fail and cause a wildfire. KIUC also notes that tropical storm force winds are between 39-73 mph[6], and history shows that wind speeds in that range are more likely to result in portions of KIUC infrastructure

[5] https://www.weather.gov/hfo/prod_questions
[6] https://www.weather.gov/hfo/prod_questions

beginning to fail. Historically, the NWS Honolulu office has issued RFWs state-wide, across the entire island chain, and often times winds have not exceeded the 20 mph threshold on every island. All of these points result in KIUC needing access to more granular weather data so that it can more accurately and timely determine actions that may need to be taken to prevent its infrastructure from causing a wildfire. Figure 2 depicts the historic occurrence of RFWs in the leeward side of the service area from 2008 through 2023[7].

Figure 2. Red Flag Warnings by Year/Month 2008-2023



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[7] Iowa State University Environmental Mesonet, https://mesonet.agron.iastate.edu/plotting/auto/?_wait=no&q=171&opt=state&station=PHFO&state=HI&_ugc_state=HI&ugc=HIZ203&c=single&phenomena=FW&significance=W&cmap=Blues&_r=t&dpi=100&_fmt=png

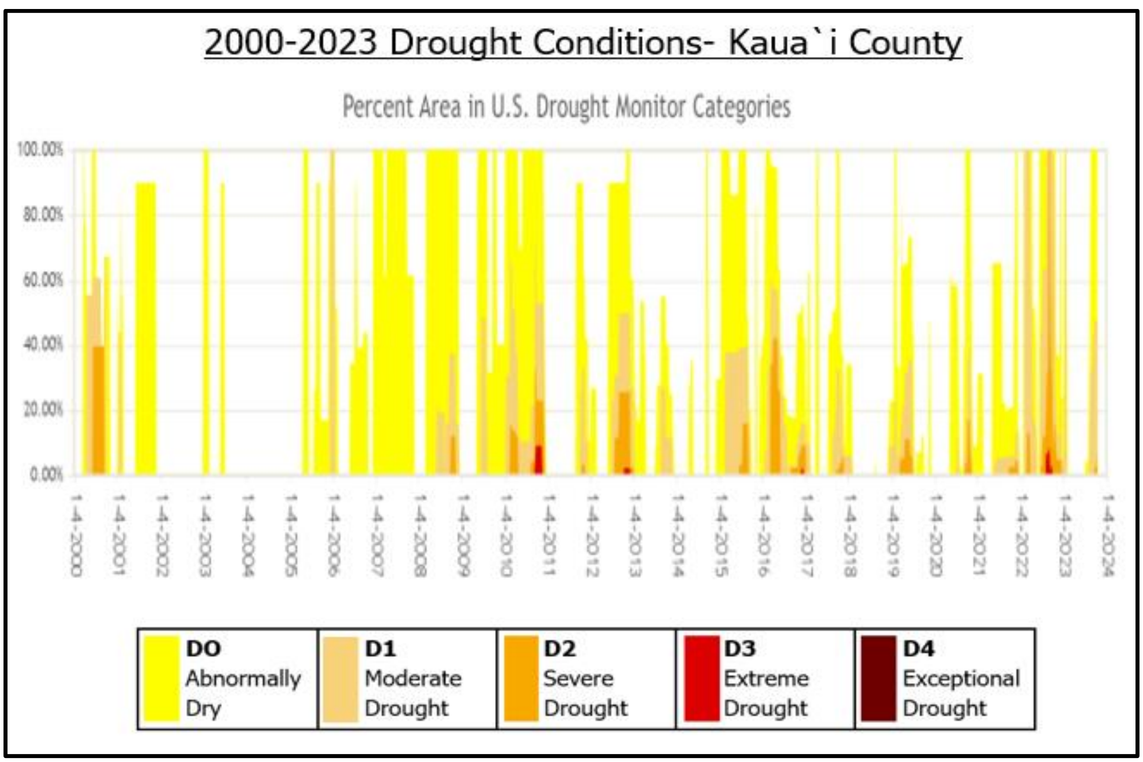
2.1.3 Drought

The U.S. Drought Monitor[8] depicts the location and intensity of drought conditions across the landscape. The system uses five categories: Abnormally Dry (D0), which are areas that may be going into or are coming out of drought, and four levels of drought, from D1 to D4.

- D1: Concerns about fire danger increase; pasture and crop growth is stunted; irrigation from reservoir water restricted; declining water levels; voluntary water restrictions; reservoir levels are depleted in high elevations.
- D2: Fire danger is high; pasture conditions are very dry/poor; cattle health is poor; coffee bean, sugar cane crops struggle; reservoir levels are low; springs are dried up; mandatory water restrictions.
- D3: Fire spread rapidly; outdoor burn bans; water hauled for livestock; cattle culls; sugar cane production limited; trees dry and drop leaves; water production reduced.
- D4: Cattle die, cattle conception rates are reduced; hunting and hiking areas may be closed; specialty crops and orchard mortality; surface water severely impacted.

Records going back to the year 2000 show drought conditions for Kaua`i County range from "None" to "D3-Extreme Drought" (Figure 2). D4-Exeptional conditions were not found in the sample date range.

Figure 3. Historic Drought Conditions



[8] https://www.drought.gov/states/hawaii/county/Kauai

2.1.4 Vegetation Encroachment

Vegetation encroachment is a constant challenge on Kaua`i, since there are no winter seasons where vegetation growth slows or ceases. Vegetation encroachment is continual and requires significant attention and investment to maintain. Although there are many challenging species that grow in and around KIUC rights of way (ROW), Albizia trees present an especially challenging scenario. Otherwise known as *Falcataria Moluccana*, Albizia have been in Hawai`i for over a century and are widespread on Kaua`i. Known as the fastest-growing tree in the world, the albizia tree can spread rapidly to dominate its surroundings. A young albizia can grow 20 feet in its first year and continue to grow 10 feet per year. With their fast growth rate and shallow roots, the Albizia trees are a major nuisance and cost to KIUC's vegetation management efforts and a hazard to the transmission and distribution system. This species of tree is invasive, and does not fully develop, which leads to weak and brittle wood. Seemingly healthy limbs can fail without warning; a phenomenon known as "sudden limb sheer". Since they can grow to 200 feet in height, their branches pose a serious risk to the power lines and power poles. All of these aspects contribute to albizia being very expensive and dangerous to remove.

2.1.5 Tree Mortality

Trees and tree limbs account for 33% of the outages in Kaua`i County. Since many portions of KIUC's distribution system are located in wooded or heavily treed areas, any tree, either live or dead, is considered a potential threat to the electric system if it is within striking distance of the power lines. Electric utilities that investigate the actual causes of outages often find that the failure of branches and trees is a significant component of the tree-related outage category[9].

In 2023 the Coconut Rhinoceros beetle has been discovered on Kaua`i. This invasive insect has cut palm populations in half on other Pacific Islands. Their occupation has the potential to decimate the palm species and damage several other fruit trees. Also, as of December 2018, both strains of *Ceratocyctis* fungi which cause Rapid Ohia Death have been confirmed to exist on the island of Kaua`i.

2.1.6 Wind Loading

Trade winds create consistently moderate and pleasant weather throughout the year with 5-15 mph winds that blow from the northeast. Because the trade winds are so consistent, many trees can be seen growing with the trade winds. Less frequently, the winds shift and blow from the south and west ("Kona winds"), resulting in relatively more outages due to vegetation being blown against their normal growth pattern, which can more easily cause limbs to break.

The hurricane season in the Pacific officially begins each year on June 1 and ends on November 30, however tropical cyclones can and do occur year round[10]. The last major hurricane to

[9] NRECA Vegetation Management Manual
[10] https://www.nhc.noaa.gov/aboutcphc.php

impact Kaua`i was Iniki in September of 1992[11]. More common are tropical storms, which are slightly weaker than hurricanes.

2.1.7 Hardware Corrosion

The iron atoms in steel will readily oxidize in the presence of oxygen. If kept dry, and within humidity levels between around 30 to 50 percent, a thin surface layer of iron oxide, referred to as "stable rust", will form and to a large degree protect the steel. Conversely, standing water and high, relative outdoor humidity accelerates corrosion, leading to a prevalence of hydrated iron oxide, also known as "cancerous rust". This is due to an increased exposure of atmospheric pollutants such as salt and man-made compounds that are distributed through pooling dew, condensation, and rainwater. Warm outdoor temperatures and higher relative humidity allow more water vapor to be present and increases the rate of corrosion. Kaua`i is a bit more humid than Maui and O`ahu due to its rainfall, with averages between 65% and 75% relative humidity. Salt spray from the ocean is the primary cause of the corrosion problem. While this is found primarily along the immediate shoreline, the issue of accelerated corrosion is also found many miles inland and on the top floors of tall structures. The catalyst for the accelerated corrosion of steel in this circumstance is not airborne salt, but airborne chloride ions. In Florida, Hawai`i, and other coastal regions, these free ions are found anywhere from three to eleven miles from the shoreline, with areas like Cape Canaveral and Honolulu exhibiting some of the most extreme examples of this condition.

2.1.8 Wood Pole Rot

The wet and humid conditions on Kaua`i are damaging to wood as well as steel. Wood poles can decay prematurely due to moisture intrusion. To combat this, KIUC are incorporating advanced pole testing technology that enables line workers to assess the condition of each pole quickly and accurately, and prioritize replacement based on its remaining service life (additional information in Section 5.4). Fiberglass poles, which are immune to the damaging effects of a wet climate, are being used to replace wood poles in select areas.

2.2 Key Risk Consequences

The aforementioned risks have many possible consequences should one or more become a contributing factor for an ignition. The list below outlines some of the worst-case scenarios, the prevention of which is the impetus for the development of this WMP:

- Personal injuries or fatalities to the public, employees, and contractors,
- Damage to public and/or private property,
- Damage and loss of KIUC-owned infrastructures and assets,
- Impacts to reliability and operations,
- Damage claims and litigation costs, as well as fines from governing bodies,

[11] https://www.nhc.noaa.gov/data/tcr/CP1992_Seasonal_TCR.pdf

- Damage to KIUC's reputation and loss of public confidence, and
- Negative public opinion of the power industry in general.

2.2.1 Wildfire History and Outlook

Hawai`i Wildfire Management Organization (HWMO) and the University of Hawai`i Cooperative Extension conducted a thorough compilation and analysis of statewide firefighting records, which revealed that wildfires are increasing in frequency, size, and severity on all islands[12]. Over 98% of wildfires are human caused; the remaining 2% are caused by lightning. Whether ignited intentionally or by accident, the origin point of most fires are along roads and human-access areas.

The El Niño – Southern Oscillation cycle (ENSO) is a recurring irregular oscillation between warm and cool patterns which can have a strong influence on weather across the Pacific basin, and directly affects rainfall distribution in the tropics. Rainfall during the developing El Niño is especially heavy from August through October. By November, a rapid decline in rainfall begins, sinking to well below average by February of the following year. A composite of Total Acres Burned (TAB) during ENSO events reveals that a large TAB is likely to occur from spring to summer in the year following an ENSO event[13]. The level of these dry conditions depends on the intensity of the El Niño event, though widespread dryness across the Hawaiian Islands is typical. There can be an increased chance of wildfires, especially from January through March as a result of these anticipated dry conditions.

Vegetation grows rapidly on Kaua`i's subtropical climate, but also dries rapidly during periods of drought. The buildup in fuels may be considerable. Fountain grass, false staghorn fern, and brooms edge provide excellent fuel beds for ignition and quick fire spread. Invasive highly flammable grasses have also been key to fueling the more intense wildfires. For several decades, the demise of plantation agriculture has contributed to increasingly frequent large wildfires on fallow farmland where grasses, haole Koa and other easily burned vegetation supplanted sugar cane, pineapple, and cattle ranching pastures.

2.2.2 Landscape Wildfire Risk Map

KIUC has contracted with Athena Intelligence[14] to develop a relative wildfire risk map of the service area for its Wildfire Mitigation Plan. The process leverages artificial intelligence, or machine learning, to produce a conditional risk ranking across the landscape. The result is a five-class index that classifies conditional risk into values ranging from Very Low to Very High, as shown in Figure 4. Additional detail maps are provided in Appendix C.

Each ranking is a composite profile, the results of various governmental, academic, and industrial datasets that describe the conditions that are either conducive or resistant to wildfire.

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[12] E. Pickett, Hawaii Wildfire Management Organization

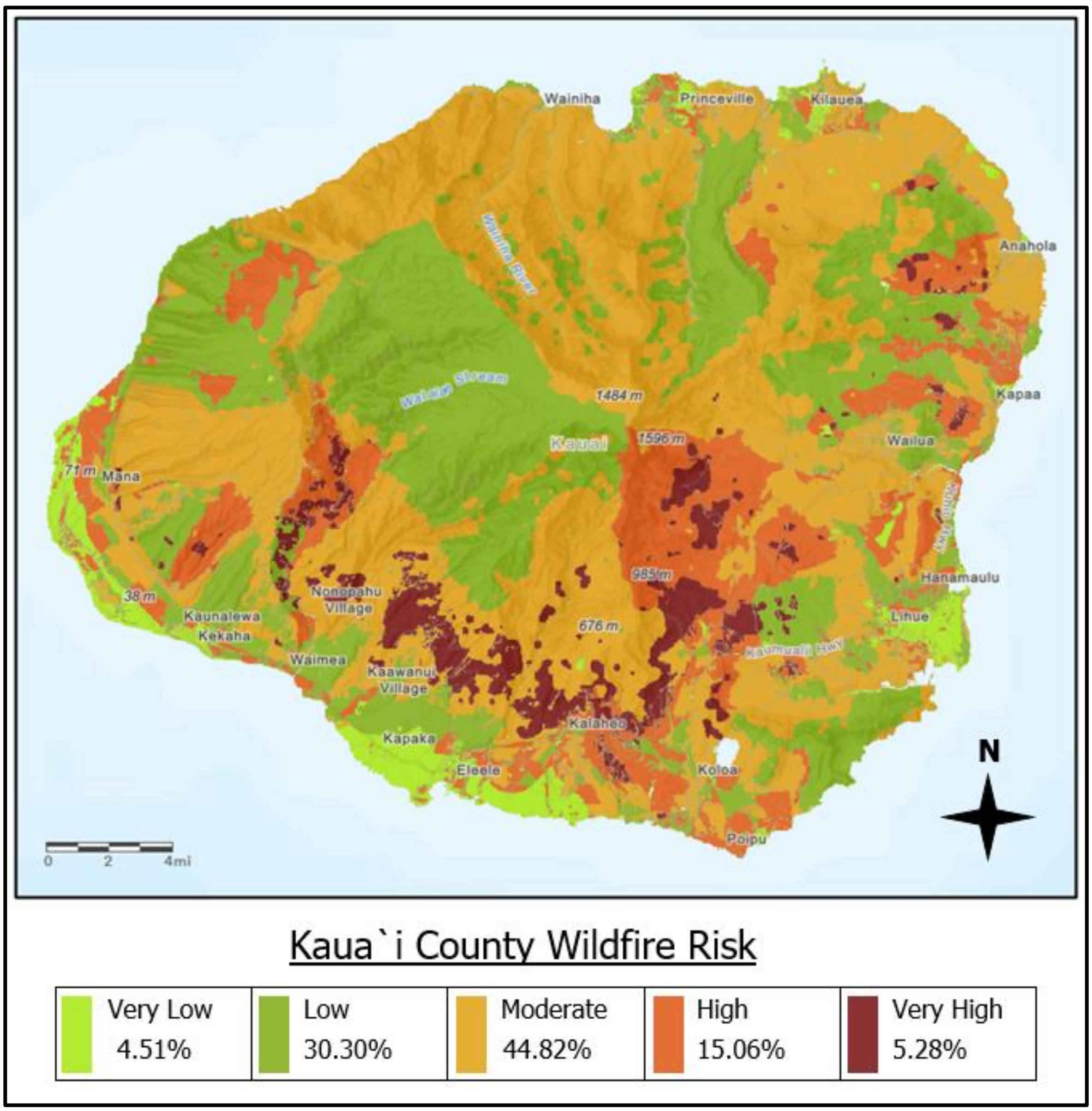
[13] Pau-Shin Chu, Weiping Yan and Francis Fujioka, International Journal of Wildland Fire, *Fire-climate relationships and long-lead seasonal wildfire prediction for Hawaii* (2002)

[14] https://www.athenaintel.io/

This historical information includes terrain, vegetation, topographic, asset locations, and climate data, including degree days, winds, rainfall, and temperature. The analysis also comprises agency data on wildfires (flame length, intensity, wildland proximity) and damage reports on structures and specific attributes contributing to damage. Every aspect of the land, the fuel, the behavior of fire, and ignition events is used in the analysis.

The raw data is then indexed, calibrated, and recaptured through a proprietary scoring system. The raw data, the indexes, and the derivatives are analyzed using artificial intelligence to project the future conditional risk and the probabilities of asset damage.

Figure 4. Kaua`i County Combined Wildfire Risk-Athena Intelligence



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3 Fire Prevention Strategies

The proposed wildfire prevention strategies can be categorized into five main mechanisms that align with KIUC's best practices. Together, the five components create a comprehensive wildfire preparedness and response plan with a principal focus on stringent construction standards, fire prevention through system design, proactive operations and maintenance programs, and specialized operating procedures and staff training.

- **Design & Construction:** KIUC's design and construction consist of system, equipment, infrastructure design and technical upgrades. These practices aim to improve system hardening to prevent contact between infrastructure and fuel sources to minimize the risk of KIUC's systems becoming a source of ignition.
- **Inspection & Maintenance:** KIUC's inspection and maintenance strategies consist of diagnostic activities as well as various methods of maintaining and ensuring all equipment and infrastructure is in proper working condition.
- **Operational Practices:** Comprised of proactive day-to-day actions taken to mitigate wildfire risks and to ensure preparedness in high-risk situations, such as dry and windy climatological conditions.
- **Situational & Conditional Awareness:** This component consists of methods to improve system visualization and awareness of environmental conditions. The practices in this category aim to provide tools to improve the other components of the plan.
- **Response & Recovery:** This strategy consists of KIUC's procedures in response to wildfire, de-energization, and other emergency events. This component aims to formalize protocols for these situations for thorough and efficient communications, emergency response and recovery.

3.1 Preventative Strategies and Programs

The components described above have several strategies and programs, most of which have already been implemented. Some are situational, and are not limited to any timeframe, or are scheduled to be completed over several years, while others are in the evaluation or proposal stages. Table 2 provides a summary of KIUC programs and activities that support wildfire prevention and mitigation.

Table 2. Mitigation Programs/Activities

DESIGN AND CONSTRUCTION
Underground distribution lines where feasible
Supervisory Control and Data Acquisition (SCADA)
Modernized recloser control
Tree wire in select areas
Bare Secondary Wire Replacement Program
Underground construction on new residential developments
Substandard pole replacement
Fiberglass crossarms
Fiberglass poles in select areas
INSPECTION AND MAINTENANCE
Infrared inspections of substation and line equipment
UAV assisted inspection (pilot program)
Biannual aerial transmission line inspections
Monthly detailed substation inspections
T&D LiDAR inspection (pilot program)
Formal asset inspection program
Transmission system aerial patrols
"Thor's Hammer" pole testing and diagnostics tool pilot program (2024)

Table 2. Mitigation Programs/Activities (continued)

OPERATIONAL PRACTICES
Wildfire protection recloser settings during red flag warnings
Hazard tree removal policy
Supervisory Control and Data Acquisition (SCADA) on substation breakers
Fire suppression equipment on line trucks
Formal vegetation management program (2024)
Vegetation cycle trim
Tree assessment for customers
Community outreach / tree planting guide
Selective Isolation
Wildfire awareness information for members
SITUATIONAL AWARENESS
Contractor/staff safety tailboard meetings prior to field work
Utility-owned weather station network
Lightning detection dashboard
TempestOne Weather Monitoring Ops Console
RESPONSE AND RECOVERY
Outage response communication protocols
Line patrols prior to re-energization
Crisis Communication Plan (CCP)
Emergency Preparedness and Recovery Plan (EPRP)

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4 Fire Mitigation Construction

4.1 Overhead vs Underground Conductor

The benefits of overhead conductor is that it is much less costly and much easier to troubleshoot following an outage event, making restoration times shorter compared to underground construction.

The downside to overhead conductor is its susceptibility to contact from foreign objects such as wildlife, vegetation, and equipment. These impacts can be minimized by using "tree-wire" which is explained later in this section.

The undergrounding of distribution lines improves reliability in high wind events and functions as an effective mitigation against wildfire. Most new residential subdivision developments are built using UG construction. KIUC has approximately 330 miles of 12.47kV UG distribution line on its network. While there are many benefits to UG infrastructure, UG lines don't prevent all outages, and can have their own unique maintenance problems. In rural areas, underground service may be unaffordable, as it requires longer stretches of line per customer and can cost from 4 to 14 times more to install than overhead conductor[15].

4.2 Bare Wire Secondary Replacement Program

Bare-wire secondary conductor is an outdated construction standard no longer installed by KIUC. Because these facilities have no fused protection, un-insulated secondary lines are a potential source for ignition when coming into contact with vegetation.

KIUC has made proactive efforts to identify, locate and replace the bare wire secondary conductor remaining on its distribution system. When planning replacement projects, the priority is to upgrade circuits with higher customer density, with additional consideration given to areas with elevated wildfire risk.

All bare wire secondary on KIUC's system is targeted to be replaced by 2025.

4.3 Circuit Recloser Upgrade

A recloser is an automatic, high-voltage electric overcurrent protective device. When a fault condition occurs, the recloser will generally close back multiple times to detect if the problem still exists. If the problem was temporary, the recloser automatically resets and restores power[16].

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[15] https://www.power-grid.com/td/underground-vs-overhead-power-line-installation-cost-comparison/#gref
https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/infrastructure/electric-reliability/undergrounding-program-description#Perspective

[16] https://www.eaton.com/content/dam/eaton/products/medium-voltage-power-distribution-control-systems/reclosers/recloser-definition-information-td280027en.pdf

As part of its commitment to providing safe and reliable utility services to KIUC's membership, KIUC has replaced older oil circuit reclosers (OCRs) with three-phase solid dielectric vacuum units, three-phase magnetic actuated vacuum units, or SF6 Gas automatic vacuum units that provide better line protection and minimize fault energy, reducing the ignition potential to start a wildfire.

Electronic Vacuum reclosers provide fast, low energy interruption with long contact life, are oftentimes programable, and do not require the high maintenance demands associated with traditional recloser devices which contain oil and utilize electromechanical mechanisms.

4.4 System Monitoring - SCADA

KIUC has retrofitted all distribution and transmission breakers, as well as downline reclosers, with supervisory control and data acquisition (SCADA) functionality to monitor circuit conditions providing early notification and faster response to system abnormalities. Connecting electronic reclosers to the operations center via SCADA also allow the operators to make recloser settings adjustments remotely, without having to dispatch personnel to the field, thus improving response time and safety.

4.5 Tree Wire

Tree wire, or covered overhead wire, consists of the conductor and the extruded covering (conductor shield, low-density inner layer, and protective outer layer). Tree wire allows closer spacing of the conductors, resists abrasion from foreign contact, withstands temporary contact from tree branches and other ground points without creating a ground fault. It is also UV stable and is tracking and abrasion resistant. KIUC has installed a small amount of tree wire on down-fuse distribution lines in heavily treed areas for service reliability reasons. While there are safety benefits to tree wire, this material takes more time to construct, maintain, and repair compared to bare wire. Another challenge with the use of tree wire is the difficulty protection equipment has in detecting line-down events. This can result in a covered downed line remaining energized more often and for longer periods than bare conductor, creating increased wildfire risk. In summary, tree wire benefits reliability for temporary vegetation contact but could pose a safety risk for fallen conductor.

5 Infrastructure Inspections and Maintenance

One of KIUC's primary missions is safely providing reliable power that is fairly and competitively priced. This requires continual maintenance and improvement of our electrical system, which includes vegetation maintenance and control within utility corridors and right-of-ways (ROWs). Managing these areas necessitates balancing stewardship with sustainability while working in accordance with all applicable local, state, and federal laws.

Recognizing the hazards of equipment that operate high voltage lines, KIUC maintains a time-based maintenance program for distribution, transmission, and substation equipment which plays an essential role in wildfire reduction. The following sections outline the inspection practices for the utility, while Table 3 provides a high level overview of the inspection schedule for all assets.

Table 3. Inspection Program Summary

ASSET CLASSIFICATION	INSPECTION TYPE	FREQUENCY
57.1kV Overhead Transmission Lines	Aerial Inspection	Annually
	Wood Pole Testing/Detailed Inspection	Every 8-10 years
12.47kV Overhead Distribution Lines	Wood Pole Testing/Detailed Inspection	Every 8-10 years
Substations	Routine Inspection	Monthly

5.1 Distribution Inspection and Maintenance Plan

KIUC's Inspection and Maintenance Plan is based on sound industry principles and practices and is designed to provide safe and reliable service. The purpose of the Maintenance Plan is to 1) provide procedures, instructions and guidance to the field inspectors and line workers who perform inspections and patrols of KIUC assets, and 2) outline criteria to prioritize inspection findings and schedules to complete repairs and replacements based on the deficiency and its potential impact on safety and reliability, considering various factors.

The inspector will document the condition of the overhead systems recording defects, deterioration, violations, safety concerns, or any other conditions that require attention. Focus of the inspection shall be on any hazards that could affect the integrity of the system or the safety of line workers and the general public.

Maintenance work shall be based on a three-tier rating system to prioritize and resolve safety and reliability issues. Inspection tags will be prioritized and issued as follows:

- **Priority # 1** – Immediate hazard:

Conditions that may affect the integrity of the system or present a hazard to workers or the general public. Priority #1 tags will be responded to **immediately** and appropriate action taken until the hazardous condition is remedied.

- **Priority # 2, 2.1, 2.2** – Non-emergency repair condition:

Conditions that require maintenance which can be scheduled to maintain the integrity of the system. Priority #2 tags will be prioritized by urgency and will be scheduled to have appropriate repairs made to correct the condition within two years where practicable. If the Priority Level 2 issue is located in a High-Risk zone and poses a potential fire risk, correction of the deficiency will occur within 3 months.

- **Priority # 3** – Minor repair condition:

Conditions that do not require near-term remediation as they do not pose a material safety, reliability, or fire risks. Priority #3 tags will be submitted by the inspector with the time interval recommended. In the judgment of the Transmission & Distribution (T&D) Department, work will be scheduled to be completed within five years.

Figure 5. Deficiency Risk Assessment Matrix[17]

Reliability Impacts ↑					
	Component Failure Could lead to system failure	**Priority 2.2** Action required 13-24 months	**Priority 2.1** Action required 4-12 months	**Priority 2** Wildfire Risk 0-3 months	**Priority 1** Immediate Action Required
	Component Failure Low risk to system	**Priority 3** Action required within 60 months	**Priority 2.2** Action required 13-24 months	**Priority 2.1** Action required 4-12 months	**Priority 2** Wildfire Risk 0-3 months
	Potential Component Failure	**Priority 3** Action required within 60 months	**Priority 3** Action required within 60 months	**Priority 2.2** Action required 13-24 months	**Priority 2.1** Action required 4-12 months
		No Impact	**Minor Impact**	**Moderate Impact**	**High Impact**
Safety Impacts →					

5.2 Overhead Asset Inspection Program

KIUC and its contractors shall report hazards found during daily field work as part of the OH inspection program, which is performed in concert with the vegetation line clearance operations. During the course of routine line clearance operations, all spans of OH primary conductor will be inspected regardless of the presence of vegetation. While on each job site, contractors should also inspect secondary and service conductors.

Tree crew personnel are to identify obvious safety hazards on KIUC's distribution and transmission overhead facilities that could pose a threat to the general public as well as our employees and contracted workers. Hazards that present an imminent threat to personal or public safety must be resolved immediately.

[17] The color codes in this figure are correlated to the Polehawk severity and Thor Pole Health Index(PHI) test results. Since immediate action is required for Priority 1 items, no testing is warranted, and therefore no color code results since Priority 1 items have a high safety impact and the components could lead to system failure. In other words, time is of the essence to mitigate Priority 1 items. KIUC's goal is to meet the timelines in this matrix once KIUC has had an opportunity to resolve the items from Polehawk and Thor. In other words, these programs are new to KIUC's processes and KIUC recognizes that current manpower and budgets are inadequate to meet these timelines as KIUC ramps up these pilot projects. KIUC expects to be meeting these timelines in this matrix by 2027.

5.3 Transmission Line Routine Inspections

Line inspections consist of helicopter, vehicle, foot, and all-terrain vehicle patrols to examine KIUC transmission assets including poles, crossarms, conductors, and related equipment. Much of the system is quite remote and quite difficult to access. Aerial inspections occur once or twice per year to assess vegetation-to-conductor clearances and equipment corrosion issues.

Visual aids assist with evaluating and detecting potential damage to above-ground components during ground-based inspections. Inspectors look for visible signs of defects, structural damage, broken hardware, abnormally sagging lines, and wildlife contacts. Any anomalies found are addressed based on the severity of the defect. The ground-based transmission line inspections also provide an evaluation of ROWs and access roads. The inspection information accumulated informs planning and scheduling of future maintenance to avoid major faults and reduce ignition potential.

5.4 Pole Management Program

To maintain KIUC's 16,700+ utility poles, a formal Pole Management Program was initiated with the goal to inspect approximately 12.5% of the poles per year. The pole inspections are performed by KIUC line workers on a planned basis to determine whether they have degraded below National Electric Safety Code (NESC) design strength requirements with safety factors.

Beginning in 2024, KIUC incorporated the Thor Poletest™ advanced pole inspection technology into the pole management program. KIUC line workers can quickly assess timber pole condition in one minutes using a special hammer connected to a geoscope with gyroscopic sensors and a sensor hub. The sensor hub is Bluetooth-enabled and quickly transmits data to the THOR Poletest™ app and interactive portal, which provide geospatial visualization and data insights on the pole's condition. This method is non-damaging to the pole, is faster, and more accurate than traditional sounding and intrusive testing.

Poles are also visually evaluated for the condition of cross arms, hardware, and attached equipment, as well as the condition and clearances of the wire spans. This information is recorded in a pole condition database which tracks inspection and ongoing replacement work.

Pole replacements are prioritized based on the level of structural defect, whether the pole is transmission or distribution, and if the pole contains equipment such as a transformer or recloser. Wood poles that pass inspection are re-tested with a target interval of 8 years.

5.5 Substation Inspections

The maintenance plan provides for regular detailed inspections of all KIUC substations. Qualified personnel use prudent care while performing inspections, following all required safety rules to protect themselves, other workers, the general public and the reliability of the system. These inspections involve a thorough look at the system to confirm that there are no structural or mechanical deficiencies, hazards, or tree trimming requirements. Inspections include bi-annual transformer oil testing, infrared thermography (IR), yard cleaning, DC system load testing, battery testing, and maintenance planning.

5.6 Circuit Recloser Inspection

The circuit recloser are not inspected on a regular cycle but do receive inspection and testing when circuits are temporarily de-energized for unrelated reasons. At that time a visual device inspection as well as a counter read verification is performed.

5.7 Geographic Information Systems (GIS) Mapping

An electric distribution utility uses a network of physical facilities to provide electric power and energy to customers connected to those facilities throughout a geographical area. Each component of the distribution system, as well as each meter, has a physical location and associated data. To plan, construct, maintain, operate, and manage the electric distribution network, KIUC develops, maintains, manages, and utilizes this GIS data.

KIUC geolocates outage information from the NISC outage management system (OMS). Future fine tuning of the cause code assignments will help operations to identify tree related outages versus general equipment damage due to storms or corrosion. This would allow KIUC to create a "heat map" of vegetation issues which assists in prioritizing VM work on the distribution system. It is a long-term goal to integrate this GIS technology into the VM program.

5.8 Unmanned Arial Vehicle LiDAR/Infrared Inspections

KIUC has recently begun using Unmanned Aerial Vehicles (UAVs) to inspect company-owned solar facilities. The vehicles are fitted with high-resolution cameras as well as infrared (IR) thermographic cameras to identify and record issues with the arrays.

Due to the cross-county alignment of many of KIUC T&D lines, the co-op is also considering integrating UAVs into the asset inspection program. The height and voltage levels of the equipment as well as conditions on the ground limit how close an inspector can approach without de-energizing the lines. Since UAV inspection does not require de-energization, bucket trucks, foot patrols, or climbing structures, inspectors can assess crossarms, pole tops, hardware, or any equipment not easily visible from the ground. Other potential uses include post storm inspection, trouble-shooting momentary outages and a general enhancement of the situational information gathering ability of the operations department. A visual record of ROW conditions can be created during the inspection process enabling KIUC to audit tree work and monitor changes in vegetation profiles.

In addition to in-house UAV inspections, KIUC will be performing UAV inspection using Light Detection and Ranging (LiDAR) technology of the entire T&D system to assess vegetation clearance distances from conductors and facilities.

5.9 Infrared Thermography

Hundreds of different pieces of equipment may be found in an electrical distribution system. They start with generation, high voltage transmission, switchyards and substations, and end with service transformers, switchgear, breakers, meters, local distribution. Abnormal heating associated with high resistance or excessive current flow is the main cause of many problems in these electrical systems.

Infrared cameras create images from heat, rather than visible light. But thermal imagers don't just make pictures from heat; they make pictures from the minute differences in heat between objects. Because excess heat is a sign of increased resistance, infrared technology is well suited to locating defects in connections and components. Thermal imagers provide critical information to avoid system failures and fires by enabling inspectors to see the heat signatures associated with high electrical resistance long before the circuit becomes hot enough to cause an outage or damage.

KIUC inspects its substation equipment monthly using infrared technology. Distribution lines are inspected by outside contractors on an annual basis. Figure 7 below shows an example of infrared inspection equipment in use.

Figure 6. Infrared Inspection

6 Vegetation Management

KIUC has been providing safe and reliable power to the residents of Kaua`i County since 2002. Vegetation management is a key component of reliability. We believe that trees are an important part of what makes Kaua`i County a beautiful place to live. To this end, KIUC is developing a formal VM program intended to maintain safe and reliable electric facilities, provide safety for the public and for utility workers, and mitigate fire throughout the service area. When work is well planned and completed, the overall impact of the desirable vegetation on the ROW is reduced, and the neighboring landowners, the motoring public, and the wildlife that uses the ROW for nesting and foraging will benefit. While we recognize and appreciate the beauty of trees, the three main benefits to tree trimming in ROW areas are; safety, reliability, and affordability.

6.1 ROW Maintenance Program

Contracted VM crews are responsible for trimming trees and vegetation around the energized power lines, utility-owned fiber optic cables, utility poles, and regulators to obtain the minimum required clearance with due regard to current and future tree health and symmetry. Beginning in 2024, KIUC adopted a Vegetation Management Plan which provides guidance for contract line clearance tree crews clearing and pruning trees year round. They re-clear the cooperative's power line ROW on each circuit systematically on a five year cycle.

KIUC maintains over 970 miles of OH ROW to minimize interruptions of services to our customers. This includes not only the maintenance of the hardware, conductors, and poles, but also trees and other vegetation that threaten to fall or grow into the powerlines. ROW maintenance is focused on providing recommended clearances between vegetation and conductors, and not on maintaining growth along the ground, below the powerlines, since grasses and bushes, and even short trees, are well outside of the required clearance area.

Vegetation to Conductor Clearance

Interfering tree limbs and falling trees or branches are a significant cause of power outages for KIUC. Since conductors move horizontally and vertically based on dynamics such as operating temperature, wind, and loading, clearance is evaluated from all possible conductor positions. Effort will be made to reduce trees, tree parts, and growth points beneath the wires and any dead or dying trees which may contact the wires.

KIUC has evaluated the vegetation characteristics and growth rates of the predominant species along the OH lines to determine the years of growth until they contact the conductor. The goal at the time of trimming is to achieve 10 feet of clearance from the conductor on distribution lines and 25 feet from transmission lines. Distribution lines are also cleared 15 feet above and 10 feet below the power lines.

6.3 Mechanical and Chemical Control Options

VM work may include chemical, manual, or mechanical techniques. The choice of control option(s) is based on effectiveness, environmental impact, site characteristics, worker and public safety concerns, and economics. KIUC chooses the mechanical technique as the preferred method of maintenance.

6.4 Site Preservation

Care shall be taken to preserve the natural ground covers where possible. Rivers, streams, beaches, natural drainage area, ponds, etc. shall not be disturbed.

6.5 Trimming Standards

Trees are trimmed or removed for safety, reliability, and compliance with National Electric Safety Code (NESC)[18] requirements. KIUC's contracted tree trimming crews are also governed by "Best Management Practices-Utility Pruning of Trees[19]" which is a companion publication to the (ANSI) A300 Part 1: Tree, Shrub, and Other Woody Plant Maintenance. This standard is intended as a guide for federal, state, municipal, and private authorities including property owners, property managers, and utilities. Contracted tree workers are expected to adhere to this standard when pruning trees near electric facilities. Correct tree trimming should promote tree growth away from electrical conductors, provide longer periods of clearance, and reduce future work. The pruning, and/or branch removal will be specific to the species of tree.

6.6 Hazard Trees

Electric utilities that investigate the actual causes of outages often find that the failure of branches and trees is a significant component of the tree-related outage category[20]. A subset of Danger Trees[21], a Hazard Tree is defined as any tree or portion of a dead, rotten, or decayed tree that may fall into or onto the overhead lines, or trees leaning toward transmission and distribution facilities.

KIUC removes hazard trees that could potentially grow, fall, or bend into the lines. The selection of trees for removal is based upon the condition of the tree, the stability of the ground around the tree, tree species, and any other defects that would cause the tree to be unstable and more likely to fall into the lines. If a tree is healthy and stable, it is usually not designated for removal, even if it is tall enough to strike the electric facilities if it should fall.

KIUC makes it a priority to remove hazard trees as soon as they are identified. Trees determined to be a potential threat shall be removed, leaving the stump as close to the ground

[18] The National Electric Safety Code, Vegetation Management Section 2IS.A.I
[19] The International Society of Arboriculture
[20] NRECA Vegetation Management Manual
[21] As defined by ANSI 300 Part 7 standards

as possible and treated to prevent resprouting. If removal is not feasible, the crown is reduced below the neutral wire and/or utility-owned fiber optic cable.

6.7 Service Orders/Hot Spots

This program involves the quick response to emergency situations. An example of this would be reports of arcing and sparking where trees are contacting the high voltage lines. Once reported, a service order would be generated and a tree trimming crew would be assigned to address the issue.

6.8 Controlling Incompatible Vegetation

In addition to patrols by KIUC field staff observing and reporting on incompatible uses and encroachments, KIUC makes efforts to educate public and private landowners about incompatible vegetation that can pose risks if planted under or near conductors by providing tree planting guidance on the KIUC website. KIUC believes that the member/customer plays an important part in our ability to address problems that may pose a threat to our power supply system. Customer input, combined with regularly scheduled ROW maintenance, helps to ensure that our power system is as reliable as possible.

6.9 Safety Standards

All personnel performing VM work on or near KIUC facilities or ROWs shall follow approved safety guidelines and procedures and comply with all applicable governmental safety and health regulations, and the safety and health provisions of their contracts.

KIUC follow two important standards for tree worker safety:

- OHSA 1910.269: Qualified electrical workers
- ANSI Z133.1 (2006): Safety requirements

Contract line clearance tree workers must meet the requirements of these standards as well as any other applicable federal, state, or local laws, codes, or regulations.

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7 Operational Practices

This chapter outlines KIUC's existing fire mitigation efforts and identifies new processes and programs KIUC may employ moving forward. Some of these programs are multi-year and programmatic, while others are situational and based on environmental conditions such as Red Flag Warnings. KIUC continues to explore new technologies and approaches to determine their ability to reduce the risk of ignition and improve system reliability. KIUC has initiated several new programs, such as infrared inspections, a situational awareness tool, and reconductoring projects. KIUC makes ongoing efforts to update its practices as new information emerges and adopts improved strategies as appropriate.

7.1 Situational Awareness and Assessment Tools

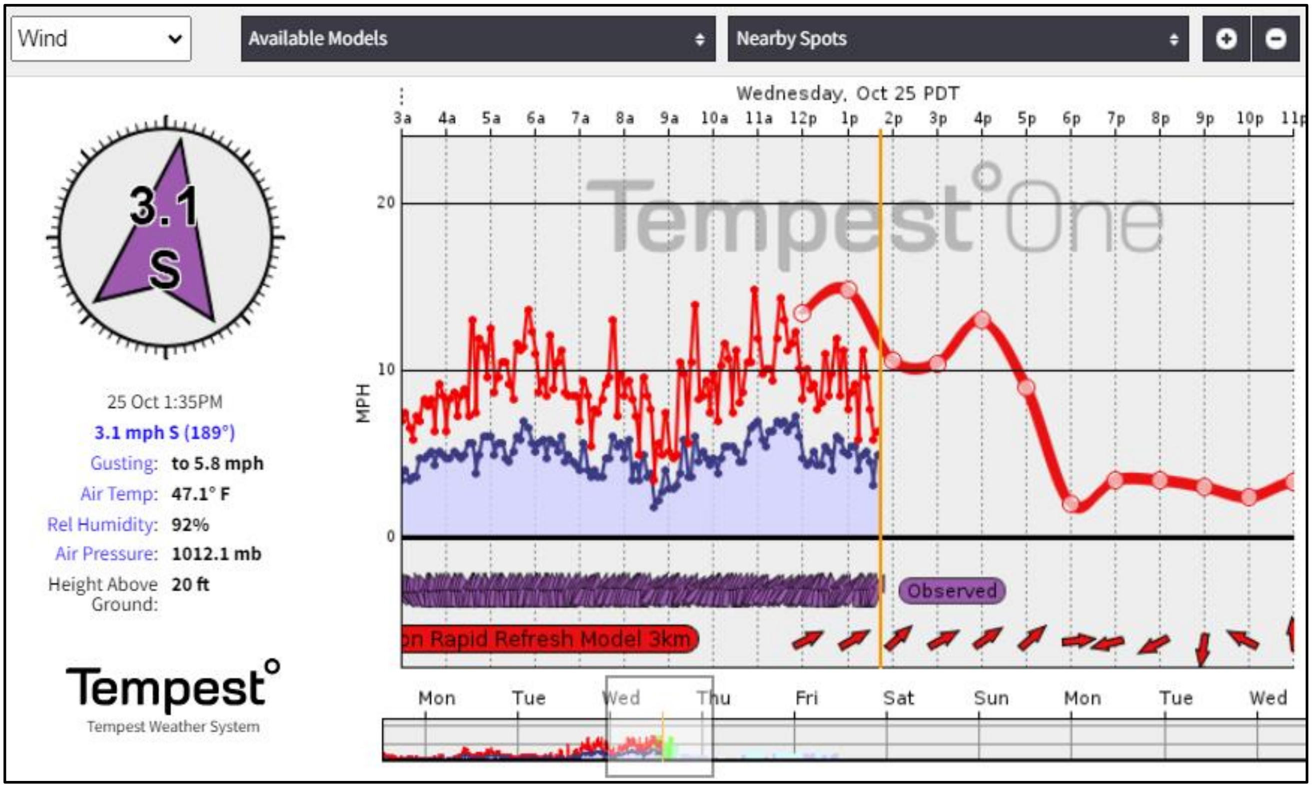
"Situational assessment" is the process by which current operating conditions are determined. "Situational awareness" (SA) is the understanding of the working environment, which creates a foundation for successful decision-making and the ability to predict how it might change due to multiple factors.

KIUC uses all resources at its disposal to monitor evolving fire weather, fuel, and other climatological conditions that may lead to fire events. It evaluates information such as real-time field observations, weather station data, ongoing wildfire reporting and other resources. Based on available information, KIUC appropriately schedules work crews, adjusts equipment settings, and prepares for fire conditions as needed.

7.1.1 Tempest Weather Stations (Pilot Project):

KIUC has purchased, and will install in 2024, Tempest weather stations at various locations throughout the service area where reliable weather data is currently unavailable. These stations are monitored remotely and provide temperature, wind data (average speed, gust, direction) barometric pressure, precipitation, and relative humidity (Figure 7). These stations are part of the DSAT program described above.

Figure 7. Tempest Weather Station Report



7.2 Red Flag Warning Protection Schemes

A Red Flag Warning (RFW) is issued by the National Weather Service (NWS) when critical fire weather conditions are forecast or met. These warnings call attention to limited weather conditions of importance that may result in extreme wildfire risk. The type of weather patterns that can cause an RFW include low relative humidity, strong winds, dry fuels, the possibility of dry lightning strikes, or any combination of the above. A RFW can be issued during an on-going event or if the fire-weather forecaster has a high degree of confidence that RFW criteria will occur within 24 or more hours.

KIUC has developed a standard operating procedure (SOP) for RFWs including post-fault patrol protocols. KIUC will implement the procedures outlined the SOP to determine settings for select protection equipment.

The purpose of this practice is to align circuit protection schemes with existing fire threat conditions. While these measures are intended to reduce the risk of ignition, re-energization patrolling times will increase significantly and may lead to prolonged customer outages.

7.3 Red Flag Warning Operational Protocols

When the System Operators receive notice that an RFW has been issued, the following guidelines are followed:

- Communication with Kaua`i Emergency Management Agency (KEMA) (who is the link to all County agencies including Kaua`i Fired Department (KFD)) to gather information on any specific area of concern
- Communicate any operational changes to State, County, and membership (external)
- Communicate any operational changes to KIUC employees (internal)
- Postpone T&D scheduled work and patrol high risk areas
- Consider helicopter flight to get real-time awareness of high-risk areas that may have large amounts of "fuel" below or near overhead lines
- Cancelling normally scheduled switching programs during the RFW period

During a RFW, work in the affected area is performed only when the following conditions are met:

- Work is required for emergency repair or restoration,
- Crew has fire suppression equipment accessible in the immediate area of work that would facilitate an immediate response to an ignition,
- Local weather conditions, terrain, and surrounding vegetation would permit crews to extinguish a fire resulting from the work being performed, and
- Crews will be on alert for fires while working or passing through high risk areas and report fires or signs of fire to the emergency services or operations center as soon as feasible.

7.4 Power Isolation

A Power Isolation (PI) preemptively de-energizes power lines during high wind events combined with hot and dry weather conditions. When considering this type of operation, KIUC examines the impacts on fire response, water supply, public safety, and emergency communications.

KIUC considers the external risks and potential consequences of a PI while striving to meet its main priority of protecting the communities and customers we serve. They include, but are not limited to:

- Potential loss of water supply to fight wildfires due to loss of production wells and pumping facilities.
- Negative impacts to emergency response and public safety due to disruptions to the internet and mobile phone service during periods of extended power outages.
- Loss of key community infrastructure and operational efficiency that occurs during power outages.
- Medical emergencies for members of the community requiring powered medical equipment or refrigerated medication. Additionally, the lack of air conditioning can negatively impact medically vulnerable populations.
- Negative impacts on medical facilities, fire, police, and schools.

- Traffic congestion resulting from the public evacuation in de-energized areas can lengthen response times for emergency responders.
- Negative economic impacts from local businesses forced to close during an outage.
- The inability to open garage doors or motorized gates during a wildfire event.

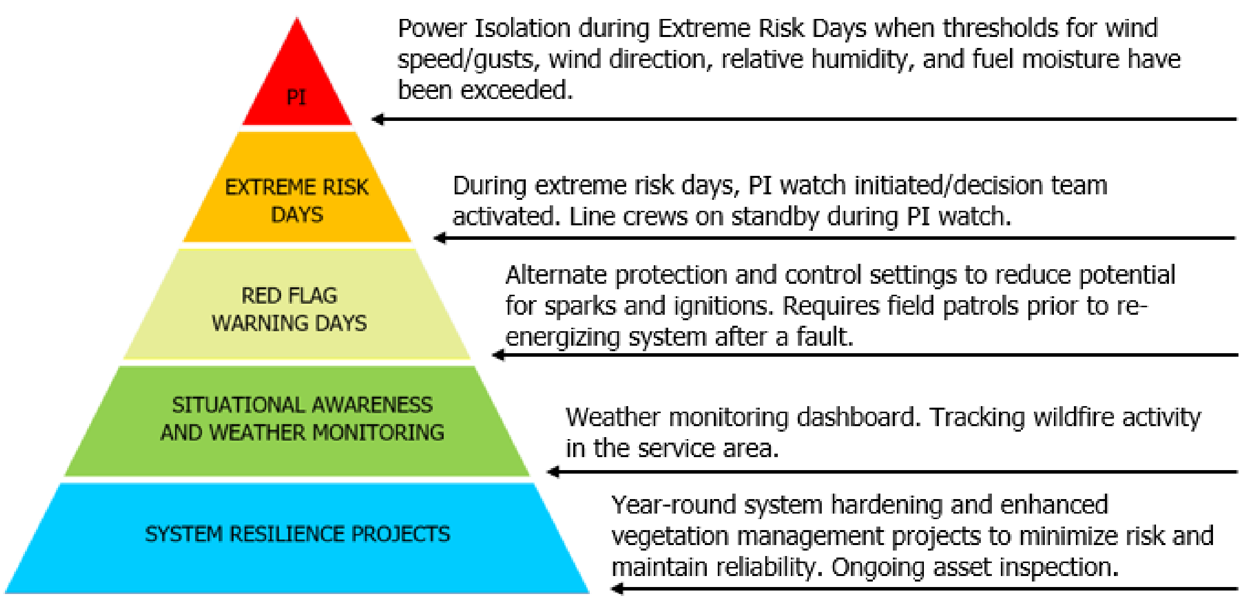
The risks and potential consequences of initiating a PI are significant and extremely complex. Based on the above considerations, KIUC reserves the option of implementing a PI when conditions dictate. While KIUC believes the risks of implementing a PI far outweigh the chances of its electric overhead distribution system igniting a catastrophic wildfire, the PI provides a last resort tool and another mitigation option.

On a case-by-case basis, KIUC will consider de-energizing a portion of its system in response to a known public safety issue or response to a request from an emergency management agency. Any isolation of the distribution system is performed in coordination with key local partner agencies, but the final determination is made by KIUC.

7.5 Wildfire Readiness Framework

KIUC's enterprise-wide approach to wildfire readiness is comprised of the conditional levels depicted in Figure 7 below. These readiness protocols are intended to harden the system overall, create situational awareness within and outside the service area, implement conservative protection and control settings during critical fire weather conditions, deploy additional resources when needed, activate the PI Decision Team, and finally, in a worst-case scenario, preemptive de-energization of portions of the system. In situations that could lead to a PI or other unplanned outage, KIUC will convene a PI Decision Team made up of KIUC department heads and senior leadership. This group will work together to ensure that appropriate and actionable information reaches all concerned stakeholders.

Figure 8. Wildfire Readiness Framework



7.6 Power Isolation Notification Protocols

KIUC management understand that poor communication during an emergency can directly contribute to injury, property damage, and even death. KIUC are developing protocols to ensure that appropriate and actionable information reaches all concerned stakeholders.

KIUC plans to begin notifying members approximately 72 to 48 hours in advance of a potential PI event with additional alerts approximately 24 hours before power is shut off. Announcements will be made once the power has been deenergized, throughout the outage, and when power has been restored. There may be situations that prevent KIUC from providing advance notice. The actual onset of extreme weather conditions and other circumstances beyond the co-op's control may impact coordination and notification efforts.

Information regarding PI or other unplanned outages will be shared with stakeholders as soon as feasible to allow for the maximum amount of time to prepare and respond. During these times KIUC will utilize the following channels of communication:

- Kaua`i Emergency Management Agency,
- Communications companies attached to or collocated with KIUC infrastructure,
- News media outlets serving the affected areas,
- KIUC mass email distribution list,
- KIUC's social media accounts (Facebook),
- Prominent postings on KIUC's website (affecting 500 members or more),
- Talking points provided to KIUC member services representatives,
- Direct calls to key accounts and identified special needs members, and
  KIUC's online "Outage Center".

7.7 Workforce Training

KIUC believes that an important line of defense against the ignition of wildfires is a well-trained and alert workforce. To that end, KIUC has fostered a culture of fire awareness and prevention by developing a set of work rules and complementary training designed to minimize the likelihood that KIUC's facilities or field work are the source of ignition for a fire.

Management has taken a proactive role in ensuring that all employees are aware of fire-threat weather conditions and requires that field workers immediately report and document the knowledge of any fires within KIUC's service territory; and document all known information related to any fire within the service territory regardless of cause. KIUC's training program for employees incorporates regulatory changes, weather updates, situational awareness, and partnerships with cooperating agencies.

Beginning in 2024 and annually thereafter, field staff will be:

- Trained on the content of the WMP,
- Trained in proper use and storage of fire extinguishers,

- Required, during pre-job briefings, to discuss the potential(s) for ignition, environmental conditions, and the closest fire extinguisher and other fire abatement tools,
- Required to report all ignition events to management for follow-up, and
- Encouraged to identify deficiencies in the WMP and bring such information to management.

7.8 Community Outreach

Defensible Space is often defined as an area around a home or outbuilding, where the flammable vegetation is modified and maintained to slow the rate and intensity of an advancing wildfire. In practice, this is an area with a minimum of 30 to 100 feet around a structure that is cleared of flammable brush or vegetation. This area would also provide room for firefighters to work to protect a structure from advancing wildfire as well as protect the forest from a structure fire.

KIUC encourages its customers to take proactive measures to safeguard their homes from wildfire danger and to prepare for emergency events through proactive messaging via social media, news releases, mass email and the quarterly Currents magazine. To help create an awareness of fire danger in the service area, and what homeowners can do to minimize it, KIUC will maintain current information on prevention and mitigation on its website.

KIUC also proactively encourages its members to sign up for the co-op's Special Needs Member list. This list is used for preemptive communications when a RFW is possible.

Customers will also be directed to links to the following safety information on the KIUC website:

- Line Safety
- Call before you dig
- Home electrical safety checklist
- Safety quiz
- Storm Sense
- Downed power line safety
- Defensible Space Guidelines for Homeowners

8 Plan Implementation and Monitoring

This chapter identifies KIUC management responsibilities for plan implementation and oversight. In addition to a robust mitigation strategy, KIUC has developed performance metrics to help analyze and monitor the co-op's wildfire mitigation efforts over time. These metrics aim to provide a data-driven evaluation to determine the effectiveness of various programs and identify areas for possible improvement. This chapter also identifies the methods for identifying plan deficiencies and the quality control and audit process for the inspection, maintenance, and VM programs.

8.1 Plan Accountability

The following outlines the various roles of KIUC staff.

- The **CEO** directs management staff responsible for operations, engineering, finance, and information technology.
- The **COO** determines when and how to notify outside agencies in cases of wildfire emergency events.
- The **COO** oversees the electric system's design.
- The **COO** is responsible for implementing the plan in general. Staff will be directed as to their roles and responsibilities.
- The **COO and senior staff** are responsible for monitoring and auditing the targets and performance metrics specified in the WMP to confirm that plan objectives are met.
- The **COO and Communications Manager** review all emergency-related communications before distribution.
- The **Communications Manager** responds to the news media and general membership.
- The **KEMA Liaison**, or designated staff, communicates with first responders, health agencies, and communication providers.
- The **KEMA Liaison** or designated staff communicates with the Offices of Emergency Management.
- The **T&D Manager** oversees the contracted VM operations and inspections.
- The **Energy Services Supervisor** communicates with key accounts prior to planned outages.

8.2 Monitoring and Auditing of the WMP

The WMP will also be included as a discussion item on the agenda of regularly scheduled management meetings. Reports of the WMP's progress and risk reduction impacts will be developed annually and circulated to appropriate utility staff to generate collaborative discussions.

At the end of each fire season, KIUC assesses company-wide wildfire mitigation efforts. All known fire starts within KIUC's service territory are tracked. Lessons learned or new best practices are defined and incorporated into the next iteration of the WMP. The plan is updated to reflect changes in the environment, technology, regulations, or any other factors that may render portions of the WMP obsolete.

8.3 Identifying Deficiencies in the WMP

The COO is responsible for ensuring that this WMP meets all public agency guidelines to mitigate the risk of KIUC's assets becoming the source or contributing factor of a wildfire. Staff responsible for assigned mitigation areas have the role of vetting current procedures and recommending changes or enhancements to build upon the strategies in the WMP. Either due to unforeseen circumstances, regulatory changes, emerging technologies or other rationales, deficiencies within the WMP will be sought out and reported to the CEO in the form of an updated WMP on a yearly basis.

The COO or their designee will be responsible for spearheading discussions on addressing any plan deficiencies and collaborating on solutions when updating the WMP. At any point in time when deficiencies are identified, the COO or their delegates are responsible for making the appropriate policy adjustments. KIUC staff and qualified stakeholders are encouraged to bring any potential deficiencies to the attention of the COO. The COO, along with the appropriate staff, will evaluate each reported deficiency, and if determined to be valid, shall record the deficiency for further action.

8.4 Performance Metrics

KIUC has selected several metrics (Table 5) intended to gauge the effectiveness of the various programs and strategies outlined in the WMP as well as evolving fire-weather conditions within the service area.

The annual tracking of these metrics will help identify circuits most susceptible to unexpected outages, time-of-year risks, and the adequacy of the VM program and asset inspection schedules. KIUC will reassess its operations and identify areas for improvement as more data becomes available and refine the WMP as needed.

As this plan is in the initial stage of implementation, relatively limited data is on hand. However, as results of the programs become evident and additional data is collected, KIUC will identify areas of its operations that will require a different approach, as well as methods that are working towards the goal of eliminating KIUC asset related ignitions. The selected metrics, as with other aspects of the plan, will likely evolve in future iterations of KIUC's WMP. Following any wildfire event, regardless of the cause, management will review and discuss what worked and what could have been done differently with staff in a roundtable discussion to improve best practices moving forward.

Table 4. Performance Metrics

Metric	Rationale	Measure of Effectiveness
Red Flag Warnings in the service area	Used to adjust annual variation in criteria	NA-Indication of overall threat level for each fire season
Number of times system is in "Fire-safe Mode"	Correlation of recloser settings to ignition events during RFWs	Reduction of ignitions during Fire-safe mode
Number of system-related ignitions: During RFW	Effectiveness of the "Fire-safe" protocols	Reduction or no material increase
Number of system-related ignitions: Non-RFW	Effectiveness of the mitigation plan	Reduction or no material increase
System Average Interruption Frequency Index (SAIFI)	Assess system hardening & overall reliability	Lowering of SAIFI Score

8.4.1 Fire Ignition Metric

At the end of emergency events, KIUC conducts a debrief and prepares an after-action report that identifies operations or procedures to correct or improve during future responses. KIUC will invoke the actions in its EPRP. For purposes of this metric, a system-related fire ignition is defined as follows:

- A KIUC facility was associated with the origin of the fire.
- The fire was self-propagating and of material other than electrical and/or communication facilities.
- The resulting fire traveled greater than one linear meter from the ignition point.
- KIUC has knowledge that the fire occurred.

8.5 Quality Assurance and Quality Control

KIUC is in the process of enhancing its system-management programs to assure that, to the extent possible, the co-op's overhead system, facilities, and equipment are unlikely to become a fire ignition source. These programs generally encompass inspection and maintenance functions and have been modified to focus on minimizing the probability that damaged or aging facilities will provide the ignition source for a fire. Inspection and repair of the KIUC distribution systems have particularly intensified in the high-risk zones depicted in Figure 5.

In addition, KIUC has implemented Quality Assurance and Quality Control standards and programs throughout its service territory, with a special focus in high risk areas. These proactive programs are designed to identify potential structural and mechanical problems before they fail.

Where the facility in need of repair is owned by a party other than KIUC, e.g., by a communication infrastructure provider, KIUC will issue a notice to repair to the facility owner and work with the facility owner to ensure necessary repairs are completed promptly. KIUC's operational goal, subject to permitting requirements and other exigencies and conditions, is to complete all facility and equipment repairs on an annual basis. Annual adjustments to the High Fire-Threat map, if any, will be reflected in the scope of the Quality Assurance and Quality Control program.

Last, KIUC closely monitors cost-effective emerging technologies, legislative and regulatory changes, and evaluates the effectiveness of the plan following each PI or wildfire event to ensure best practices are utilized for the safety of staff, facilities, members, and the community.

8.6 Inspection QC Process

KIUC routinely coordinates and monitors the effectiveness of inspections with Operations staff, its vegetation and tree trimming contractors, and any company with whom KIUC has contracted for pole inspections to ensure that all system inspections are completed in a timely manner and meet or exceed the requirements established by law. Any deficiencies identified through this process are addressed prior to the start of the fire season for the next year.

Appendix A: Definitions

Circuit Breaker: An electrical switch designed to protect an electrical circuit from damage caused by overcurrent/overload or short circuit. The basic function is to interrupt current flow after protective relays detect a fault.

Danger Tree: A danger tree is any tree, on or off the right of way, that can contact electric power lines. A **danger tree** may be completely healthy and intact, or it may be sick or dead. Even a healthy tree could sustain damage in a severe storm and impact nearby power lines, thus the potential for "danger."

Distribution System: The final stage in the delivery of electric power carrying electricity from the transmission system to individual consumers. The KIUC distribution system includes 12.47Kv lines not tied to generation facilities.

Defensible Space: An area around a structure, either natural or manmade, where material capable of causing a fire to spread has been treated, cleared, reduced, or changed to act as a barrier between an advancing wildfire and the structure. In practice, it is defined as an area a minimum of 30 feet around a structure that is cleared of flammable brush or vegetation.

Fire Hazard: "Hazard" is based on the physical conditions that give a likelihood that an area will burn over a 30 to 50-year period without considering modifications such as fuel reduction efforts.

Fire Risk: "Risk" is the potential damage a fire can do, to the area under existing conditions, including any modifications such as defensible space, irrigation and sprinklers and ignition resistant building construction which can reduce fire risk. Risk considers the susceptibility of what is being protected.

Fire Season: 1) Period(s) of the year during which wildfires are likely to occur, spread, and affect resource values sufficiently to warrant organized fire management activities. 2) A legally enacted time during which burning activities area regulated by state or local authority.

Fire Weather Watch: A term used by fire weather forecaster to notify using agencies, usually 24 to 72 hours ahead of the event, that current and developing meteorological conditions may evolve into dangerous fire weather. A watch means critical fire weather conditions are possible, but not imminent or occurring.

Hardening: Modifications to electric infrastructure to reduce the likelihood of ignition and improve the survivability of electrical assets.

Hazard Tree: A specific type of danger tree that poses a greater likelihood of causing damage to electric power lines or equipment. In this case, the tree is structurally unsound and positioned in a way that it could fall onto conductors.

Landscape: Refers generally to the area of interest in a project or study and could refer to modeled or on-the-ground conditions.

Recloser: Recloser is a device that is used in over-head distribution systems to interrupt the circuit to clear faults. Automatic reclosers have electronic control senses and vacuum interrupters that automatically reclose to restore service if a fault is temporary. There are several attempts that may be made to clear and reenergize the circuit and if the fault still exists the recloser locks out. Reclosers are made in single-phase and three-phase versions and use oil or vacuum interrupters.

Red Flag Warning (RFW)[22]: A term used by fire- weather forecasters to call attention to limited weather conditions of importance that may result in extreme burning conditions. It is issued when it is an on-going event, or the fire weather forecaster has a high degree of confidence that Red Flag criteria will occur within 24 hours of issuance. The criteria for Red Flag events per the Honolulu Weather Forecast Office are:

- A Keetch-Byram Drought Index (KDBI) greater than or equal to 600,
- Relative humidity less than or equal to 45 percent, and
- Winds greater than or equal to 20 mph

Remote Automatic Weather Station (RAWS): an apparatus that automatically acquires, processes, and stores local weather data for later transmission to the GOES Satellite, from which that data is retransmitted to an earth-receiving station for use in the national Fire Danger Rating System.

Right-of-Way (ROW): The corridor of land under (and adjacent to) a transmission or distribution line.

Risk: A measure of the probability and severity of adverse effects that result from exposure to a hazard.

SCADA: SCADA is an acronym for Supervisory Control and Data Acquisition. SCADA generally refers to an industrial computer system that monitors and controls a process. In the case of the transmission and distribution elements of electrical utilities, SCADA will monitor substations, transformers, and other electrical assets. It is possible to control or reset some equipment remotely using SCADA.

Substation: Part of the electrical generation, transmission and distribution system, substations transform voltage from high to low, or the reverse, or perform any of several other important functions. Between the generating station and consumer, electric power may flow through several substations at different voltage levels. A substation may include transformers to change voltage levels between high transmission voltages and lower distribution voltages, or at the interconnection of two different transmission voltages.

22 Source: https://w1.weather.gov/glossary/index.php?word=Red%20Flag%20Warning

Transmission System: The bulk delivery of electrical energy from a generating site to an electrical substation. At KIUC, for line maintenance purposes, the transmission system is comprised of 57.1kV (sub-transmission) structures, and switches.

Unmanned Aerial Vehicle (UAV): An unmanned aerial vehicle, or drone, is a powered, aerial vehicle that does not carry a human operator, uses aerodynamic forces to provide vehicle lift, can fly autonomously or be piloted remotely. Typically mounted with high resolution camera, and/or infrared, LiDAR equipment.

Vegetation: Trees, shrubs, and any other woody plants.

Vegetation Management: A broad term that includes tree pruning; brush removal through the use of power saws and mowers; the judicious use of herbicides and tree growth regulators; hazard tree identification and removal; the implementation of strategies to minimize the establishment of incompatible species under and near power lines; and the control of weeds.

Wildfire: Also called wildland fire, an unplanned, uncontrolled fire in a forest, grassland, brushland or land sown to crops.

Wildfire Mitigation Plan (WMP): A comprehensive plan to reduce the threat and severity of wildfire within an electric utility's service area. Plans include the preventive strategies and programs adopted by the utility to minimize the risk of its facilities causing wildfires along with its emergency response and recovery procedures.

Wildlands*:* Forests, shrub lands, grasslands, and other vegetation communities that have not been significantly modified by agriculture or human development*. A more specific meaning for fire managers, used by the National Wildfire Coordinating Group (which coordinates programs of participating wildfire management agencies nationwide), refers to an area in which development is essentially non-existent (except for roads, railroads, power lines, and similar transportation facilities); structures, if any, are widely scattered.

Wildland Urban Interface (WUI): Line, area, or zone where structures and other human development meet or intermingle with vegetative fuels in wildlands.

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Appendix B: Acronym Glossary

ANSI	American National Standards Institute
BMP	Best management practices
CEO	Chief Executive Officer
COO	Chief of Operations
DSAT	Daily Situational Awareness Tool
EOC	Emergency Operation Center
FWW	Fire Weather Watch
FWZ	Fire Weather Zone
KV	Kilovolt
KWH	Kilowatt Hours
LDE	Line Down Event
MW	Mega Watts
MVCD	Minimum Vegetation Clearance Distance
NESC	National Electric Safety Code
NWS	National Weather Service
NF	National Forest
OH	Overhead
OEM	Office of Emergency Management
PI	Power Isolation
QA	Quality Assurance
QC	Quality Control
RAWS	Remote Automated Weather Station
RFW	Red Flag Warning
ROW	Right-of-Way
SCADA	Supervisory Control and Data Acquisition
SA	Situational Awareness
T&D	Transmission and Distribution
UAV	Unmanned Aerial Vehicle
UG	Underground

USFS	United States Forest Service
VM	Vegetation Management
WHP	Wildfire Hazard Potential
WMP	Wildfire Mitigation Plan
WUI	Wildland Urban Interface

Appendix C: Wildfire Risk Detail Maps

Figure 9. Waieli, Kehaha Detail Map

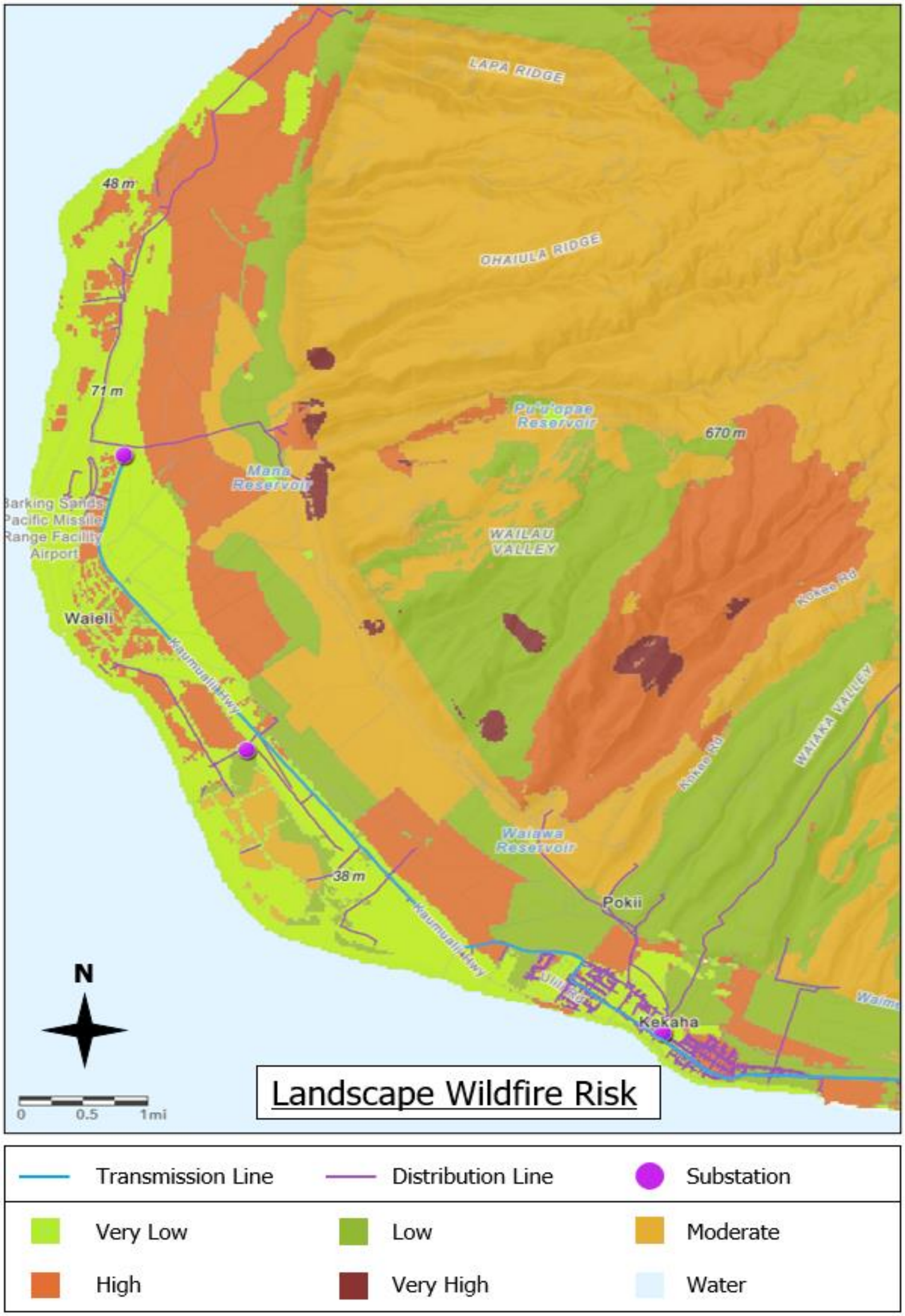

Figure 10. Waimea to Eleele Detail Map

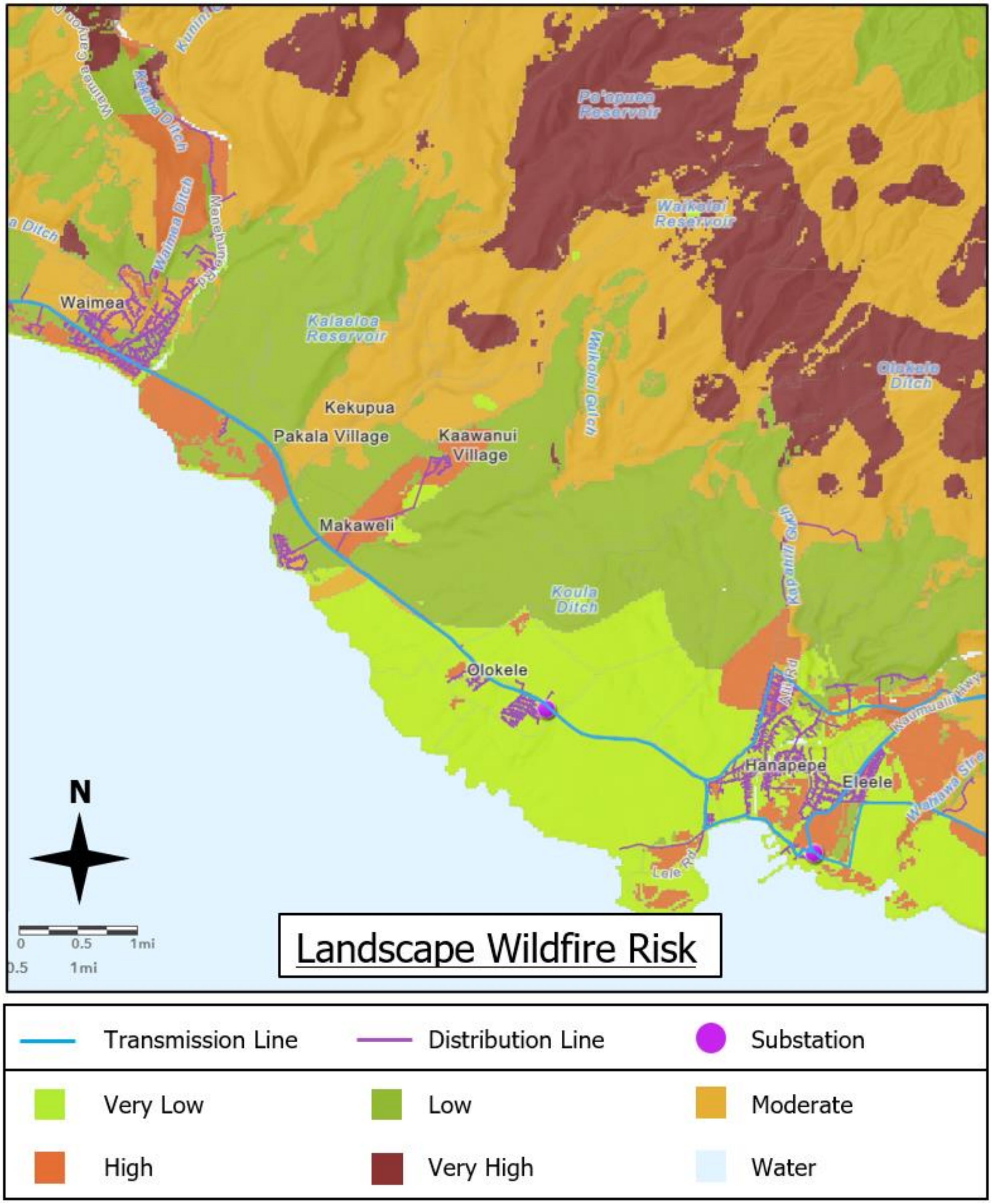

Figure 11. Kahaheo, Lawai, Omao, Koloa Detail Map

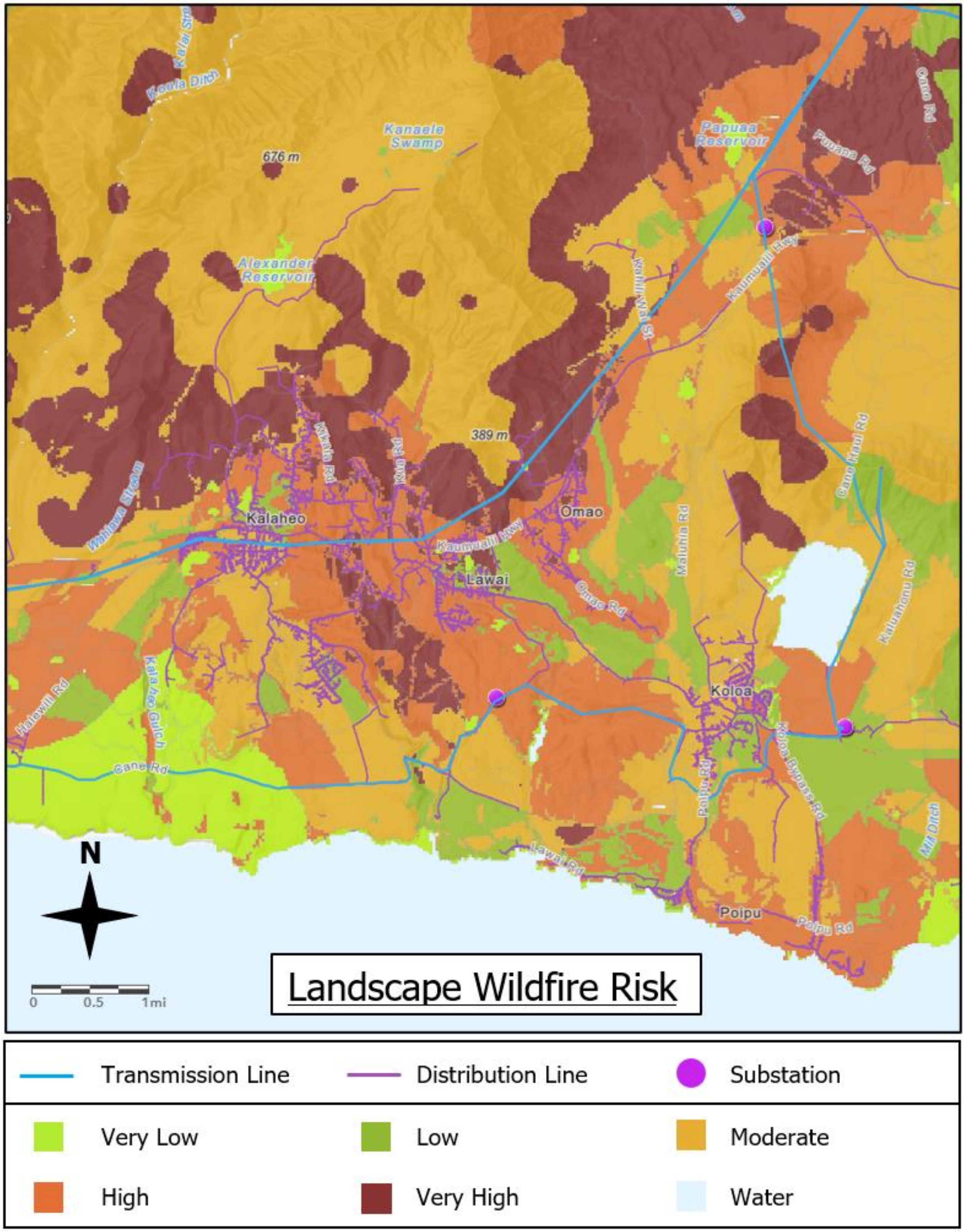

Figure 12. Koloa, Hanamaulu, Lihue, Detail Map

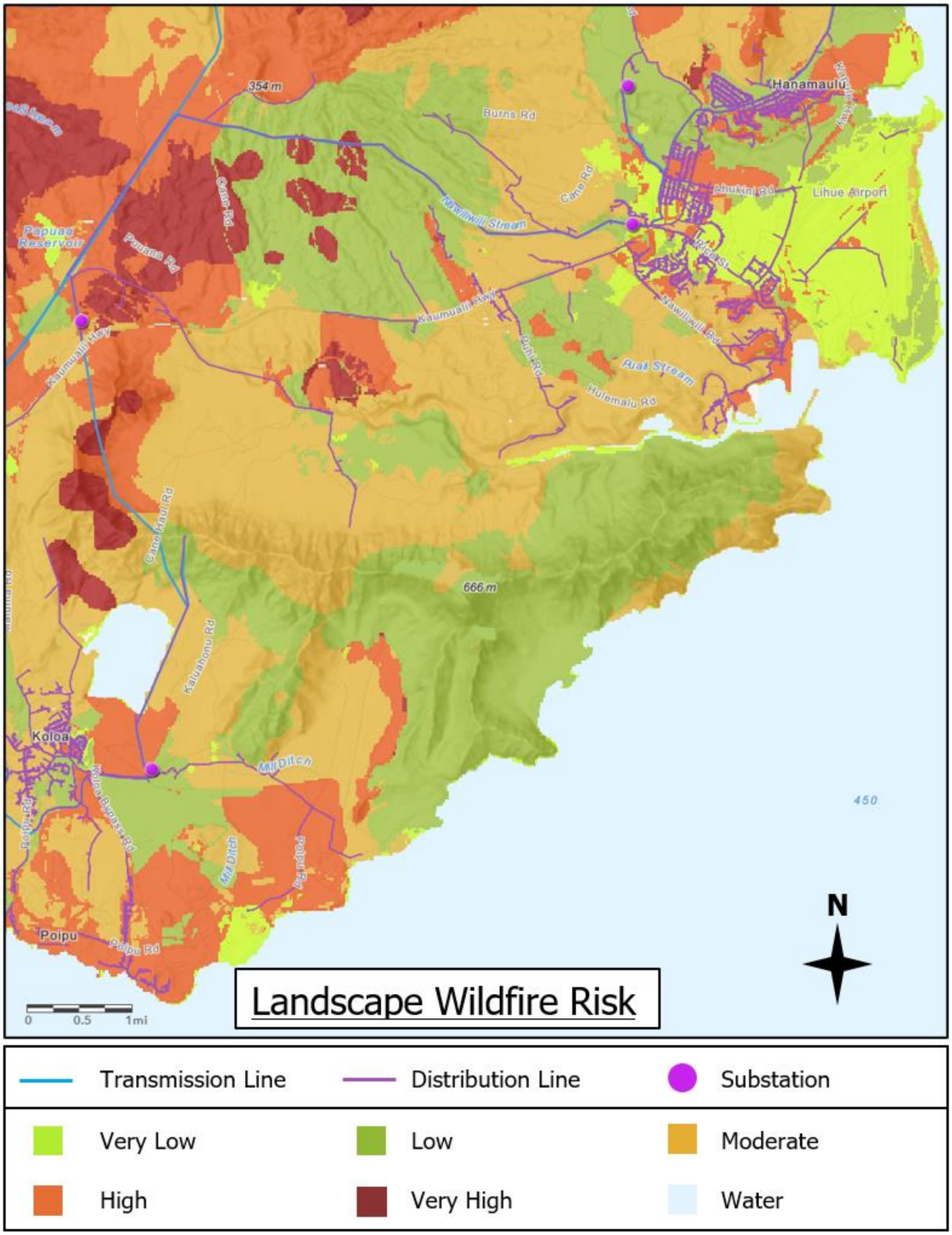

Figure 13. Wailua, Kapaa, Anahola Detail Map

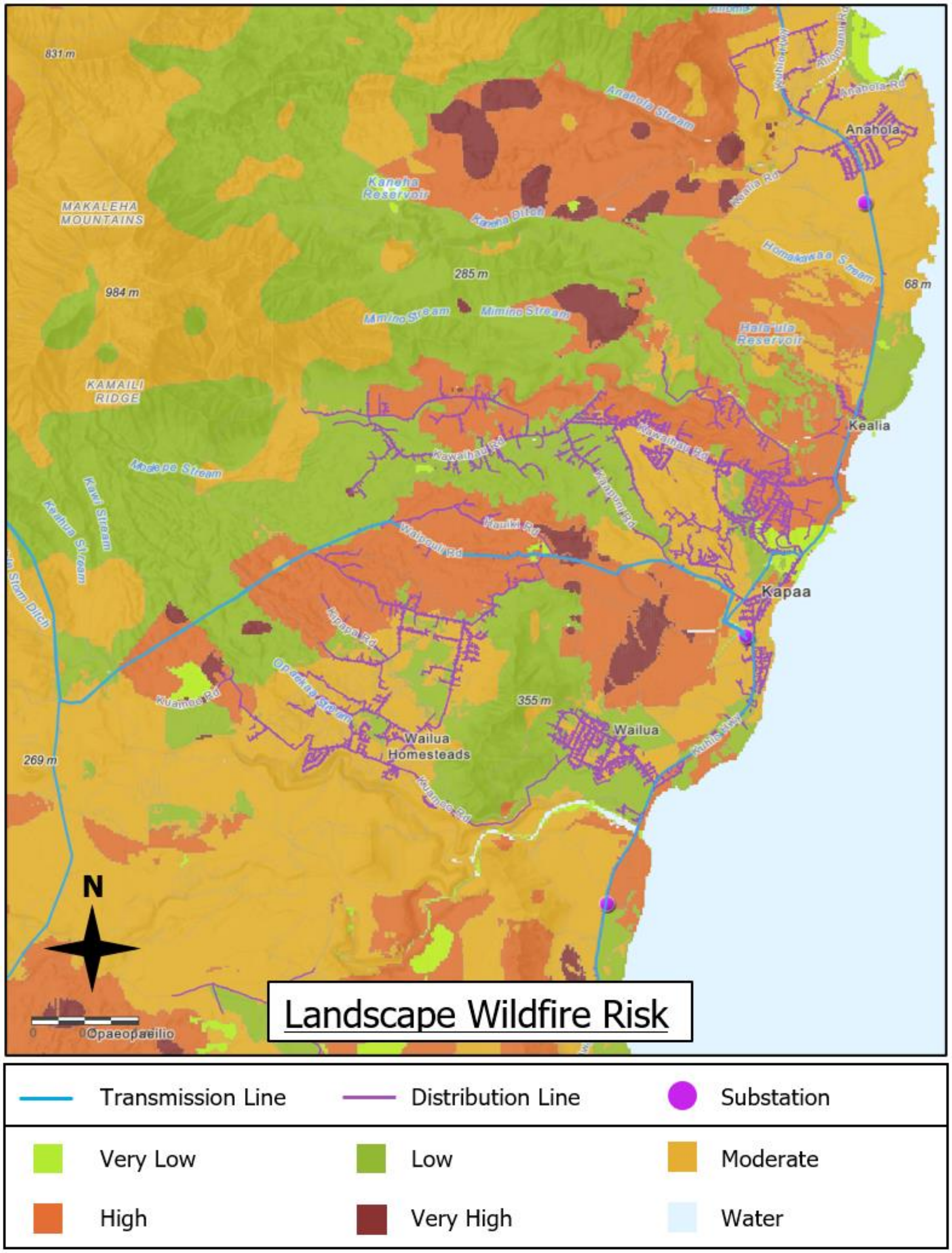

Figure 14. Anahola, Moloaa, Kilauea, Kalihiwai Detail Map

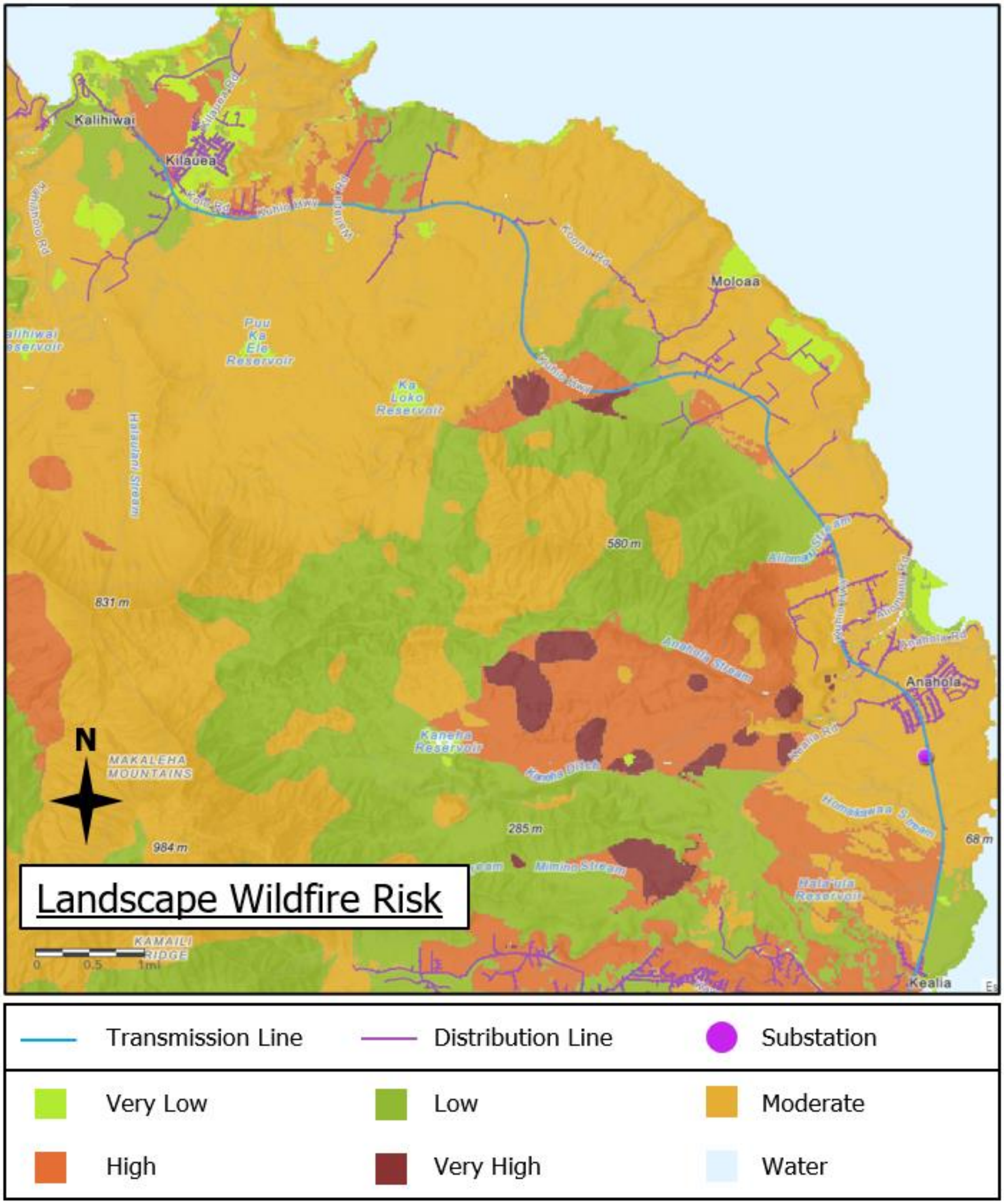

Figure 15. Princeville, Wainiha, Haena Detail Map

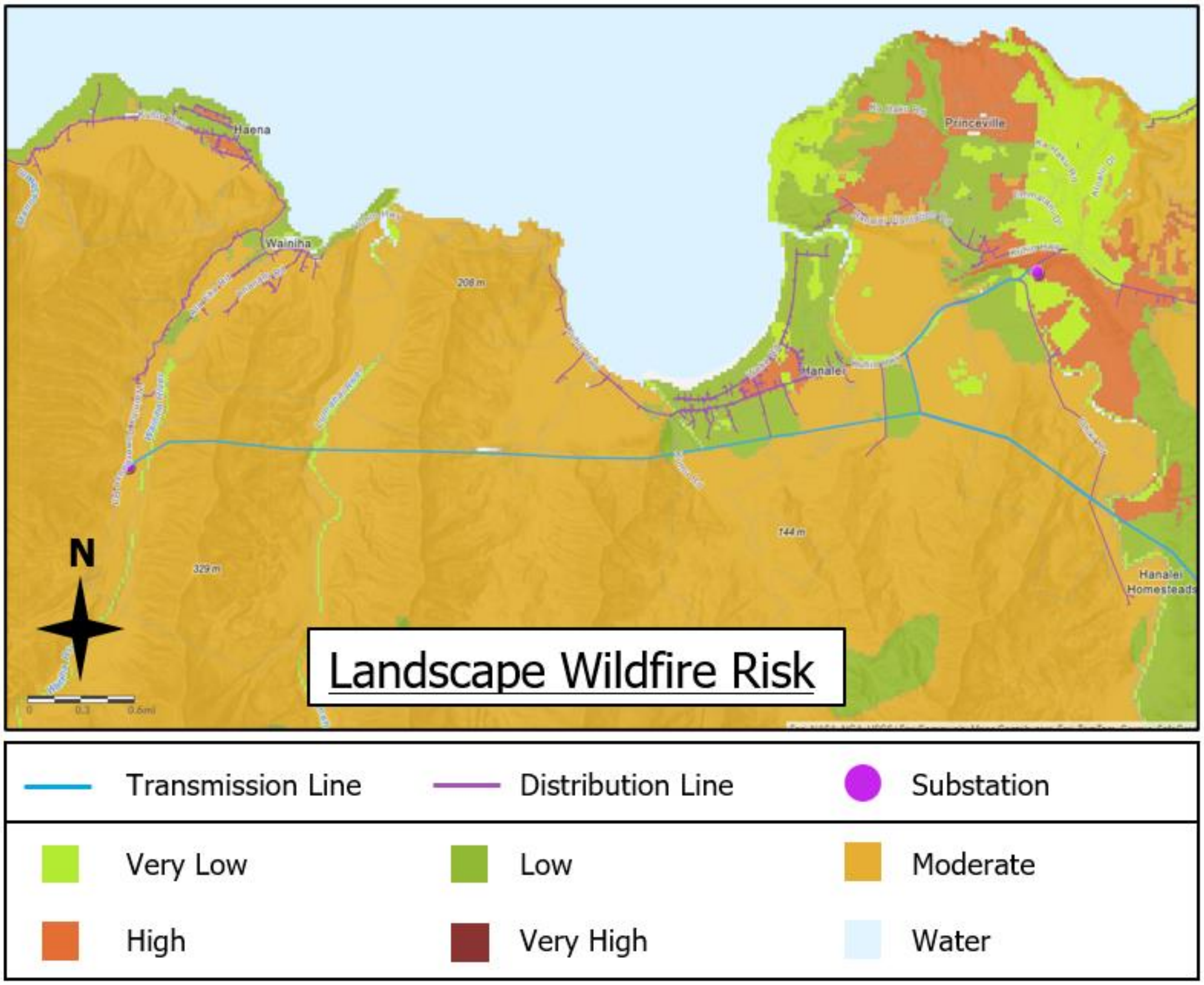

Figure 16. Kokee State Park, Waieli Detail Map