

**Table 4-85. North Kohala Environmental Resources**

Agricultural Land of Importance (acres)	Crop Land (acres)	Pasture Land (acres)	Hunting Areas (acres)	Wetlands (acres)
43,101	2,200	52,100	3,322	2,329

Federal Reserves (acres)	State Reserves (acres)	Exceptional Trees (number)	Anchialine Pools (number)	Reservoirs (number)	Endangered and Critical Habitats (acres)
0	3,794	0	0	8	3,342

The following environmental resources in North Kohala are located in the Volcanic High Hazard Area: agricultural land of importance (62 acres), pasture land (56 acres), hunting areas (77 acres), wetlands (216 acres), state reserves (77), and endangered and critical habitats (44 acres) (see **Table 4.6-11**).

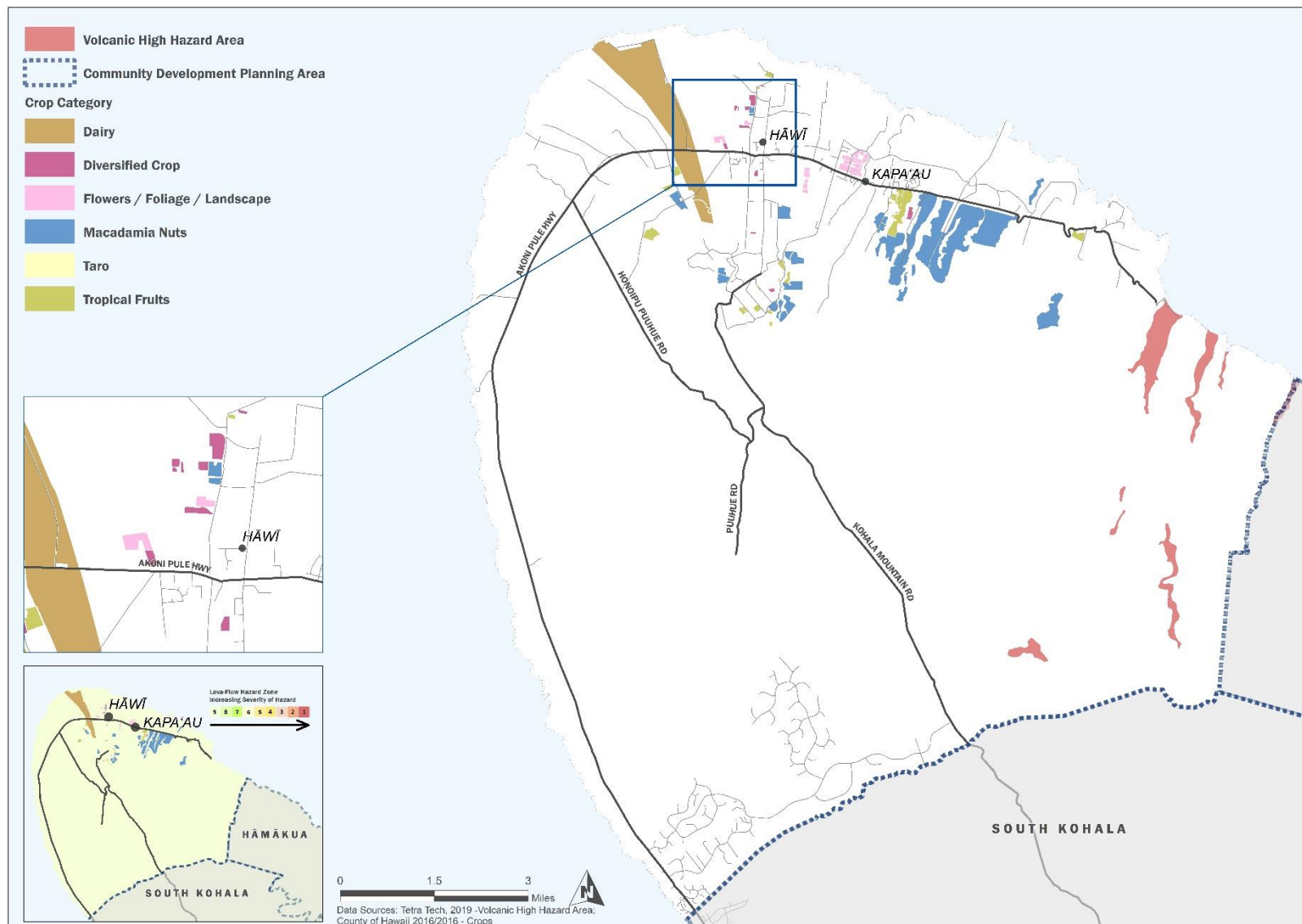


Figure 4-130. North Kohala Important Agricultural Crops Located in Lava Zones and Volcanic High Hazard Area

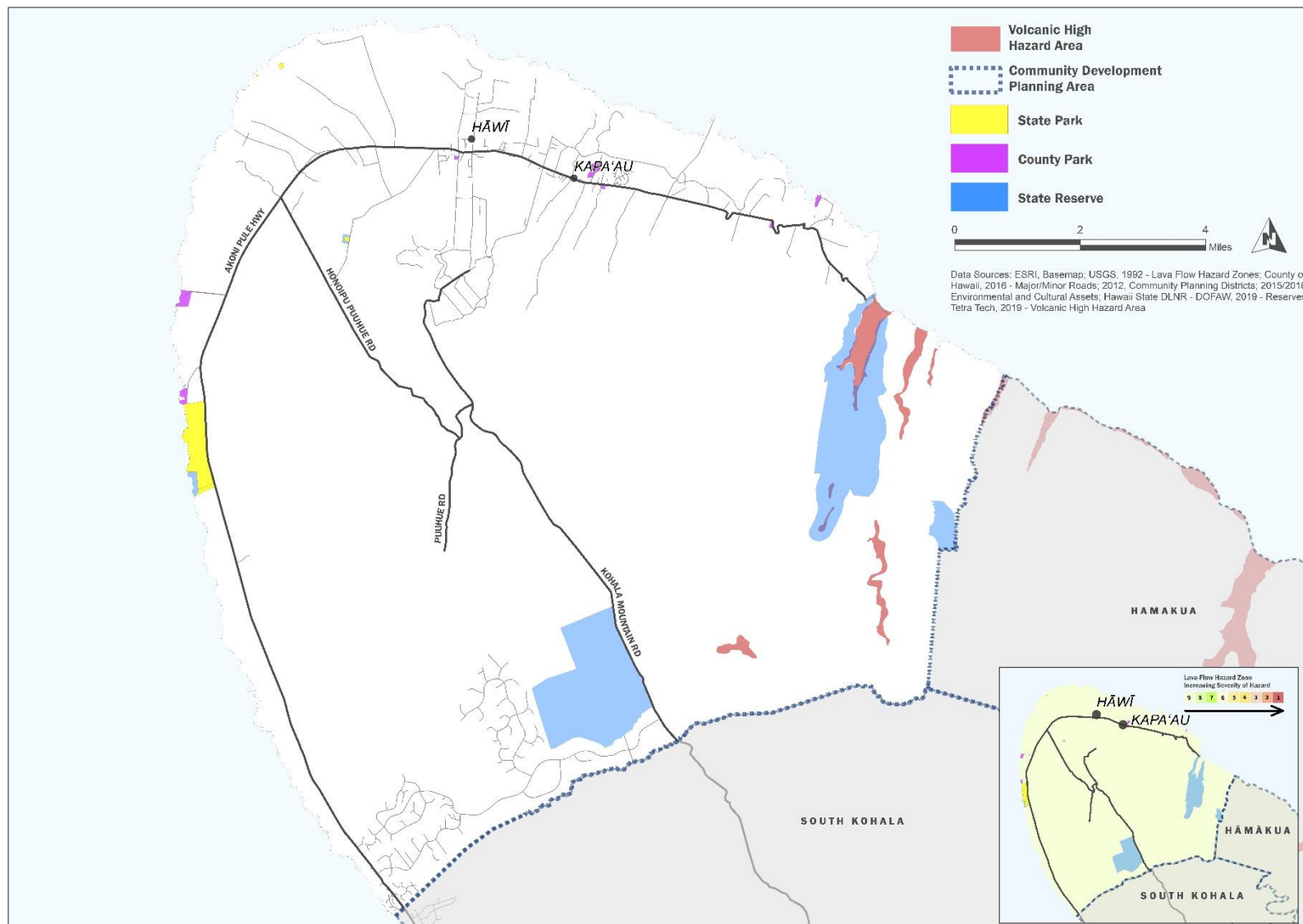


Figure 4-131. Protected Environmental Land in North Kohala Located in Lava Zones and Volcanic High Hazard Area



Table 4-86. North Kohala Environmental Resources

Hazard Area	Total Protected Land (acres / %)	SLUD Conservation Land (acres / %)	Endangered and Threatened Habitat (acres / %)	Exceptional Trees (number / %)	Open Space: General and Protected (acres / %)	Agricultural Land of Importance (acres / %)
Volcanic High Hazard Area	77 / 2%	593 / 4.7%	44 / 1.3%	0 / 0%	1,242 / 1.5%	62 / 0.10%
Lava Zone 1	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%
Lava Zone 2	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%

SLUD State Land Use District

Note: Acres and total numbers of environmental resources in each hazard area were calculated separately as distinct and separate areas; therefore, individual hazard area totals do not equate to the Volcanic High Hazard Area total.

Hazard Area	Crop Land (acres / %)	Pasture Land (acres / %)	Hunting Areas (acres / %)	County Park (acres / %)	State Park (acres / %)	National Park (acres / %)
Volcanic High Hazard Area	0 / 0%	56 / 0.10%	77 / 2.3%	0 / 0%	0 / 0%	0 / 0%
Lava Zone 1	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%
Lava Zone 2	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%

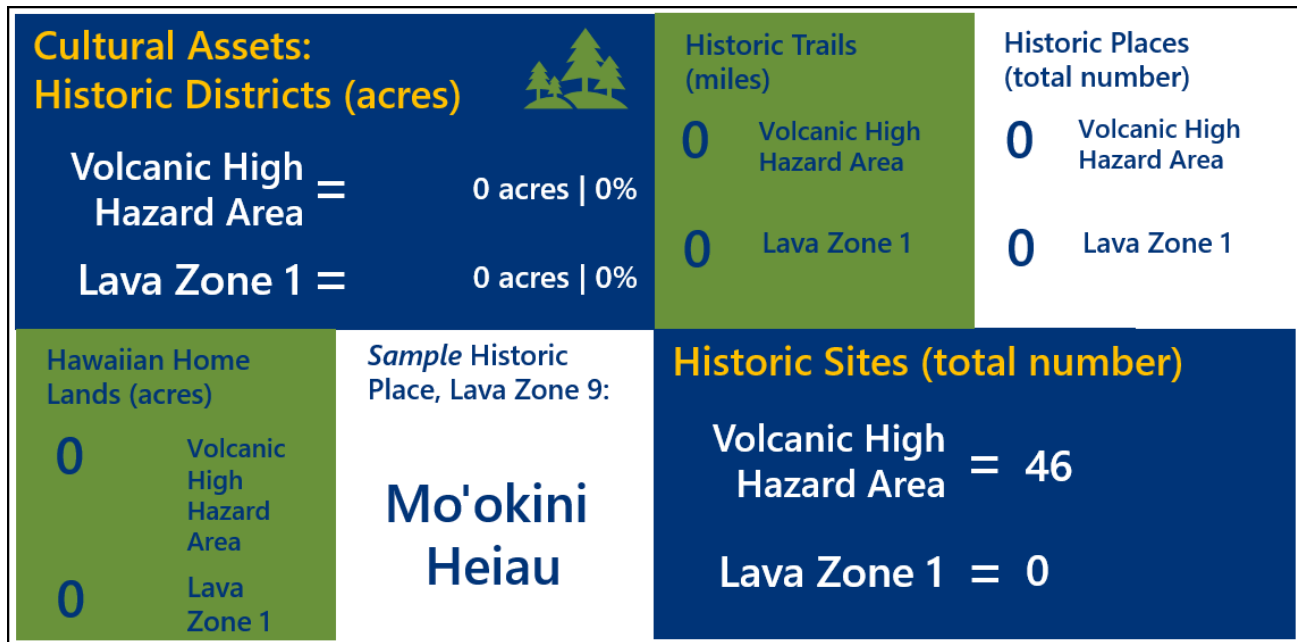
Note: Acres and total numbers of environmental resources in each hazard area were calculated separately as distinct and separate areas; therefore, individual hazard area totals do not equate to the Volcanic High Hazard Area total.

Hazard Area	Wetlands (acres / %)	Reservoirs (number / %)	Anchialine Pools (number / %)
Volcanic High Hazard Area	216 / 9.3%	0 / 0%	0 / 0%
Lava Zone 1	0 / 0%	0 / 0%	0 / 0%
Lava Zone 2	0 / 0%	0 / 0%	0 / 0%

Note: Acres and total numbers of environmental resources in each hazard area were calculated separately as distinct and separate areas; therefore, individual hazard area totals do not equate to the Volcanic High Hazard Area total.



4.6.7 CULTURAL ASSETS



Note: All percentages are relative to the North Kohala District

Figure 4-132. North Kohala Cultural Assets Located in the Volcanic High Hazard Area and Lava Zone 1

North Kohala is home to many formally designated and locally recognized cultural assets, historic places, and sites that are important because they help to shape the identity of the place and the people of North Kohala, as well as the County. A location-based database of culturally significant sites to Native Hawaiians was not available for use in this risk assessment; disclosure of the location of sacred and otherwise culturally significant sites is prohibited, in some instances, by federal law. To align with the County General Plan update, Hawaiian Home Lands, historic sites and trails were used for this analysis.

Cultural assets are considered non-renewable resources. Lava flows and other natural hazards can isolate or cover cultural sites and native land. A total of 46 historic sites are in the Volcanic High Hazard Area and vulnerable to seismic activity (see **Table 4-87**). Historic sites are North Kohala's only cultural asset located in the Volcanic High Hazard Area.

It is important to note that many of the cultural assets are located along the coast and overlap with other hazard areas including tsunami, flood, and high landslide risk areas (see **Figure 4-133**).

Table 4-87. North Kohala Cultural Resources by Volcanic Hazard Area

Hazard Area	Hawaiian Home Lands (acres / %)	Historic Districts (acres / %)	Historic Places (number / %)	Historic Sites (number / %)	Historic Trail (miles / %)
Volcanic High Hazard Area (VHHA)	0 / 0%	0 / 0%	0 / 0%	46 / 7.8%	0 / 0%
VHHA with Additional Natural High Hazard Area	0 / 0%	0 / 0%	0 / 0%	46 / 100%	0 / 0%
Lava Zone 1	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%
Lava Zone 2	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%

Note: Acres and total numbers of cultural resources in each hazard area were calculated separately as distinct and separate areas; therefore, individual hazard area totals do not equate to the VHHA total.

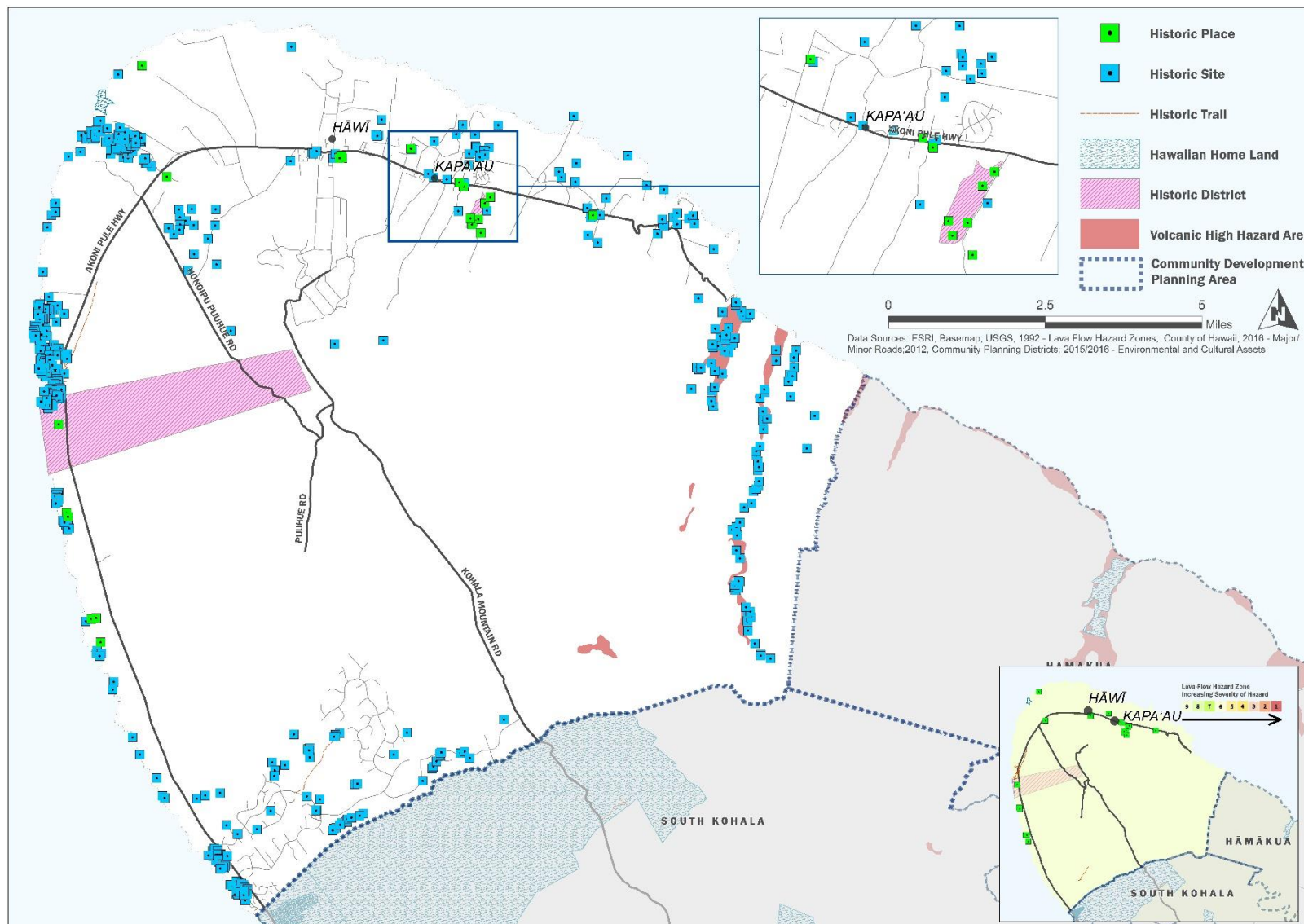


Figure 4-133. Cultural Assets in North Kohala and Volcanic Hazards



4.6.8 FUTURE LAND USE AND DEVELOPMENT

North Kohala is comprised of mixed land use classifications as categorized by the Land Use Pattern Allocation Guide (LUPAG) (*see Figure 4-134*). While LUPAG designations guide decisions related to future land use, County zoning determines a parcel's current permitted land use and development entitlements.

The majority of North Kohala is designated agricultural land, either important agricultural land or extensive agriculture, representing a total of 62,873 acres or 78.8% of land in the District. Important agricultural land is defined as "those with better potential for sustained high agricultural yields because of soil type, climate, topography, or other factors. Important agricultural lands were determined by including the following lands:

1. Lands identified as "Intensive Agriculture" on the 1989 General Plan Land Use Pattern Allocation Guide maps
2. Lands identified in the Agricultural Lands of Importance to the State of Hawai'i (ALISH) classification system as "Prime" or "Unique"
3. Lands classified by the Land Study Bureau's Soil Survey Report as Class B "Good" soils (There are no Class A lands on the Island of Hawai'i)
4. Lands classified as at least "fair" for two or more crops, on an irrigated basis, by the U.S. Department of Agriculture (USDA) Natural Resource Conservation Service's study of suitability for various crops
5. State agricultural parks

(Source: CHPD 2017)

Following agricultural land, North Kohala has designated conservation lands (14%) and low-density urban (3.4%) land. The remaining 4% of North Kohala is classified as a mix of open area, rural, urban expansion, medium-density urban, industrial, and resort. Overall, the land in the Volcanic High Hazard Area is mainly classified as conservation land (86%), extensive agriculture (9.5%), and open area (4.5%) (*see Table 4-88 and Figure 4-134*).

Table 4-88. North Kohala Land Use (LUPAG classification) in the Volcanic High Hazard Area and Lava Zones

LUPAG Classification	Total Area (acres)	Volcanic High Hazard Area (acres)	Lava Zone 1 (acres)	Lava Zone 2 (acres)	Lava Zone 3 (acres)
Conservation	11,232	565	0	0	0
Extensive Agriculture	21,921	62	0	0	0
Important Agricultural Lands	41,039	0	0	0	0
Industrial	51	0	0	0	0
Low-Density Urban	2,680	0	0	0	0
Medium-Density Urban	177	0	0	0	0
Open Area	2,102	28	0	0	0
Resort	47	0	0	0	0
Rural	437	0	0	0	0
Urban Expansion	258	0	0	0	0

LUPAG Land Use Pattern Allocation Guide

While the Volcanic High Hazard Area represents the area with the greatest volcanic risk in the County, it is not the target for the vast majority of future urban development in North Kohala. However, land identified for future urban expansion may be susceptible to other natural hazards. For example, the resort and urban expansion areas are adjacent to North Kohala's tsunami evacuation zone, and nearby areas susceptible to landslides.

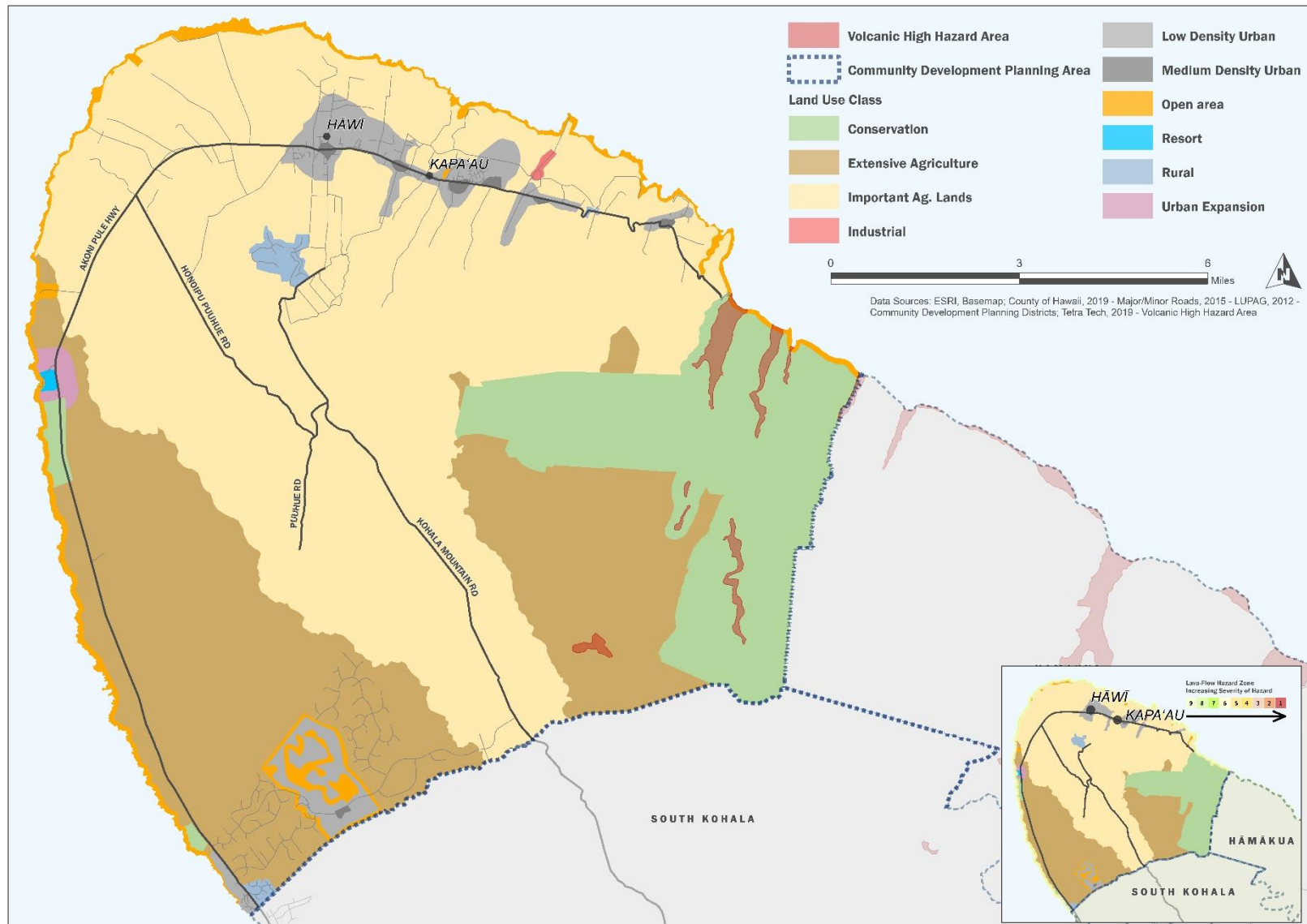


Figure 4-134. North Kohala Land Use Pattern Allocation Guide (LUPAG) Classifications



In preparation for the County General Plan update, a build-out analysis was conducted to determine residential and non-residential capacity. North Kohala has 56,070 acres of identified residential greenfield area (70.8% of total North Kohala land) illustrating the scale of potential future targeted development. Future land use decisions and future policy may consider the location of the volcanic and additional natural high hazards prior as part of future development decisions.

North Kohala is the only CDP in the County with 100% of its greenfield and potential redevelopment land (residential and commercial) located outside of the Volcanic High Hazard Area (see **Table 4-89**). At the same time, the exposure to other natural hazard impacts should also be taken into consideration when considering future development decisions. In general, 92.85% of North Kohala's parcels, are located in another natural high hazard area.

Table 4-89. North Kohala Build-out Analysis Results and Hazard Areas

Hazard Area	Residential Greenfield (parcels / %*)	Residential Potential Redevelopment (parcels / %*)	Non- Residential Greenfield (parcels %*)	Non-Residential Potential Redevelopment (parcels / %*)
Volcanic High Hazard Area (VHHA)	0 / 0%	0 / 0%	0 / 0%	0 / 0%
VHHA with Additional Natural High Hazard Area	0 / 0%	0 / 0%	0 / 0%	0 / 0%
Lava Zone 1	0 / 0%	0 / 0%	0 / 0%	0 / 0%
Lava Zone 1 with Additional Natural High Hazard Area	0 / 0%	0 / 0%	0 / 0%	0 / 0%
Lava Zone 2	0 / 0%	0 / 0%	0 / 0%	0 / 0%
Lava Zone 2 with Additional Natural High Hazard Area	0 / 0%	0 / 0%	0 / 0%	0 / 0%

*The percentage of parcels relative to the total number in the North Kohala District.

Note: Parcels in each hazard area were calculated separately as distinct and separate areas; therefore, individual hazard area totals do not equate to the VHHA total.

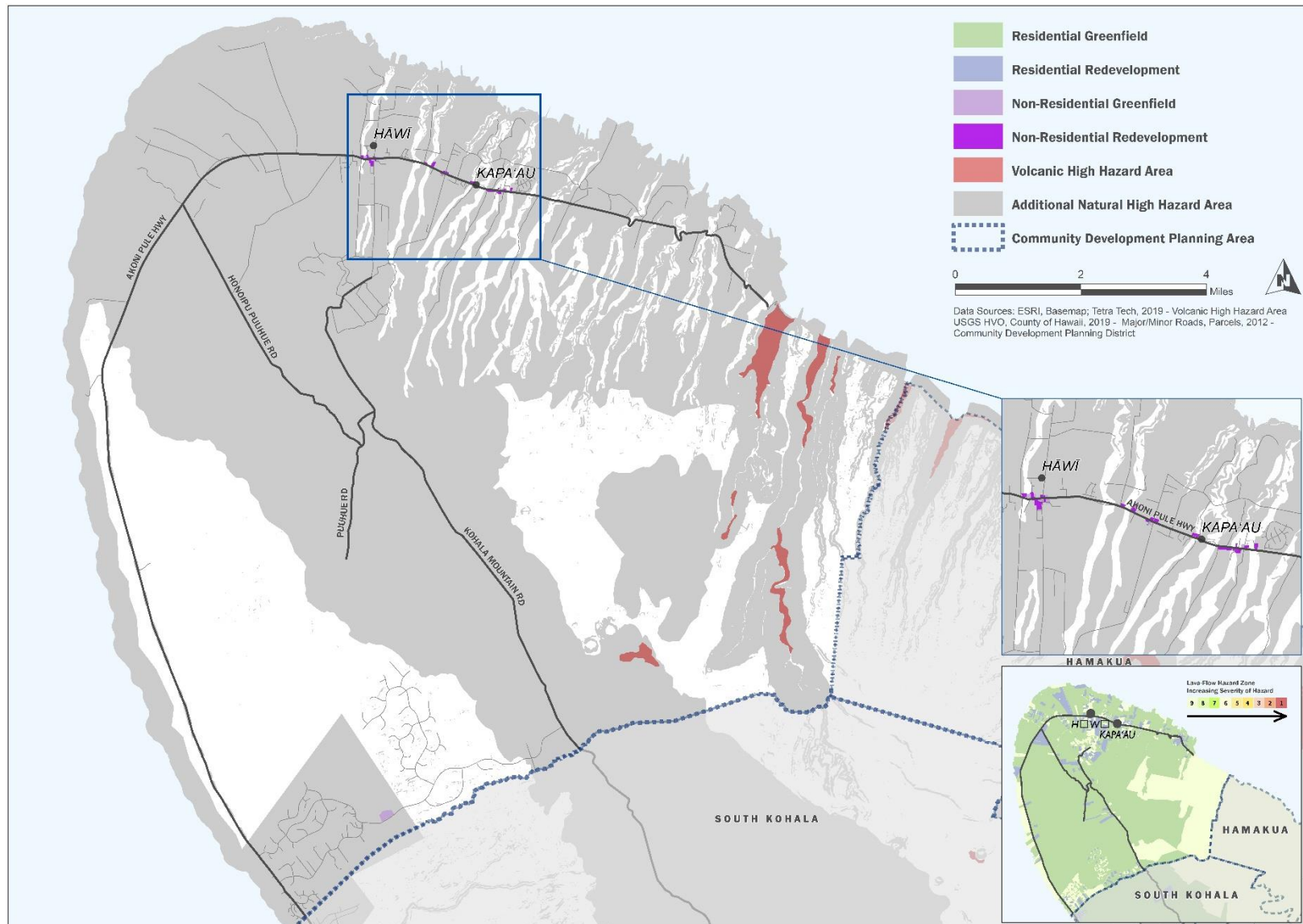


Figure 4-135. North Kohala Greenfield and Redevelopment Areas and Volcanic Hazard Area



There is a significant lack of hazard insurance for many structures, across the County. In 1991, State of Hawai'i lawmakers created a nonprofit collection of insurance companies called the Hawai'i Property Insurance Association to address this gap. The State assembled the nonprofit to provide basic property insurance for people who are unable to buy coverage in the private market, due to insurers being uncomfortable with Hawai'i's significant volcano risk (Weiss 2018).

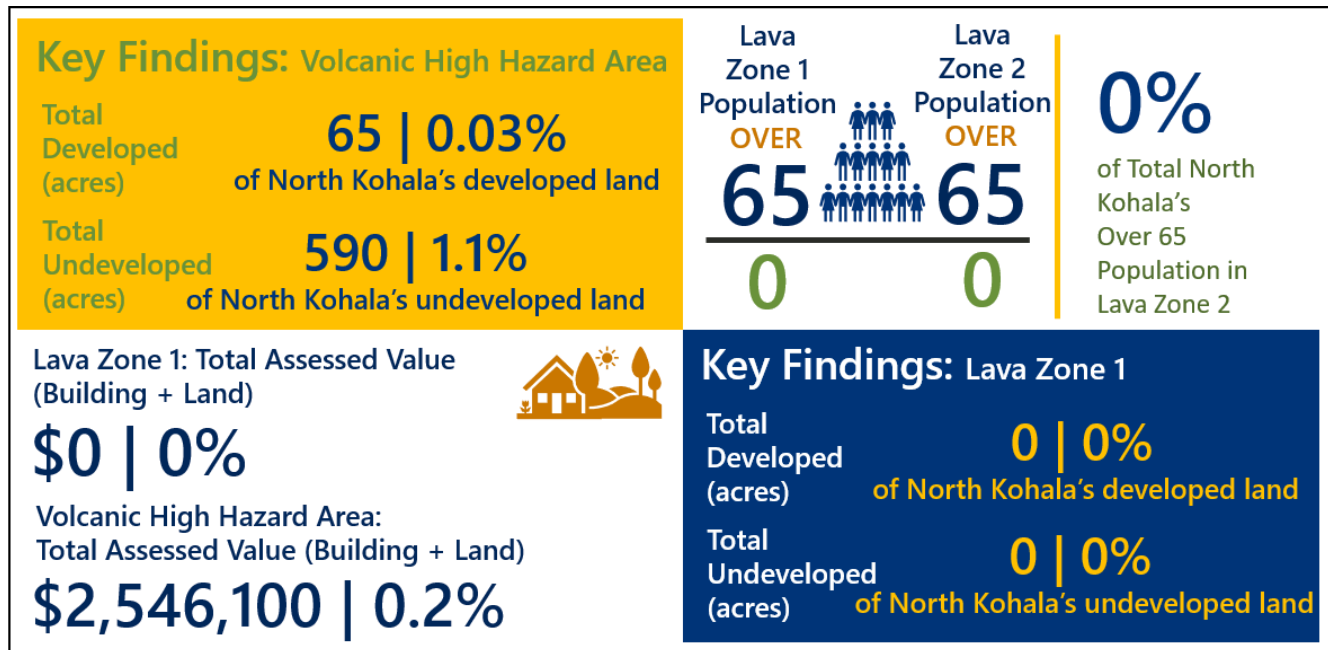
Volcanic hazard risk, and other high hazard risks, combined with limited insurance is a considerable factor when planning for the continued growth of North Kohala. Critical questions that need to be addressed prior to moving forward with future plans for development/re-development and decisions about future population centers are:

- Who will be able to afford to live in an area that is vulnerable to high hazard risks?
- Physical exposure to a range of hazards has may cause certain areas to more affordable to live. What are the choices available to economically vulnerable households?
- Will the most vulnerable be forced to move to other less vulnerable districts?
- Will they remain and bear the burden when the next event takes place?
- What strategies do the County and community need to develop to manage residential development and infrastructure development relative to the expected demand on emergency services and repetitive losses in an area with high exposure to hazards?

These questions will be critical to address moving forward with all plans for future development/re-development and decisions about future population growth in North Kohala. Development or redevelopment is not always the preferred option. In fact, Hilo has already been leading the way in the County when they took an approach to some of their past damaged land to not rebuild after the 1946 Tsunami, but rather turned the damaged land into a park—looking to other low-hazard exposure land for development and population growth.



4.6.9 KEY FINDINGS



Note: All percentages are relative to the North Kohala District. According to the analysis, there are no residents located in lava zone 1.

Figure 4-136. North Kohala Key Findings

Understanding what is at risk from natural hazards and future changes that impact vulnerability can assist in North Kohala's planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The following summarizes the key findings for the North Kohala District:

- 100% of North Kohala's population lives in lava zone 9, which has low lava-flow hazard risk.
- 92.85% of North Kohala's parcels are located in the Additional Natural High Hazard Area. Meaning, while the volcanic hazard risk for North Kohala is low, there are other natural hazards present that may or may not impact future development and/or life safety of the District's residents.
- North Kohala is the only CDP in the County with majority agriculture LUPAG classified land (78.8%) which emphasizes the long-standing importance of agriculture in the District

North Kohala will continue to be faced with important future decisions pertaining to life safety, development, redevelopment, and general land use. Perhaps most significant is balancing its population, sacred places and agricultural land located within areas of high hazards. An understanding and assessment of risk, exposure, and implications of redevelopment and/or greenfield development, which could create new land uses and potentially increased population within North Kohala, should be carefully considered. The vast majority of North Kohala is outside of the Volcanic High Hazard Area; however, a large portion of the district is exposed to additional natural hazards touching more than 90% of all total parcels. Decisions about future growth and life safety should be approached carefully and cautiously, from an all-hazards perspective—for North Kohala in particular.



4.7 Puna

4.7.2 OVERVIEW

The Puna Community Development Plan district (CDP), herein referred to as Puna, is located in the center eastern portion of the Island of Hawai'i. It is bordered by the Hilo District to the northwest and the Ka'u District to the west. The region's eastern and southern borders are defined by the Pacific Ocean. Within Puna there are four regional town centers: Kea'au, Hawaiian Paradise Park (HPP), Pāhoa and Volcano Village, all centered in the eastern half of the District located along the north-south Kea'au-Pāhoa Road. Puna's landscape is dynamic, stretching from Kīlauea's summit east to the ocean. It includes new and historic lava features, black sand beaches, and many other cultural and natural environmental resources forged by the power of volcanoes (Hawai'i Tourism Authority 2019).

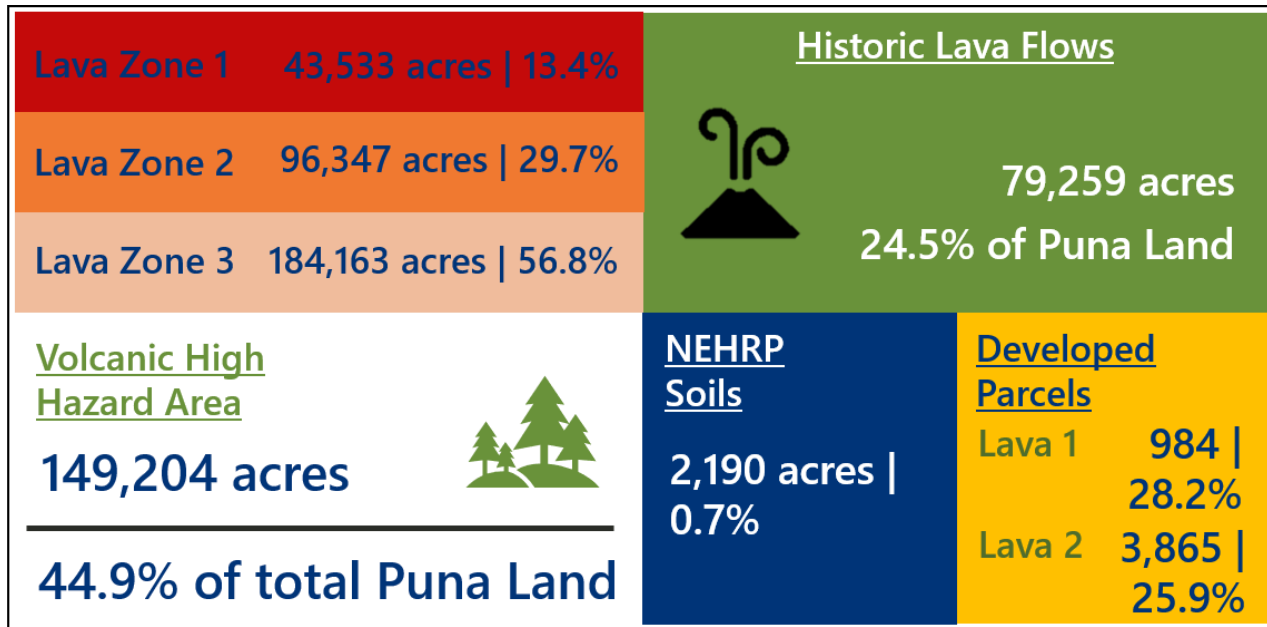


Puna's identity has been significantly informed by the presence of the Kīlauea Volcano, its historic volcanic events, as well as the more recent 2018 Kīlauea eruption and the 35-year Pu'u 'Ō'ō eruptions. Traditional Hawaiian culture views Puna as Pele's workshop, a place where the volcano goddess continually creates and recreates the very land they relied upon for survival.

Present day, Puna's character and developmental patterns are largely rural, with most development being in subdivisions. The occurrence of informal settlements is known to occur throughout Puna. Prior to the 2018 Kīlauea eruption, Puna was one of the fastest growing districts in the County, a trend which the County anticipates will continue for years to come (CHPD 2019).



4.7.3 VOLCANIC HAZARDS



Note: All percentages are relative to the Puna District

Figure 4-137. Puna Volcanic Hazard Exposure Overview

Today, Kīlauea is considered the most active volcano in the world. Kīlauea's southeast flank runs through Puna. Since 1952, Kīlauea has erupted 34 times. From 1983 to 2018 the volcano's East Rift Zone, located in Puna, erupted nearly continuously. In 2018, the decades-long continuous activity on the middle East Rift Zone subsided, and the summit lava lake drained following an intrusion into Kīlauea's Lower East Rift Zone that resulted in a 4-month eruption. The 2018 eruption represents Kīlauea's largest eruption in approximately 200 years, accompanied by the largest caldera collapse at the summit within the same time period (U.S. Geological Survey [USGS] 2019b).

Puna is located within USGS-delineated lava-flow hazard zones 1, 2, and 3 (**Figure 4-138**). Lava zone 2 makes up the southern, ocean-facing portion of Puna, while to the north lava zone 1 runs parallel to lava zone 2 and encompasses the East Rift Zone (including Pu'u 'Ō'ō, located just to the east of the Kīlauea Volcano).

Over 43% of Puna is located within lava-flow hazard zones 1 and 2, which includes flows surrounding vents that have a history of frequent lava flows (zone 1) or areas adjacent to or downslope from zone 1 (zone 2) (Wright et al. 1992). Pāhoā has areas in both lava zones 1 and 2. Of the 16% of land in Puna that is developed (or parcel with a building assessment value according to County assessor records), 26.5% (or 13,407 acres) is located within high-risk lava flow hazard zones 1 and 2 (**Table 4-90**). For the purposes of this assessment, developed and undeveloped land has been calculated at the parcel level (regardless of private or public ownership).

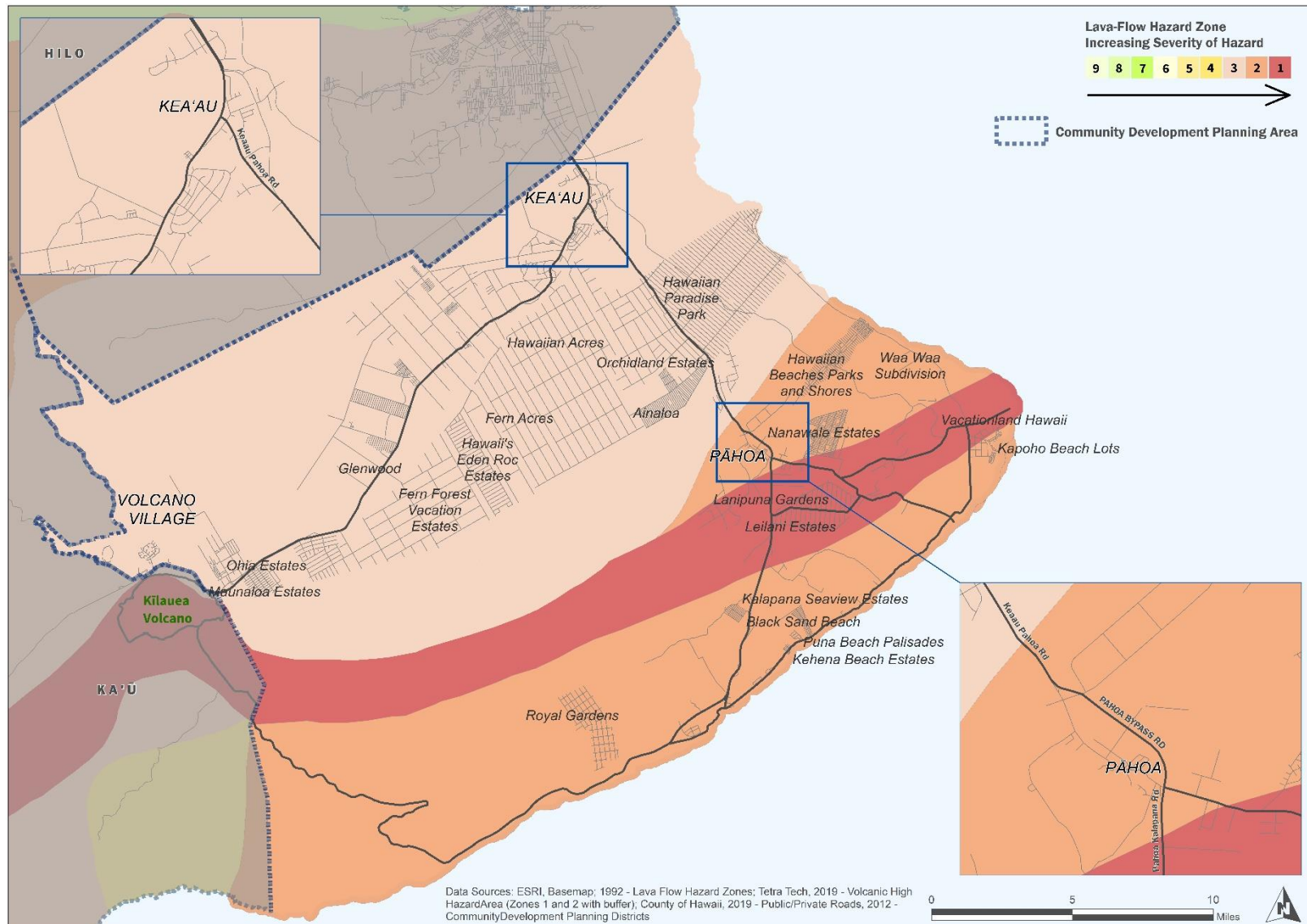


Figure 4-138. Lava Zones in Puna

**Table 4-90. Puna Developed vs. Undeveloped Parcel Area by Lava Zone**

	Total Area (acres)	Lava Zone 1 (acres)	Lava Zone 2 (acres)	Lava Zone 3 (acres)	Lava Zone 4 (acres)	Lava Zone 5 (acres)	Lava Zone 6 (acres)	Lava Zone 7 (acres)	Lava Zone 8 (acres)	Lava Zone 9 (acres)
Puna District	324,043	43,533	96,347	184,163	0	0	0	0	0	0
Developed	50,518	6,780	6,627	37,111	0	0	0	0	0	0
Undeveloped	273,526	36,753	89,720	147,052	0	0	0	0	0	0

Note: Developed parcels reflect a parcel that contains a building assessment value per the County assessor records.

Lava zone 3 makes up the remaining northern area of Puna and encompasses 56.8% of the district. Both Kea'au and HPP are located in lava zone 3. According to the USGS, lava zone 3 is less hazardous than lava zone 2 due to its distance from recently active vents and (or) because of topography. It should be noted that lava zone 3 has been covered by historic lava flows in Puna (1 to 5% covered since 1800 and 15 to 75% covered within the past 750 years) (Wright et al. 1992). However, lava is not the only volcanic risk which Puna faces.

Soil conditions have a profound influence on the characteristics of ground shaking during an earthquake. Puna has 2,190 acres (or 0.7% of total land area) of softer soils (National Earthquake Hazard Reduction Program [NEHRP] types D and E, such as fill, mud and sand) that amplify ground shaking.

Puna air quality, as well as those areas downwind of volcanic emissions, can be compromised due to vog. Vog is the visible haze comprised of water vapor, carbon dioxide, sulfur dioxide (SO₂) and particulate matter which poses respiratory challenges for residents and responders in the affected area. Its impacts can be felt up to hundreds, if not thousands, of miles away (State of Hawai'i 2018). Regular ash emissions from the summit of Kīlauea, and acidic ocean entry plumes (generated by lava flows into the sea, also known as laze) also contribute to poor air quality in downwind locations, as was experienced during the 2018 Kīlauea eruption (U.S. Department of the Interior Strategic Sciences Group 2018).

Additional volcanic hazards associated with Kīlauea that can impact Puna include but are not limited to the following:

- Eruptions or collapse without warning at near-vent areas
- Active lava flows within forested areas can produce methane blasts capable of propelling boulder-sized rocks and other debris into the air and brushfires
- Tephra, including volcanic ash and Pele's hair (a form of lava, appearing as volcanic glass fibers or thin strands of volcanic glass), can be carried several kilometers downwind of the summit vent within the Halema'uma'u Crater
- Ash plumes, if they rise above the thermal layer into the jet stream, could be deposited in Puna
- Explosive eruptions in the summit lava lake can throw fragments of rock and molten lava near the rim of the Halema'uma'u Crater, an area that has been closed to the public since early 2008 due to volcanic hazards

As discussed in **Section 3 - Methodology**, spatially available high volcanic hazard area data was aggregated delineating areas with the highest volcanic risk in the County of Hawai'i. This category is referred to as the Volcanic High Hazard Area (VHHA). The Volcanic High Hazard Area represents the location throughout the County with the greatest risk to the volcanic hazard: lava zones 1 and 2, historic lava flow events (1790-2018), and NEHRP D&E soils. This risk assessment focuses on Puna's exposure to the Volcanic High Hazard Area and lava-flow hazard zones 1 and 2. Overall, nearly half of Puna is located within the Volcanic High Hazard Area (45.5%) with the remainder located in lava zone 3. Refer to **Table 4-90** and **Figure 4-139** for a summary of Puna's land area in each volcanic hazard area.



In addition to volcanic hazards, Puna is prone to other natural hazard events. These hazards include tsunamis, earthquakes, floods, tropical cyclones, landslides, subsidence, coastal erosion, sea level rise, high surf, drought and wildfires. Further, as a result of the 2018 Kīlauea event, the lava has developed new terrain in the District and the resulting flood hazard risk is unknown at this time; discussed further in **Section 3 - Methodology**). In addition to examining the assets exposed to the high volcanic hazard area, it is important to determine if those assets are located in additional high hazard zones to inform the identification of recovery and mitigation strategies. **Figure 4-139** illustrates the additional high hazard areas located in Puna and **Figure 4-140** illustrates the additional high hazard areas relative to the lava zones and the Volcanic High Hazard Area.

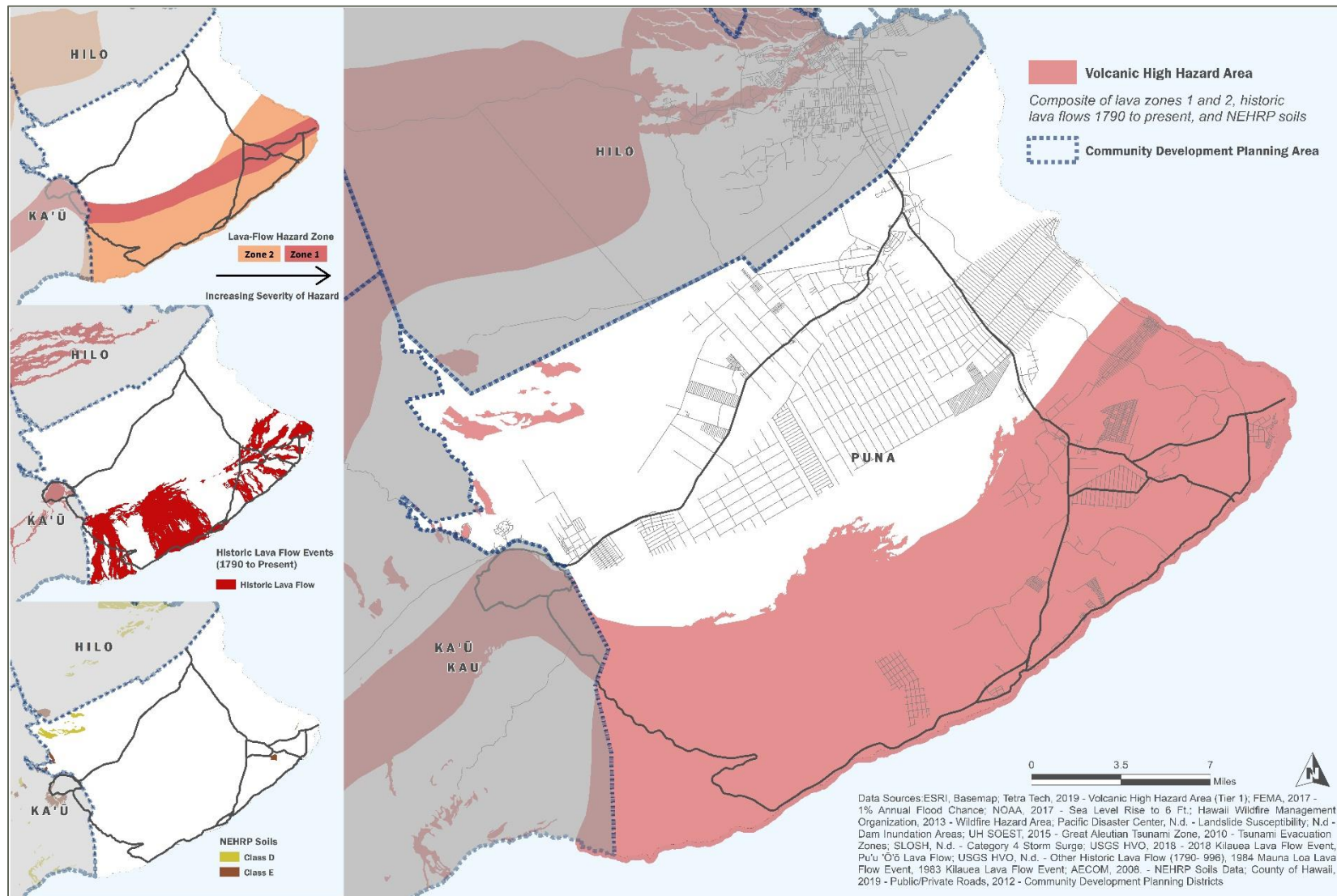


Figure 4-139. Volcanic High Hazard Areas in Puna

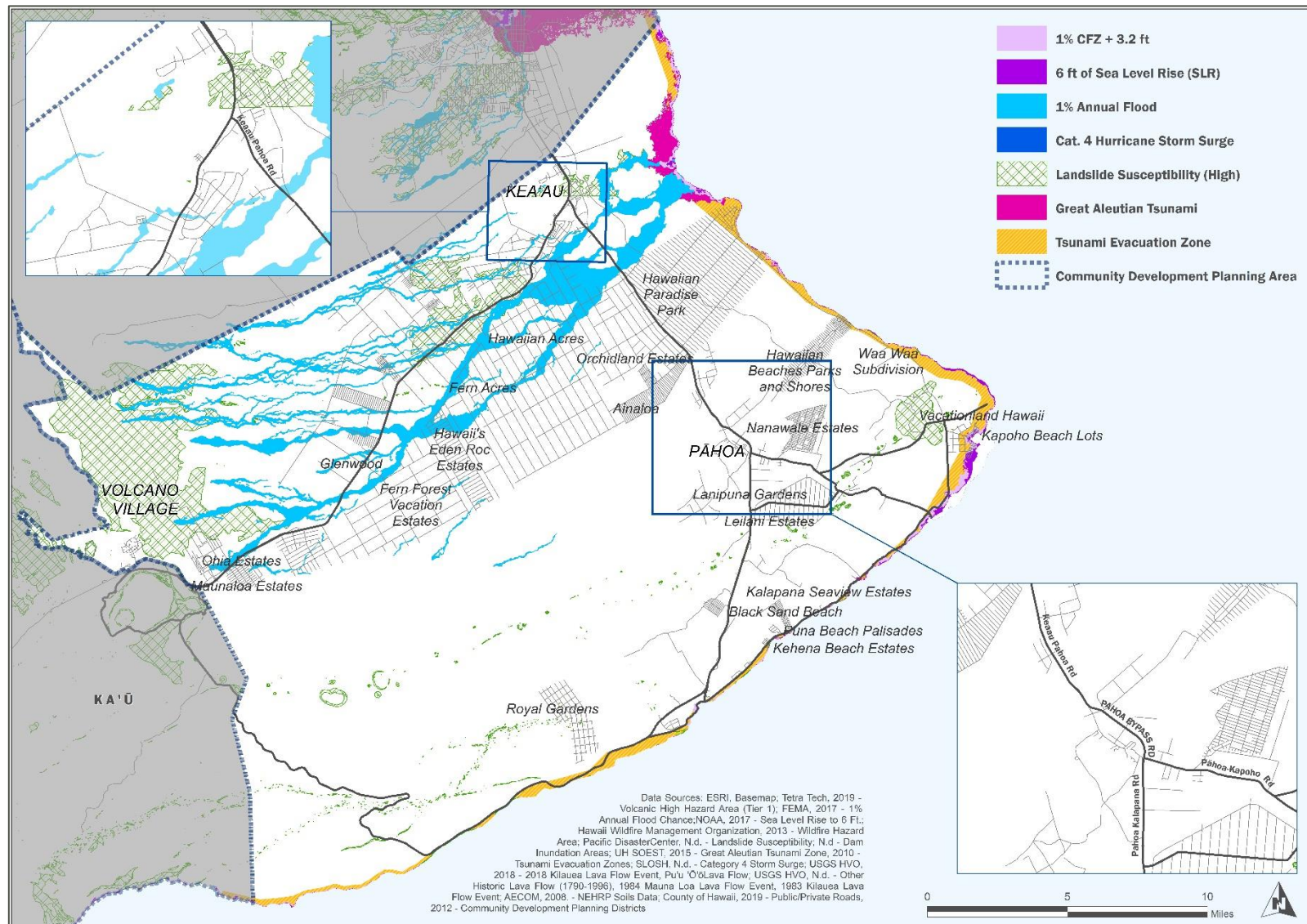


Figure 4-140. Additional High Hazard Areas in Puna

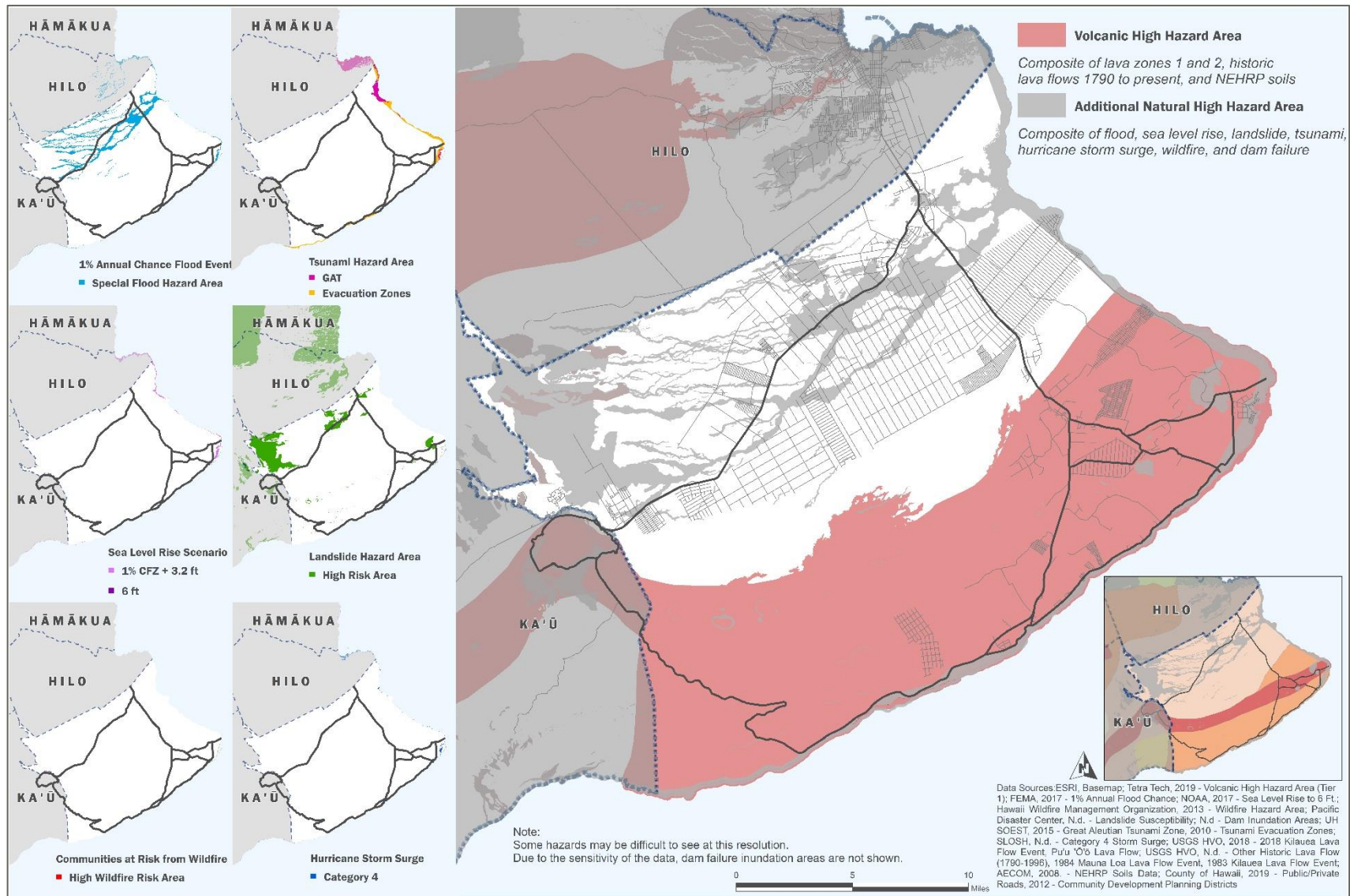
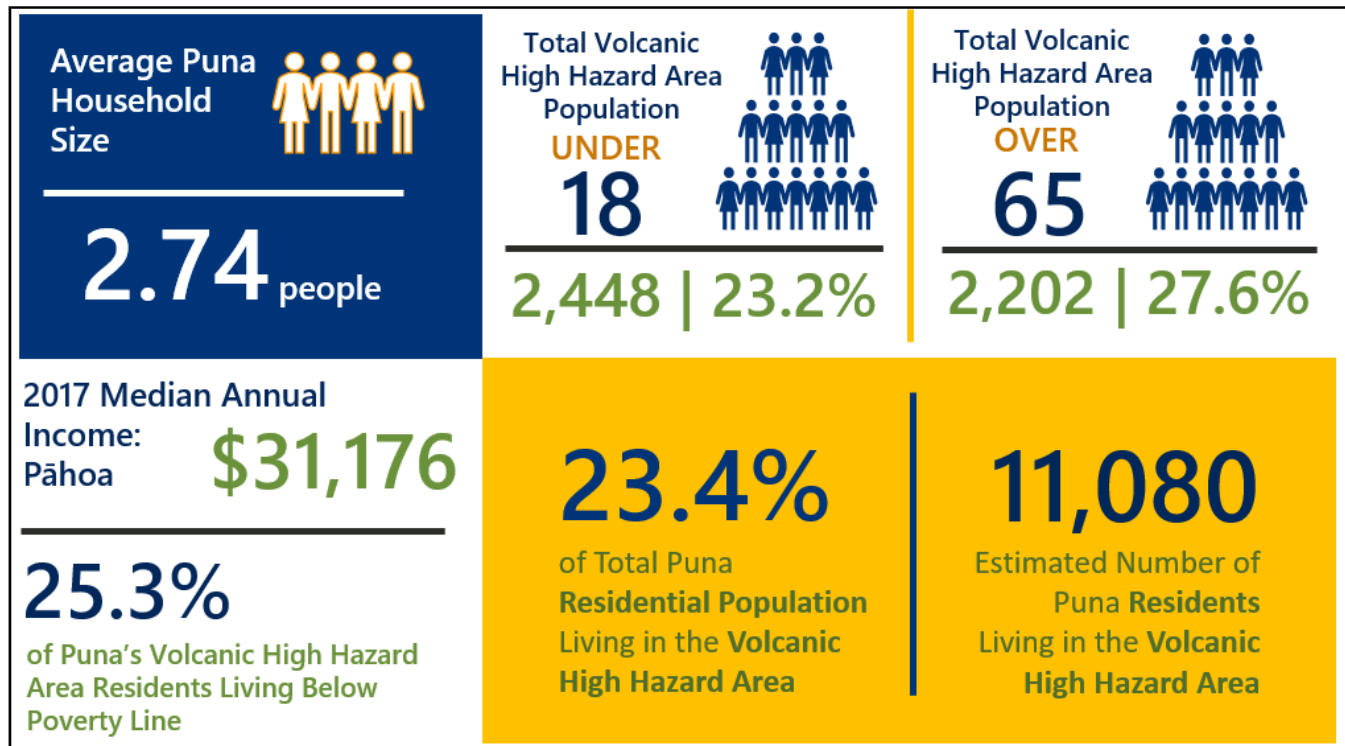


Figure 4-141. Volcanic High Hazard and Additional Natural High Hazard Areas Located in Puna



4.7.4 POPULATION



Note: All percentages are relative to the Puna District

Figure 4-142. Puna Population Exposure to the Volcanic High Hazard Areas

As of 2017, Puna's total population was 47,352, which represents 24.1% of the County's total population (U.S. Census 2017). According to the 2012 Puna Community Development Plan, Puna is experiencing the fastest rate of growth of all the districts in the County of Hawai'i. By 2030, the population is projected to grow to approximately 75,000 (County of Hawai'i 2008). As the Puna District population increases, so too will the numbers of residents at risk to the volcanic hazard.

As noted in **Section 3 – Methodology**, examining resident and household exposure to the volcanic hazard is challenging because parcel-level demographic data is generally not available. Instead, demographic statistics from the 2017 ACS were collected for each U.S. Census tract within the County. Each tract's 2017 population count and the number of 2019 residential parcels in the tract were used to calculate the average number of persons per household. This data was then used to conduct the population exposure assessment using each parcel's estimated household size. The results of this analysis are limited based upon the data available and should only be used for planning purposes until higher resolution data is available.

The entire Puna District is located within a lava zone (1, 2 or 3); therefore, all residents in Puna are exposed to the lava flow hazard. As previously noted in Section 3, there is no calculated probability associated with each lava-flow hazard zone. The zones, ranked from 1 through 9, represent a qualitative scale of increasing hazard as the numbers decrease, based on the probability of coverage by lava flows. This means that land classified as lava zone 1 is the most hazardous (USGS 2019a).



Figure 4-143 summarizes the number of Puna residents living in lava zones 1, 2, and 3. As shown, the greatest number of residents live in lava zone 3. However, more than 2,000 residents live in lava zone 1 alone and an estimated 11,000 residents live in lava zones 1 and 2 combined.

Figure 4-144 illustrates the population density across Puna relative to the Volcanic High Hazard Area. The greatest population density is in HPP and surrounding subdivisions, that cascades into the Lower East Rift Zone. Note, these resident totals do not reflect the number of undocumented residents, tourists and visitors residing in the District.

The Puna District has:

- The greatest number of households in the County located in the Volcanic High Hazard Area (4,417 households)
- The greatest number of households located in lava zone 1 (913 households)
- The greatest number of households located in lava zone 2 (3,504 households)

At the individual resident level, countywide, Puna also ranks:

- High for exposure with the greatest number of residents living in the Volcanic High Hazard Area
- Greatest number of residents in lava zone 1, and greatest number of residents living in lava zone 2

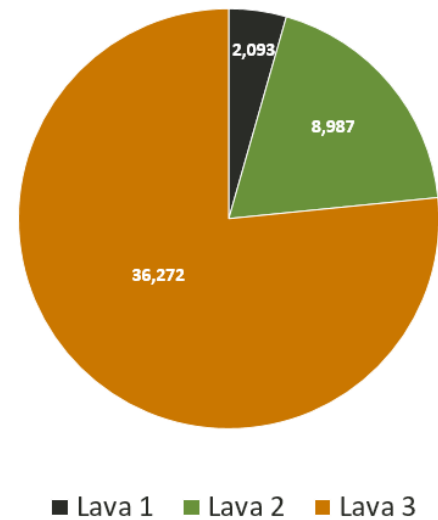


Figure 4-143. Number of Puna Residents in Lava Zones 1 through 3

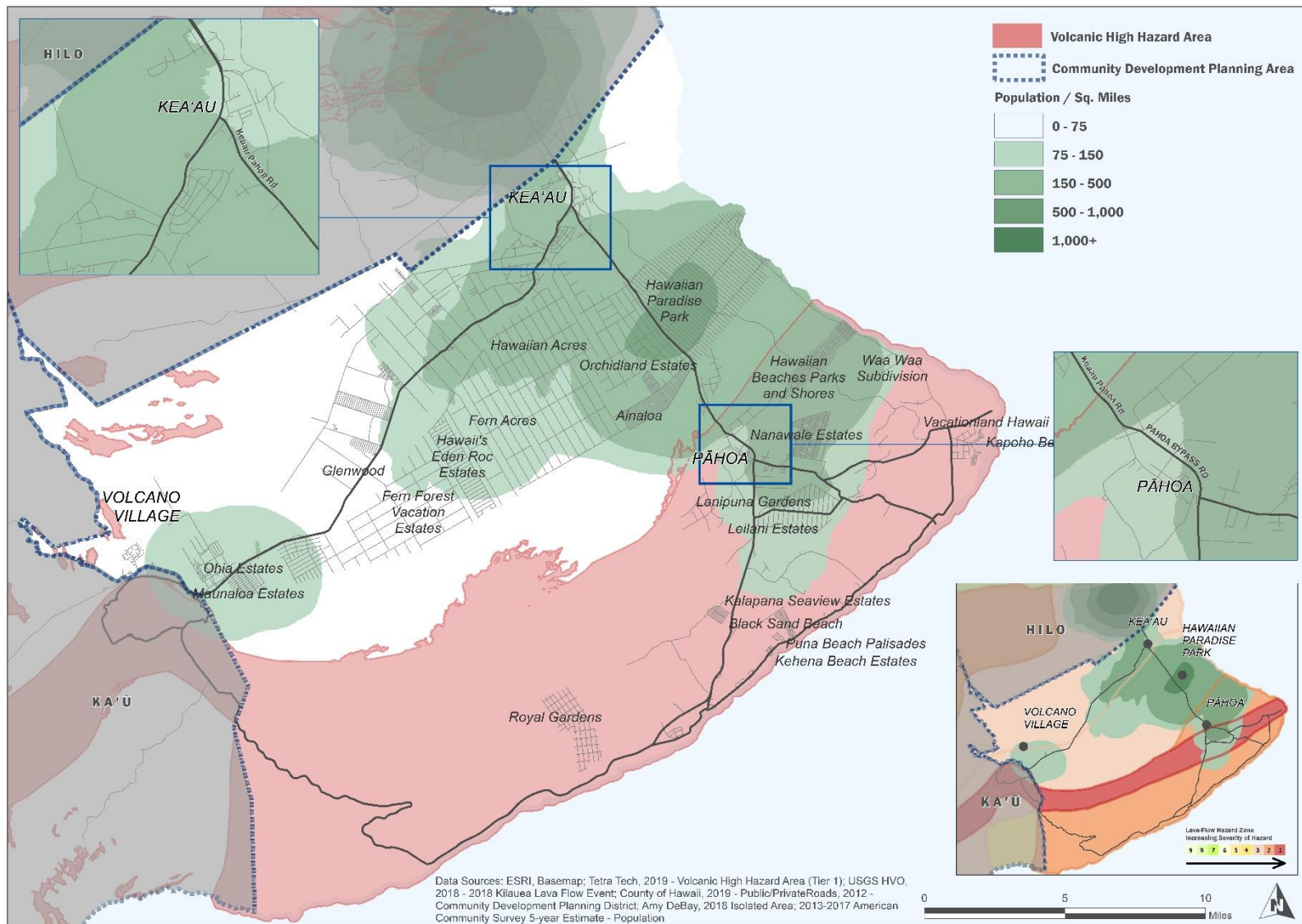


Figure 4-144. Puna Population Density Relative to the Volcanic Hazards



Research has shown that some populations, while they may not have more hazard exposure, may experience exacerbated impacts and prolonged recovery if/when impacted (Donner 2011). This is due to many factors including their physical and financial ability to react or respond during a hazard. This population is referred to as socially vulnerable to hazard events. At the same time, County residents are unique and although may be faced with exposure to a greater number of natural hazard events, this may have increased their overall level of resilience. This is likely due to factors including, but not limited to: institutional knowledge of hazard events, intimate knowledge of the natural elements of the County (particularly for those residents who have lived in the County for an extended period of time), and varying levels of existing self-sufficiency. In 2019, the Pacific Disaster Center released the Kīlauea Eruption Risk Assessment (KERA) report that identified key social drivers of volcanic hazard vulnerability: 1. socioeconomic status; 2. access to information; and 3. household composition (Pacific Disaster Center 2019). To align with the KERA report, the County examined the exposure of these vulnerable populations to the volcanic hazard.

Table 4.7-3 summarizes the vulnerable population statistics in Puna by number of residents. The District has a significant percentage of low-income residents. For example, the 2017 median annual income of residents in Pāhoa was \$31,176 (one of the lowest incomes on the Island) with 23.2% of residents living below the poverty line (U.S. Census 2017). Additionally, many Puna residents lack adequate housing (U.S. Department of the Interior Strategic Sciences Group 2019).

Residents with no internet, participating in SNAP (Supplemental Nutrition Assistance Program), and living below the poverty line represent the top three vulnerable population categories in Puna in terms of total number of residents. The County may consider the high rate and density of residents with no internet in future planning efforts, especially with specific focus on ways in which to provide alternative means of communication to those residents during an event or during awareness campaigns.

Nearly half of Puna residents living in the Volcanic High Hazard Area are either under 18 years of age or over 65 years of age (46.6%). Additionally, 20% of residents living in the Volcanic High Hazard Area have no phone so they have limited connectivity in terms of receipt of standard hazard alerts and emergency evacuation notices. Further, 21.8% of residents living in the Volcanic High Hazard Area have physical limitations due to a disability. The following summarizes the residents living in the Volcanic High Hazard Area that are considered the most vulnerable to the volcanic hazard in Puna (estimates generated using American Community Survey (ACS) 2017 data; therefore, pre-2018 Kīlauea event population statistics):

- 2,448 people under 18 years of age
- 2,202 people over 65 years of age
- 2,254 single parents
- 1,435 people living with a disability
- 3,566 people with no internet access
- 496 people with no vehicle access
- 209 people with no phone access
- 858 people who are unemployed representing nearly half of total unemployed in Puna

Table 4-91. Puna Vulnerable Population

Estimated Vulnerable Populations	
No Internet	16,014
SNAP	12,460
Below Poverty Line	11,008
Under 18	10,545
Single Parent	9,783
Over 65	7,986
Disability	6,595
No Health Insurance	3,569
No Diploma	2,396
Non-English Speaking	2,247
Unemployed	1,933
No Vehicle	1,578
No Phone	1,034



- 3,051 people utilizing SNAP
- 2,784 people living below the poverty line—representing 25.3% of all those living below the poverty line in Puna

Many Puna residents utilize a catchment system for water supply and many residents live “off-the-grid” and are not connected to central power (Pushard 2019). In the late 1980s, studies conducted on private rainfall catchment systems in the South Kona area revealed higher than average acidity in several water samples. Drinking the acidic water does not pose a health hazard, but such water can leach lead from the lead roof flashings, lead-headed nails, and solder connections found in many plumbing systems, resulting in unsafe levels of lead in the drinking water. Extensive testing in 1988 determined that many rainfall catchment systems in the County of Hawai'i, particularly those in the districts adjacent to or downwind of an active volcanic vent, contained elevated levels of lead (Tetra Tech 2018). Populations at greatest risk to lead exposure are children less than 6 years old and pregnant women (Centers for Disease Control and Prevention [CDC] 2019).

Tables 4.7-4 through 4.7-7 summarize the exposure of vulnerable residents in Puna by socioeconomic factor to the volcanic hazard, as well as where the volcanic hazard area overlaps with another high hazard zone.

Table 4-92. Puna Household Composition by Volcanic Hazard Area - A measure of households containing one or more vulnerable groups susceptible to the negative impacts of natural disasters.

Hazard Area	Total Residents (number / %)	Under 18 (number / %)	Over 65 (number / %)	Single-Parent Household (number / %)	Persons with Disability (number / %)
Volcanic High Hazard Area (VHHA)	11,080 / 23.4%	2,448 / 23.2%	2,202 / 27.6%	2,254 / 23%	1,435 / 21.8%
VHHA with Additional Natural High Hazard Area	587 / 5.3%	128 / 5.2%	118 / 5.4%	118 / 5.2%	76 / 5.3%
Lava Zone 1	2,093 / 4.4%	328 / 3.1%	575 / 7.2%	306 / 3.1%	315 / 4.8%
Lava Zone 1 with Additional Natural High Hazard Area	35 / 1.7%	9 / 2.7%	6 / 1%	8 / 2.6%	4 / 1.3%
Lava Zone 2	8,987 / 19%	2,210 / 20.1%	1,627 / 20.4%	1,948 / 19.9%	1,120 / 17%
Lava Zone 2 with Additional Natural High Hazard Area	552 / 6.1%	120 / 5.6%	112 / 6.9%	110 / 5.7%	72 / 6.4%

Note: Total residents in each hazard area were calculated separately as distinct and separate; therefore, individual hazard area totals do not equate to the VHHA total.

Table 4-93. Puna Household Member Health and Transportation by Volcanic Hazard Area - A measure of households with increased vulnerability due to the lack of a vehicle (i.e. evacuation); and a measure of the population's access to critical services such as access to transportation routes and medical services.

Hazard Area	No Vehicle (number / %)	No Health Insurance (number / %)
Volcanic High Hazard Area (VHHA)	496 / 31.4%	801 / 22.4%
VHHA with Additional Natural High Hazard Area	27 / 5.3%	43 / 5.3%
Lava Zone 1	123 / 7.8%	183 / 5.1%
Lava Zone 1 with Additional Natural High Hazard Area	1 / 1.1%	2 / 1.3%
Lava Zone 2	373 / 23.6%	617 / 17.3%
Lava Zone 2 with Additional Natural High Hazard Area	25 / 6.7%	40 / 6.5%

Note: Total residents in each hazard area were calculated separately as distinct and separate; therefore, individual hazard area totals do not equate to the VHHA total.

**Table 4-94. Puna Resident Access to Information by Volcanic Hazard Area - A measure of the ability to receive, comprehend and appropriately act on complex messaging with regard to natural disasters.**

Hazard Area	No High School Diploma, Over 25 Years Old (number / %)	Non-English Speaking (number / %)	No Internet (number / %)	No Phone (number / %)
Volcanic High Hazard Area (VHHA)	523 / 21.8%	416 / 18.5%	3,566 / 22.3%	209 / 20.2%
VHHA with Additional Natural High Hazard Area	28 / 5.3%	22 / 5.3%	189 / 5.3%	11 / 5.5%
Lava Zone 1	110 / 4.6%	58 / 2.6%	704 / 4.4%	75 / 7.3%
Lava Zone 1 with Additional Natural High Hazard Area	2 / 1.4%	1 / 2.5%	11 / 1.6%	0 / 0.5%
Lava Zone 2	413 / 17.2%	357 / 15.9%	2,862 / 17.9%	133 / 12.9%
Lava Zone 2 with Additional Natural High Hazard Area	26 / 6.4%	20 / 5.7%	178 / 6.2%	11 / 8.2%

Note: Total residents in each hazard area were calculated separately as distinct and separate; therefore, individual hazard area totals do not equate to the VHHA total.

Table 4-95. Puna Resident Socioeconomic Status, by Volcano Hazard Area - A measure of the population that is less likely to have the necessary economic resources to adequately prepare for or recover from a natural disaster.

Hazard Area	Unemployed (number / %)	Receiving SNAP (number / %)	Below Poverty Line (number / %)
Volcanic High Hazard Area (VHHA)	858 / 44.4%	3,051 / 24.5%	2,784 / 25.3%
VHHA with Additional Natural High Hazard Area	45 / 5.3%	161 / 5.3%	148 / 5.3%
Lava Zone 1	127 / 6.6%	534 / 4.3%	585 / 5.3%
Lava Zone 1 with Additional Natural High Hazard Area	3 / 2.3%	10 / 1.9%	8 / 1.4%
Lava Zone 2	731 / 37.8%	2,518 / 20.2%	2,199 / 20%
Lava Zone 2 with Additional Natural High Hazard Area	42 / 5.8%	151 / 6%	140 / 6.3%

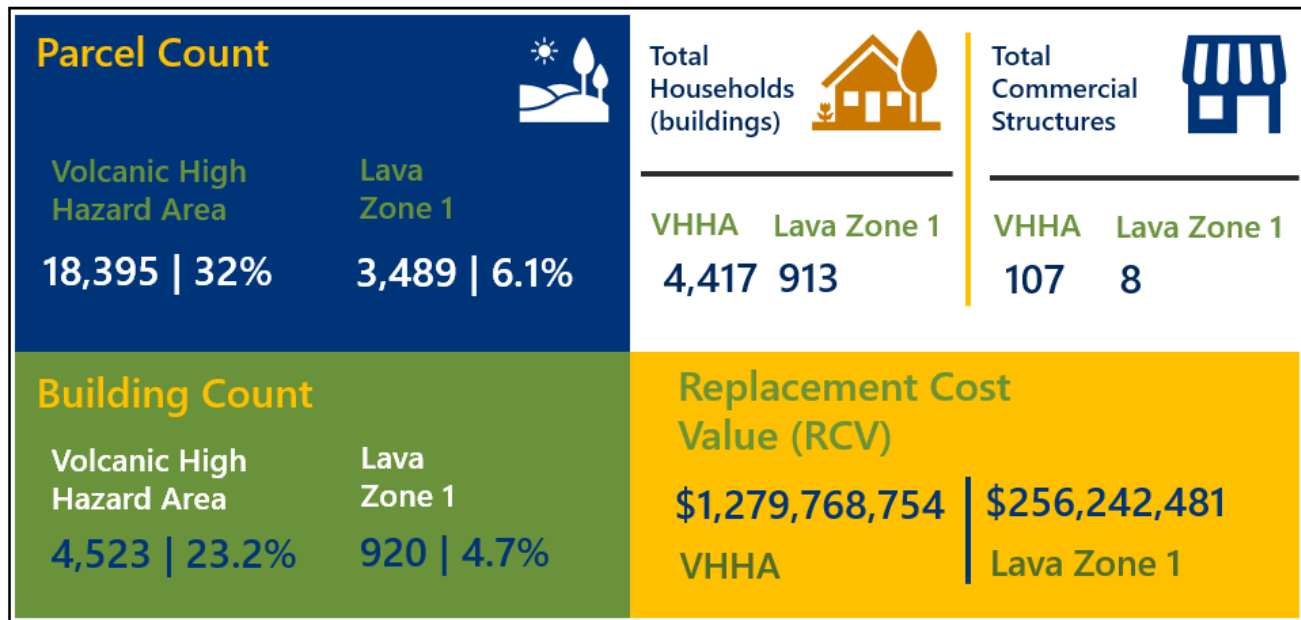
SNAP Supplemental Nutrition Assistance Program

Note: Total residents in each hazard area were calculated separately as distinct and separate; therefore, individual hazard area totals do not equate to the VHHA total.

According to the 2008 Puna Community Development Plan, because of the built form and low density of Puna's subdivisions, evacuation of residents on a short notice (in the event of a lava flow or other hazard event like tsunami or wildfire) is a significant concern and something to be factored into future planning efforts. Furthermore, the subdivisions often have few streets, which is notable considering the typical large size of each subdivision. The relative high-density nature of Puna's vulnerable populations (i.e. children, elderly, people with a disability) is also an important factor. With limitations on speed of evacuation, the County may consider alternative emergency messaging strategies. These alternative strategies could help Puna's residents without internet access or phones, or those who will need longer to evacuate (like the elderly, people with limited mobility, and children).



4.7.5 PARCELS AND BUILDINGS



Note: All percentages are relative to the Puna District

Figure 4-145. Puna Parcels and Buildings Located in a Volcanic High Hazard Area (VHHA)

The recent pattern of development and growth in Puna is the result of widespread land subdivision within the past half century. Most subdivision lots are served by publicly accessed private roads of varying standards. The streets generally lack sidewalks and lighting, and do not meet current County standards in terms of pavement width, vertical geometrics, drainage and other design parameters. None of the subdivisions have central sewer systems and only a couple have private water systems. As noted earlier, many lots rely on individual catchment systems supplemented with private delivery trucks for potable water. Large sections of some subdivisions are off the power grid (CHPD 2008).

Overall, Puna has the greatest building exposure to the volcanic hazard in the County. A total of 18,395 parcels (32%) and 4,523 buildings (23.2%) in Puna are located in the Volcanic High Hazard Area. At greatest risk to the lava-flow hazard are those developed parcels located in lava zone 1 (984 developed parcels and 920 buildings [statistics reflecting buildings after the 2018 Kīlauea eruption]); and lava zone 2 (3,865 developed parcels and 3,603 buildings). **Figure 4-146** illustrates the developed parcels by lava-flow hazard zone.

Lava flow will burn structures and bury land as well as everything else in its path. For the purposes of this analysis, the total assessed value (land and building) located in the volcanic hazard areas is reported to illustrate the potential future loss to existing parcels and development. The total assessed value of parcels located in the Volcanic High Hazard Area is an estimated \$1.027 billion which is greater than 20% of the Puna District's total parcel assessed values. In terms of the replacement cost value of buildings (estimated structure and contents), an estimated \$1.280 billion is located in the Volcanic High Hazard Area (**Table 4-96**).

**Table 4-96. Number of Parcels and Buildings Exposed to Volcanic Hazards**

Hazard Area	Total Number of Parcels (number / %)	Total Assessed Value (land and structure)	Total Number of Buildings (number / %)	Replacement Cost Value (structure and contents)	Total Households (buildings / %)	Total Commercial Units (buildings / %)
Volcanic High Hazard Area (VHHA)	18,395 / 32%	\$1,026,590,200	4,523 / 23.2%	\$1,279,768,754	4,417 / 23.2%	107 / 23.1%
VHHA with Additional Natural High Hazard Area	1,640 / 8.9%	\$191,617,000	230 / 5.1%	\$74,108,808	230 / 5.2%	0 / 0%
Lava Zone 1	3,489 / 6.1%	\$139,071,900	920 / 4.7%	\$256,242,481	913 / 4.8%	8 / 1.7%
Lava Zone 1 with Additional Natural High Hazard Area	230 / 6.6%	\$28,174,200	13 / 1.4%	\$2,490,744	13 / 1.4%	0 / 0%
Lava Zone 2	14,899 / 25.9%	\$855,926,700	3,603 / 18.5%	\$1,023,526,273	3,504 / 18.4%	99 / 21.4%
Lava Zone 2 with Additional Natural High Hazard Area	1,405 / 9.4%	\$132,655,600	217 / 6%	\$71,618,063	217 / 6.2%	0 / 0%

Note: Data in each hazard area were calculated separately as distinct and separate areas; therefore, individual hazard area totals do not equate to the VHHA total.

Replacement cost value calculated using 2019 RS Means data.

Source: June 2019 Real Property Tax (RPT) database and 2019 County parcel dataset; buildings determined on parcels using the DWELDAT and COMDAT tables.

The County of Hawai'i did not adopt modern building codes contained in the 1982 Uniform Building Code (UBC) until 1985, meaning the County did not start requiring seismic building standards until 1985. All structures built prior to 1985 are therefore, for the purposes of this analysis, considered to be unreinforced and susceptible to hurricane and earthquake damage due to the lack of uplift ties and a complete load path of connections (Martin and Chock, Inc. 2015). The frequency and location of the structures built prior to 1985 (both residential and commercial) is illustrated on **Figure 4-147** with many clustered very close or even overlapping with the 2018 Kilauea flow.

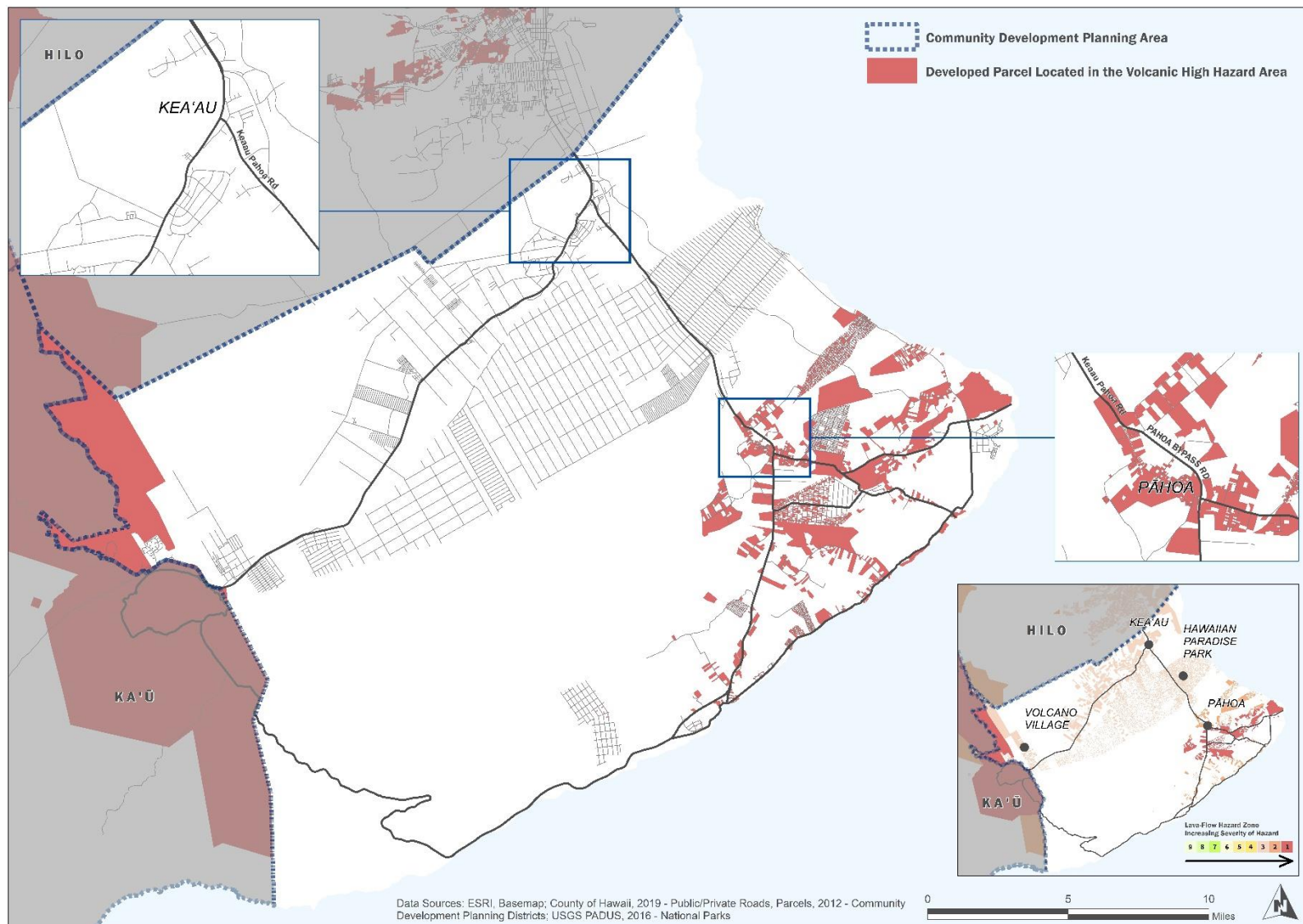


Figure 4-146. Developed Parcels in Puna by Lava Zone and the Volcanic High Hazard Area

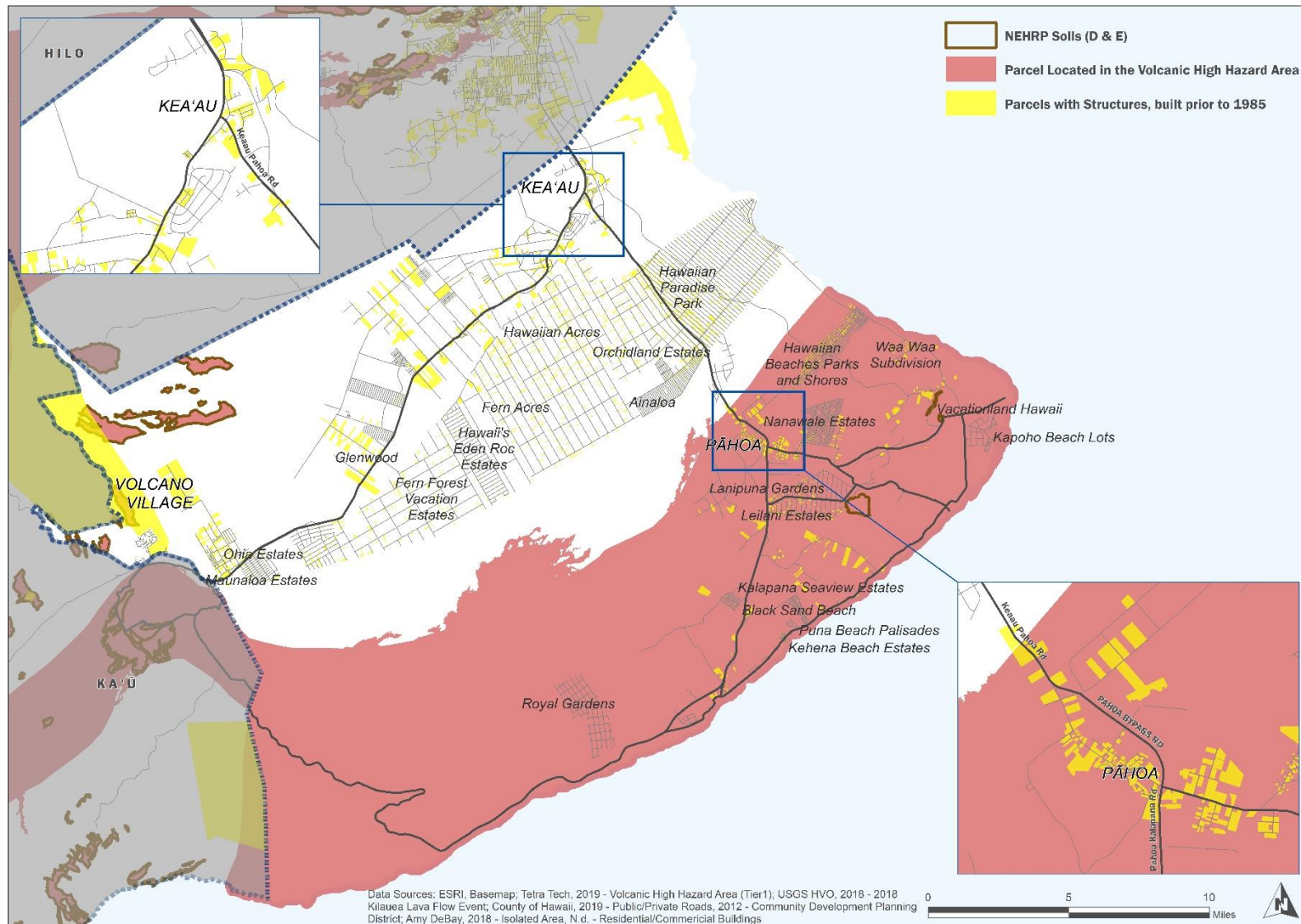


Figure 4-147. Puna Parcels with Structures Constructed Pre-1985 in the Volcanic High Hazard Area



4.7.6 CRITICAL FACILITIES AND LIFELINES

Critical Facilities + Lifelines		Safety + Security Assets	Socially Vulnerable Assets
Volcanic High = 41 45.6% Hazard Area		15 Volcanic High Hazard Area	5 Volcanic High Hazard Area
Lava Zone 1 = 10 11.2%		1 Lava Zone 1	0 Lava Zone 1
Utility Assets	Food, Water, + Shelter Assets	Transportation Assets	Recovery Support Assets
11 Volcanic High Hazard Area	6 Volcanic High Hazard Area	0 Volcanic High Hazard Area	4 Volcanic High Hazard Area
9 Lava Zone 1	0 Lava Zone 1	0 Lava Zone 1	0 Lava Zone 1

Note: All percentages are relative to the Puna District

Figure 4-148. Puna Critical Facilities and Lifelines Located in the Volcanic High Hazard Area and Lava Zone 1

Through the development of the volcanic risk assessment, 90 critical facilities and lifelines were identified in Puna. The critical facility and lifeline categories align with the 2015 County Hazard Mitigation Plan asset categories.

Table 4.7-9 summarizes the exposure of these critical facilities to the volcanic hazards. Overall, the Puna District's critical facilities are heavily located in the Volcanic High Hazard Area, and therefore susceptible to volcanic event impacts (*see Figure 4-149*). Of the 41 critical assets located in the Volcanic High Hazard Area, 10 are located in lava zone 1 (9 utility assets, and 1 safety and security asset), and 31 are located in lava zone 2. Relative to the County, Puna has the highest percentage of critical facilities and lifelines located in the Volcanic High Hazard Area (45.6%).

Infrastructure provides connectivity between communities and resources, as well as emergency access to keep residents safe. It is closely tied to housing providing livable spaces with services needed for communities to thrive. The miles of road that intersect the Volcanic High Hazard Area and lava zones 1 and 2 were determined in an effort to understand their exposure and where potential future losses may be incurred. Most roads servicing Puna District subdivisions are privately owned and not designed for through traffic; however, residents rely on this infrastructure to travel to hospitals located outside of Puna when seeking medical assistance and other lifeline services. Much of this critical infrastructure was impacted during the 2018 eruption for the County to decide whether to restore or explore other options.

Ka'ū and Puna are the only CDPs with roadway that intersects lava zone 1. There are 74.1 miles of roadway in Puna that intersect lava zone 1 with the majority being publicly accessed private roads (41.5 miles) and County roads (23.9 miles). Similarly, the majority of the 306.8 miles of road in the Volcanic High Hazard Area are private (140.3 miles) and County roads (121.2 miles).



Similar to the discussion on structures constructed pre-1985, there are a number of critical facilities in Puna constructed prior to 1985 and therefore more vulnerable to earthquake damage (during a volcanic eruption or occurring separately). Based on year-built data, nearly half of Puna's critical facilities and lifelines were constructed prior to 1985. Depending upon the specific facility's design and mitigation measures installed post construction, earthquake damage prior to an eruption or during an eruption could have significant implications of life safety and the resilience of infrastructure systems.



Table 4-97. Puna Critical Facilities by Volcanic Hazard Area

Hazard Area	Number of Critical Facilities (number / %)	Built Prior to 1985 (number / %)	Safety and Security Assets (number / %)	Food, Water and Shelter Assets (number / %)	Recovery Support Assets (number / %)	Socially Vulnerable Assets (number / %)	Utility Assets (number / %)
Volcanic High Hazard Area (VHHA)	41 / 45.6%	2 / 5%	15 / 53.6%	6 / 46.2%	4 / 57.1%	5 / 33.3%	11 / 73.3%
Lava Zone 1	7 / 17.5%	0 / 0%	6 / 42.9%	0 / 0%	1 / 25%	0 / 0%	0 / 0%
Lava Zone 1 with Additional Natural High Hazard Area	10 / 11.2%	N/A	1 / 3.7%	0 / 0%	0 / 0%	0 / 0%	9 / 60%
Lava Zone 2	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%
Lava Zone 2 with Additional Natural High Hazard Area	30 / 33.7%	N/A	14 / 50%	6 / 46.2%	4 / 57.1%	5 / 33.3%	2 / 13.3%
VHHA with Additional Natural High Hazard Area	7 / 23.3%	0 / 0%	6 / 46.2%	0 / 0%	1 / 25%	0 / 0%	0 / 0%

N/A Not applicable

Note: Critical facilities in each hazard area were calculated separately as distinct and separate areas; therefore, individual hazard area totals do not equate to the VHHA total.

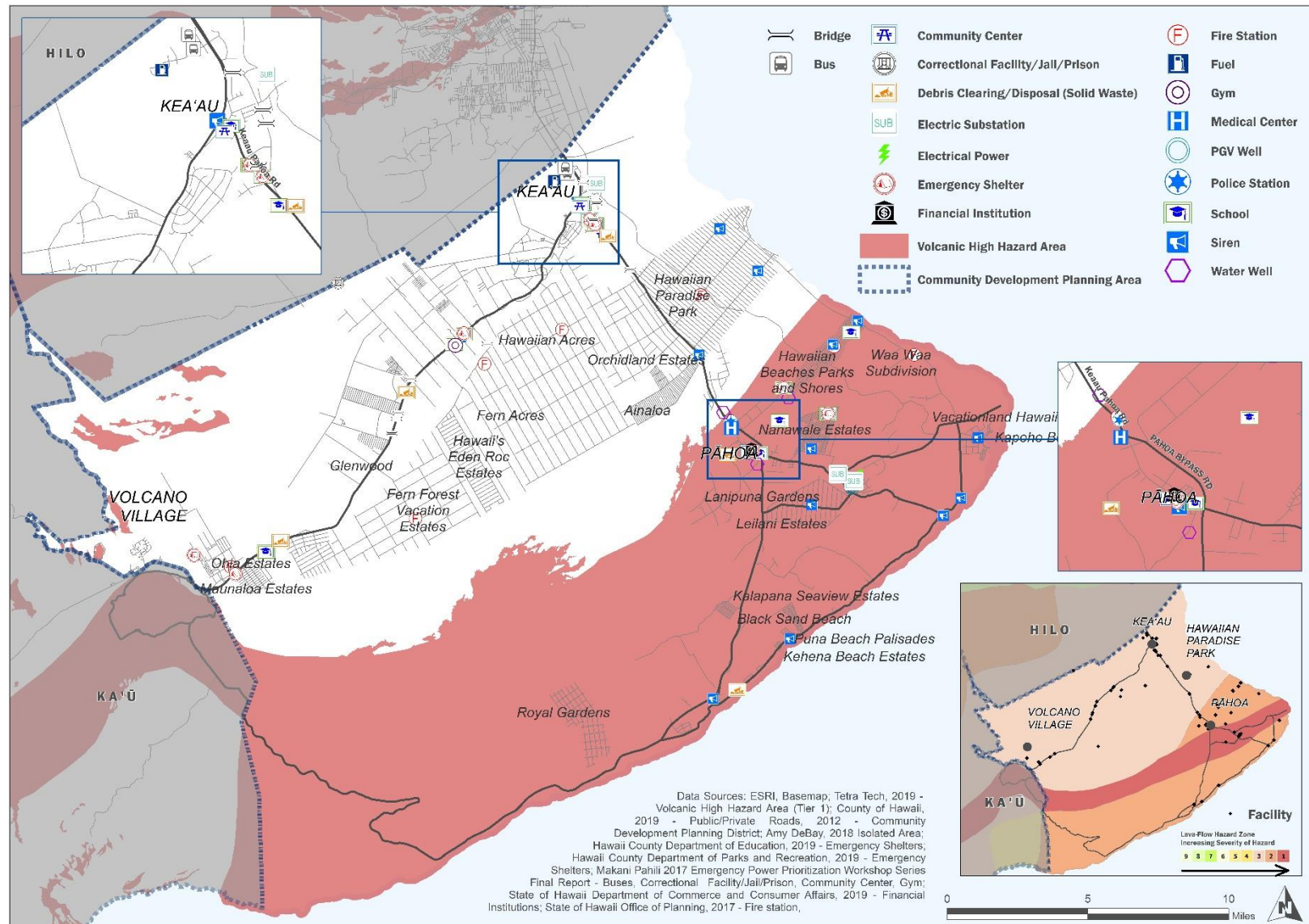
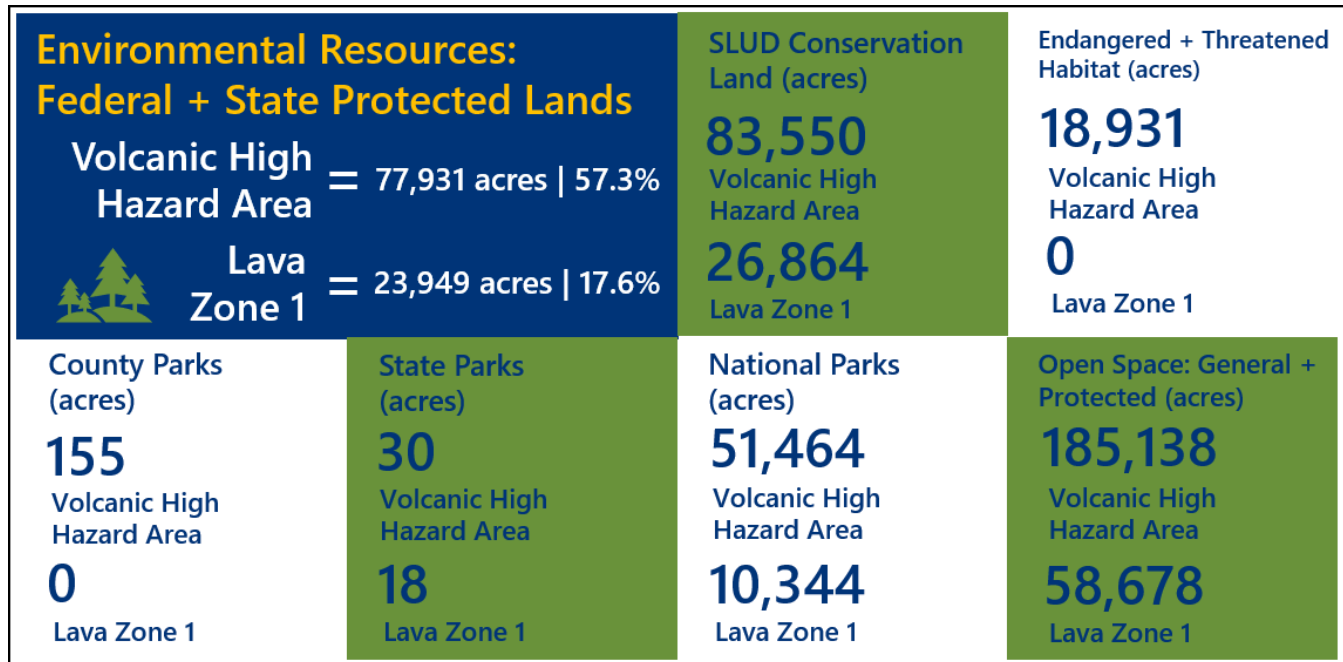


Figure 4-149. Puna Critical Facilities Located in Volcanic High Hazard Areas



4.7.7 ENVIRONMENT



Note: All percentages are relative to the Puna District

Figure 4-150. Puna Environmental Resources Located in the Volcanic High Hazard Area and Lava Zone 1

The majority of land in Puna is undeveloped with vast acreage of intact natural area that is protected under federal and state regulations (CHPD 2008). Agriculture in the region includes papaya, macadamia nuts, and orchid farming (Figure 4-152 and Figure 4.7-7). The area's exceptional trees, surfing spots, and Lava Tree State Monument attracts locals and tourists alike (U.S. Department of the Interior Strategic Sciences Group 2018).

Much of the land around the Kīlauea Volcano is undeveloped and protected by the Hawai'i Volcanoes National Park, which was founded on August 1, 1916, predating both the establishment of the National Park Service (August 25, 1916) and Hawaiian statehood (August 21, 1959). The Park has over 2 million visitors each year who spend around \$166 million in communities near the park. This spending supports over 2,000 local jobs. The Park also protects a range of prehistoric Native Hawaiian and Euro/American historic sites and is a site of spiritual significance for Native Hawaiian communities today (U.S. Department of the Interior Strategic Sciences Group 2018).

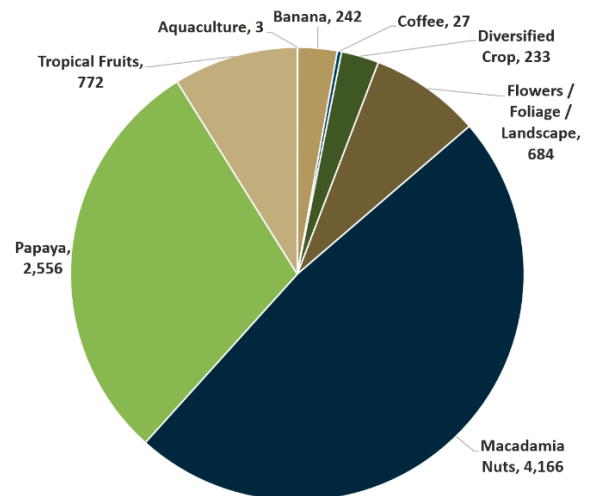


Figure 4-151. Puna Crop Land (Acres)



As part of this planning process, environmental assets identified as part of the General Plan update (in progress) were used for this assessment (see **Table 4-98**). **Figure 4-150** and **Figure 4-153** illustrate the environmental resources relative to the Volcanic High Hazard Area in Puna.

Table 4-98. Puna Environmental Resources

Agricultural Land of Importance (acres)	Crop Land (acres)	Pasture Land (acres)	Hunting Areas (acres)	Wetlands (acres)
61,343	8,683	14,461	40,924	242

Federal Reserves (acres)	State Reserves (acres)	Exceptional Trees	Anchialine Pools	Reservoirs	Endangered and Critical Habitats (acres)
96,533	39,526	126	110	18	63,272

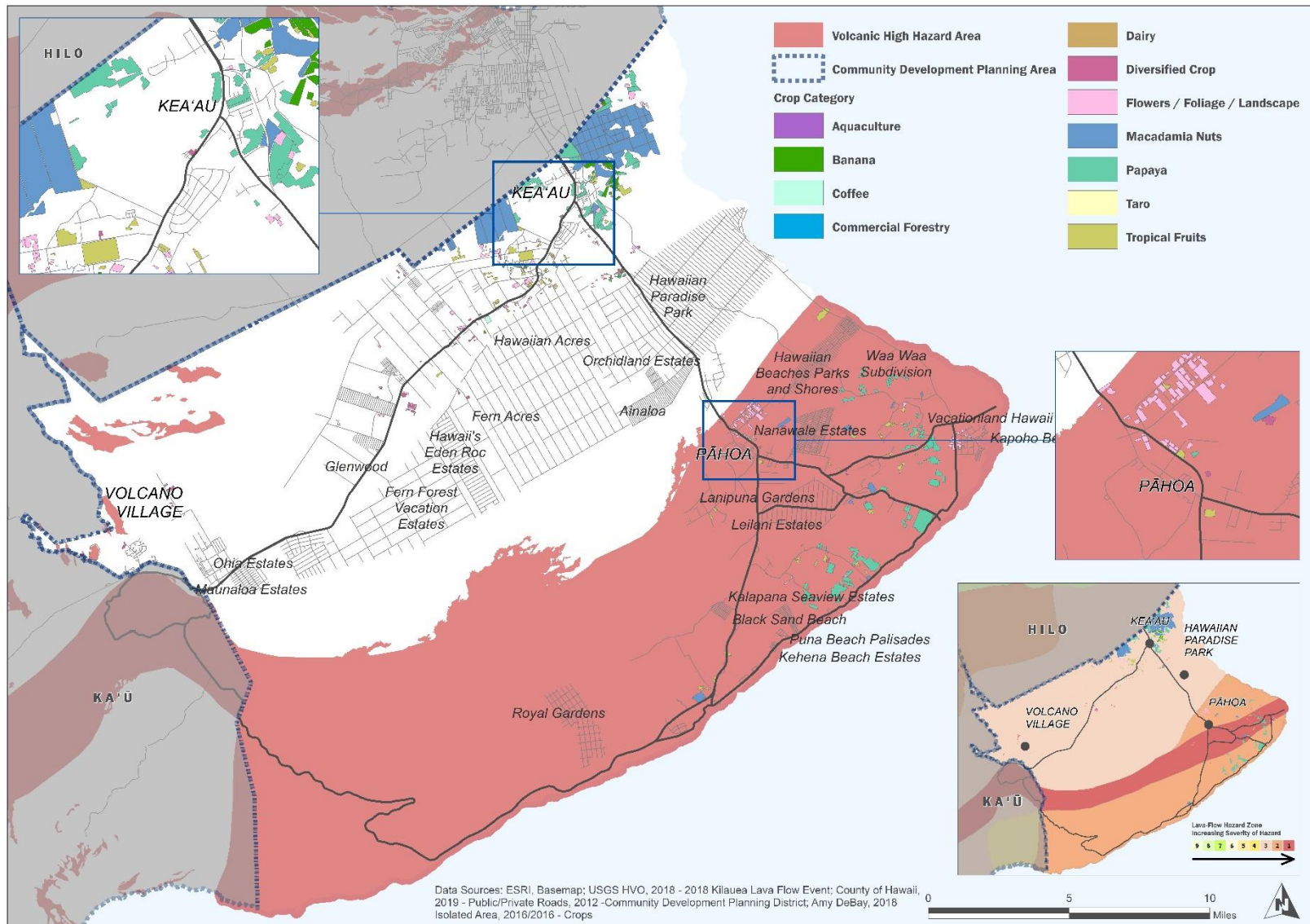


Figure 4-152. Puna Important Agricultural Crops Located in Lava Zones and Volcanic High Hazard Areas

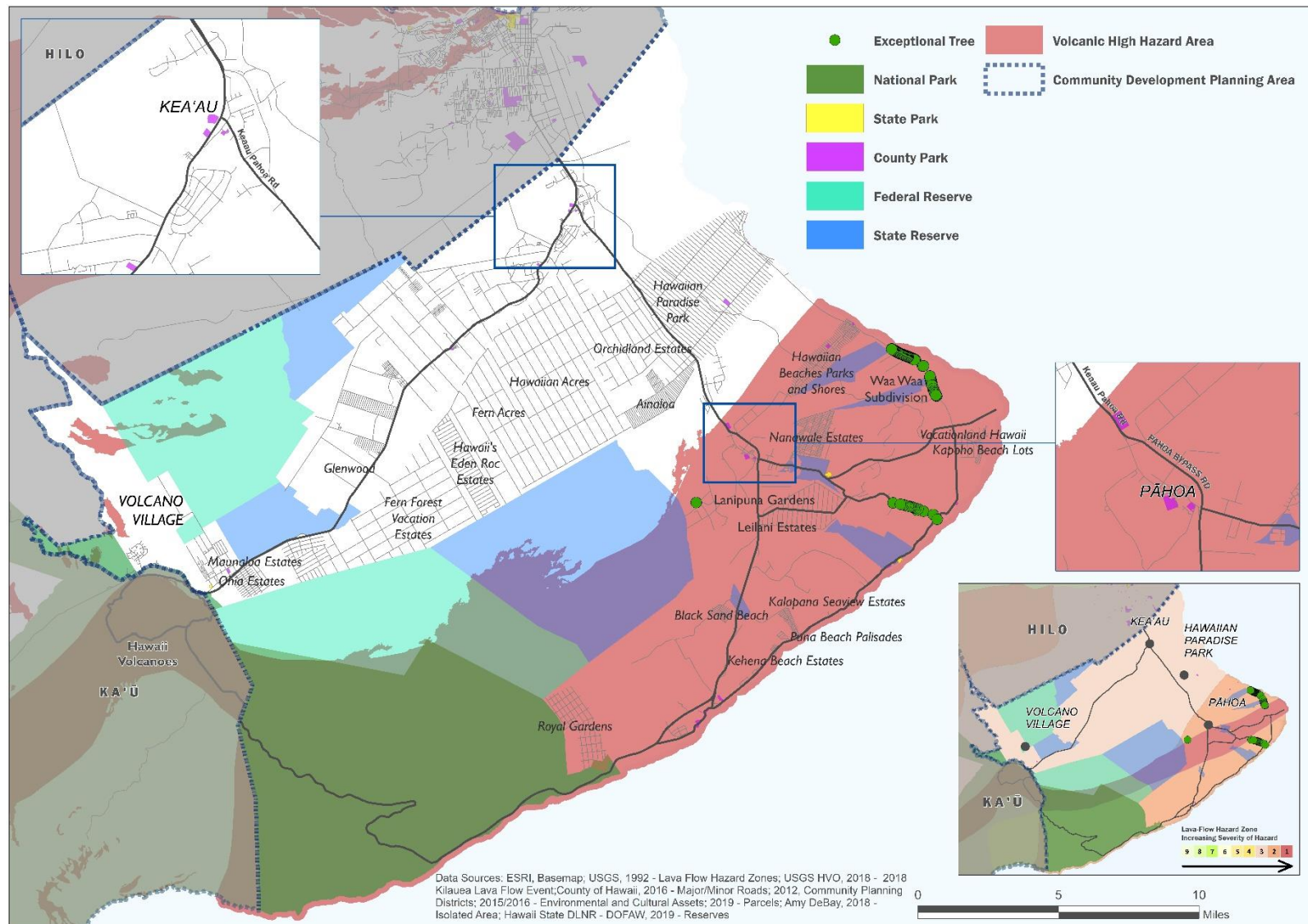


Figure 4-153. Protected Environmental Land in Puna Located in Lava Zones and Volcanic High Hazard Areas

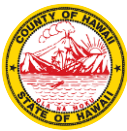


Puna has the County's highest percentage of federal and/or state reserve land located in a Volcanic High Hazard Area (57.3%) and lava zone 1 (17.6%). Puna's remaining protected land, including Hawai'i Volcanoes National Park, is nearly exclusively found in lava zone 1 or 2 (see **Table 4-99**).

Over 35% of Puna's Agricultural Land of Importance is in a Volcanic High Hazard Area, totaling 22,726 acres. The greatest percent of wetlands in the District are in a Volcanic High Hazard Area (50.7%) and the greatest percentage of anchialine pools in the District are in a Volcanic High Hazard Area (92.7%).

Thousands of acres of Puna's environmental resource land is located in lava zone 1. Over 25,000 acres (18.3%) of State Land Use Districts (SLUD) conservation land and over 20,000 acres of protected land (17.6%) is in lava zone 1. Over 10,000 acres (19.3%) of national park land is in lava zone 1, with nearly 100% (95.9%) located in a Volcanic High Hazard Area. All the County's identified exceptional trees are located in Puna's lava zones 1 or 2.

Except for banana and coffee, nearly all important agricultural crop types are located in lava zone 1. Over 50% of papaya crop land is in either lava zone 1 or lava zone 2. Flowers/foliage/landscape and tropical fruit crop land is also located in lava zones 1 and 2 (nearly 50%). All Puna's aquaculture crop land is in lava zone 1 (3 acres). Banana, coffee, diversified crops, and macadamia nuts are nearly 100% grown in lava zones 3 through 6.

**Table 4-99. Puna Environmental Resources Located in Volcanic High Hazard Areas**

Hazard Area	Total Protected Land (acres / %)	SLUD Conservation Land (acres / %)	Endangered and Threatened Habitat (acres / %)	Exceptional Trees (number / %)	Open Space: General and Protected (acres / %)	Agricultural Land of Importance (acres / %)
Volcanic	77,931 / 57.3%	83,550 / 57%	18,931 / 29.9%	126 / 100%	185,138 / 54.6%	22,726 / 37%
Lava Zone	23,949 / 17.6%	26,864 / 18.3%	0 / 0%	1 / 0.8%	58,678 / 17.3%	3,486 / 5.7%
Lava Zone	47,186 / 34.7%	49,350 / 33.7%	16,065 / 25.4%	125 / 99.2%	111,360 / 32.8%	18,751 / 30.6%

SLUD State Land Use District

Note: Acres and total numbers of environmental resources in each hazard area were calculated separately as distinct and separate areas; therefore, individual hazard area totals do not equate to the Volcanic High Hazard Area total.

Hazard Area	Crop Land (acres / %)	Pasture Land (acres / %)	Hunting Areas (acres / %)	County Park (acres / %)	State Park (acres / %)	National Park (acres / %)
Volcanic High Hazard Area	2,287 / 26.3%	1,368 / 9.5%	12,209 / 29.8%	155 / 68.6%	30 / 81.2%	51,464 / 95.8%
Lava Zone 1	564 / 6.5%	333 / 2.3%	4,389 / 10.7%	0 / 0%	18 / 46.9%	10,344 / 19.3%
Lava Zone 2	1,723 / 19.8%	1,035 / 7.2%	5,304 / 13%	155 / 68.6%	13 / 34.3%	40,923 / 76.2%

Note: Acres and total numbers of environmental resources in each hazard area were calculated separately as distinct and separate areas; therefore, individual hazard area totals do not equate to the Volcanic High Hazard Area total.

Hazard Area	Wetlands (acres / %)	Reservoirs (number / %)	Anchialine Pools (number / %)
Volcanic High Hazard Area	123 / 50.7%	6 / 33.3%	102 / 92.7%
Lava Zone 1	5 / 2%	3 / 16.7%	1 / 0.9%
Lava Zone 2	117 / 48.4%	3 / 16.7%	101 / 91.8%

Note: Acres and total numbers of environmental resources in each hazard area were calculated separately as distinct and separate areas; therefore, individual hazard area totals do not equate to the Volcanic High Hazard Area total.



In addition to lava flow, other volcanic hazards may also impact environmental resources. Besides respiratory tract health effects like those in humans, vog can also cause the death of wildlife and livestock because of contaminated food consumption. Wildlife and grazing livestock, for example, can die after ingesting water or grass that has been heavily contaminated by falling ash and other volcanic particles. As noted in **Table 4-99**, nearly 30% of hunting land and 10% of pasture land is in the Volcanic High Hazard Area. .

Also, of great concern to wildlife and livestock is the deposition of fluoride salts carried by vog onto forage crops. The scientific literature has documented a number of events where there have been significant losses of sheep, cattle, and horses because of acute exposure as well as chronic exposure and accumulation of fluoride salts by grazing animals (Martin and Chock 2013).

A 2010 study on the effects of fluoride and sulfates on forage lands downwind of the Kīlauea's Halema'uma'u Crater indicated that forage samples contained fluoride and sulfate values higher than recommended by the World Health Organization. The study also indicated that although elevated concentrations of fluoride and sulfate do induce adverse health/nutritional effects on grazing animals, the elevated levels of these compounds do not impact the quality of meat from those animals that would be used for public consumption (Thomas and Macomber 2010).

The general effects of sulfur dioxide exposure to plants varies between plant species, age, and the sulfur dioxide dosage. These effects may include:

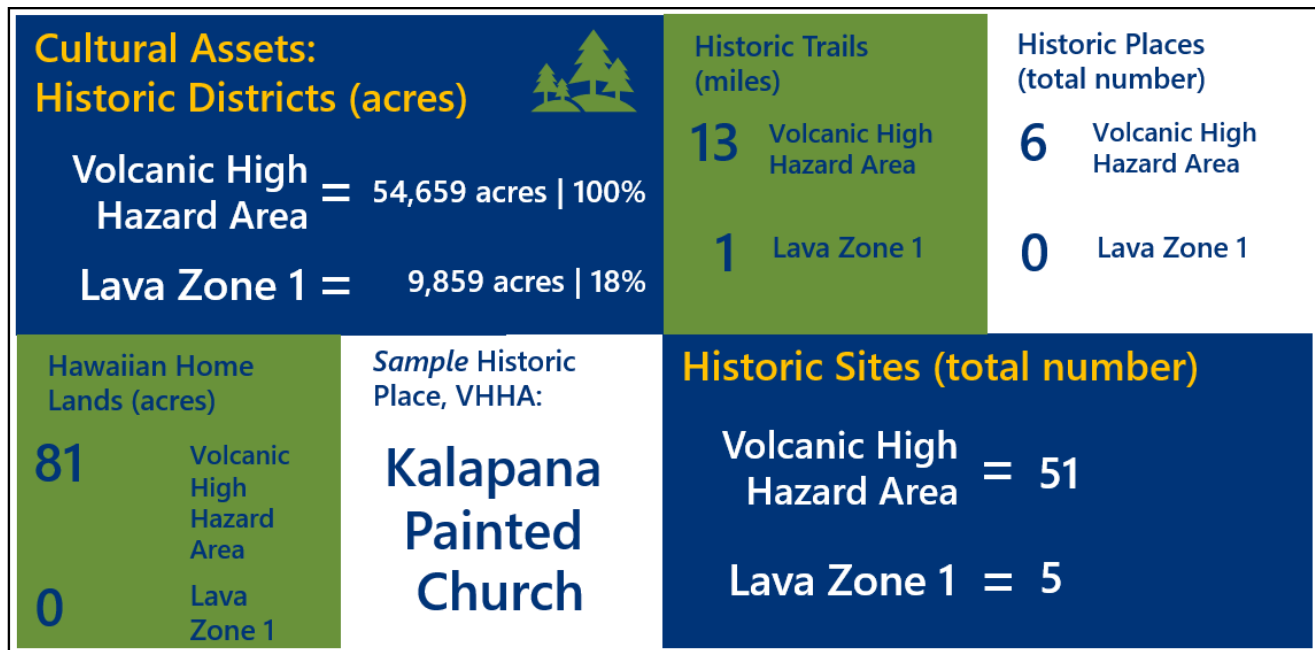
- Reduced seed germination
- Enhanced susceptibility to other diseases
- Foliar necrosis (spots, blight)
- Epicuticular wax erosion
- Rupture of epidermis, plasmolysis
- Reduced chlorophyll content
- Increased membrane permeability of plant leaves
- Decreased plant growth (root length, shoot length, leaf numbers)
- Plant organ or entire plant death

Downwind of Kīlauea, farmers growing food crops, foliage crops, and cut flowers have all experienced immediate and severe losses due to damage arising from exposure to high concentrations of sulfur dioxide and sulfuric acid aerosols. Although downwind ranches did not experience immediate impacts, over time, they have found that horses, cattle, and goats have developed serious adverse health impairment consistent with chronic fluoride exposure as well as severe mineral deficiencies. Currently, the mediating factors in these health impacts are not well understood, although excess bone fluoride has been measured and therefore chronic exposure to and intake of fluoride is clearly one aspect of the problem. A secondary economic issue has been greatly accelerated corrosion of fencing, pipelines, and deterioration of ranching equipment. Anecdotal reports of service life losses of 60% to 70% suggest that the economic impacts of these losses could be severe (Tetra Tech2018).

The impacts resulting from gas discharge detailed above are based on existing rates of discharge from more or less fixed locations of emissions. In the event of significant increases in the discharge rate from Kīlauea, or an eruption by Mauna Loa with ten or more times the gas production rate of Kīlauea, the impacts from the gas can be expected to increase correspondingly.



4.7.8 CULTURAL ASSETS



Note: All percentages are relative to the Puna District

Figure 4-154. Puna Cultural Assets Located in the Volcanic High Hazard Area and Lava Zone 1

Puna is home to many formally designated and recognized cultural assets, historic places and sites that are important for shaping the identity of place and the people of Puna and the County. A location-based database of culturally significant sites to Native Hawaiians was not available for use in this risk assessment; disclosure of the location of sacred and otherwise culturally significant sites is prohibited, in some instances, by federal law. To align with the County General Plan update, Hawaiian Home Lands, historic sites and trails were used for this analysis.

Cultural assets are non-renewable resources. Lava flows can cut off or cover cultural sites and native land. A total of 81 acres of Hawaiian Home Lands in Puna, 6 historic places, 51 historic sites and 13 miles of historic trail are in the Volcanic High Hazard Area. All 81 acres of Hawaiian Home Lands are in lava zone 2 (see **Table 4-100**).

It is important to note that a majority of the cultural asset locations are along the coast and overlap with other hazard areas including tsunami, sea level rise, flood and coastal erosion (see **Figure 4-155**).

Table 4-100. Puna Cultural Resources by Volcanic Hazard Area

Hazard Area	Hawaiian Home Lands (acres / %)	Historic Districts (acres / %)	Historic Places (number / %)	Historic Sites (number / %)	Historic Trail (miles / %)
Volcanic High Hazard Area (VHHA)	81 / 2.8%	54,659 / 100%	6 / 31.6%	51 / 48.1%	13 / 25.9%
VHHA with Additional Natural High Hazard Area	0 / 0%	2,030 / 3.7%	2 / 10.5%	37 / 72.5%	6 / 11.4%
Lava Zone 1	0 / 0%	9,859 / 18%	0 / 0%	5 / 4.7%	1 / 2.5%
Lava Zone 2	81 / 2.8%	44,801 / 82%	6 / 31.6%	46 / 43.4%	12 / 23.4%

Note: Acres and total numbers of cultural resources in each hazard area were calculated separately as distinct and separate areas; therefore, individual hazard area totals do not equate to the VHHA total.

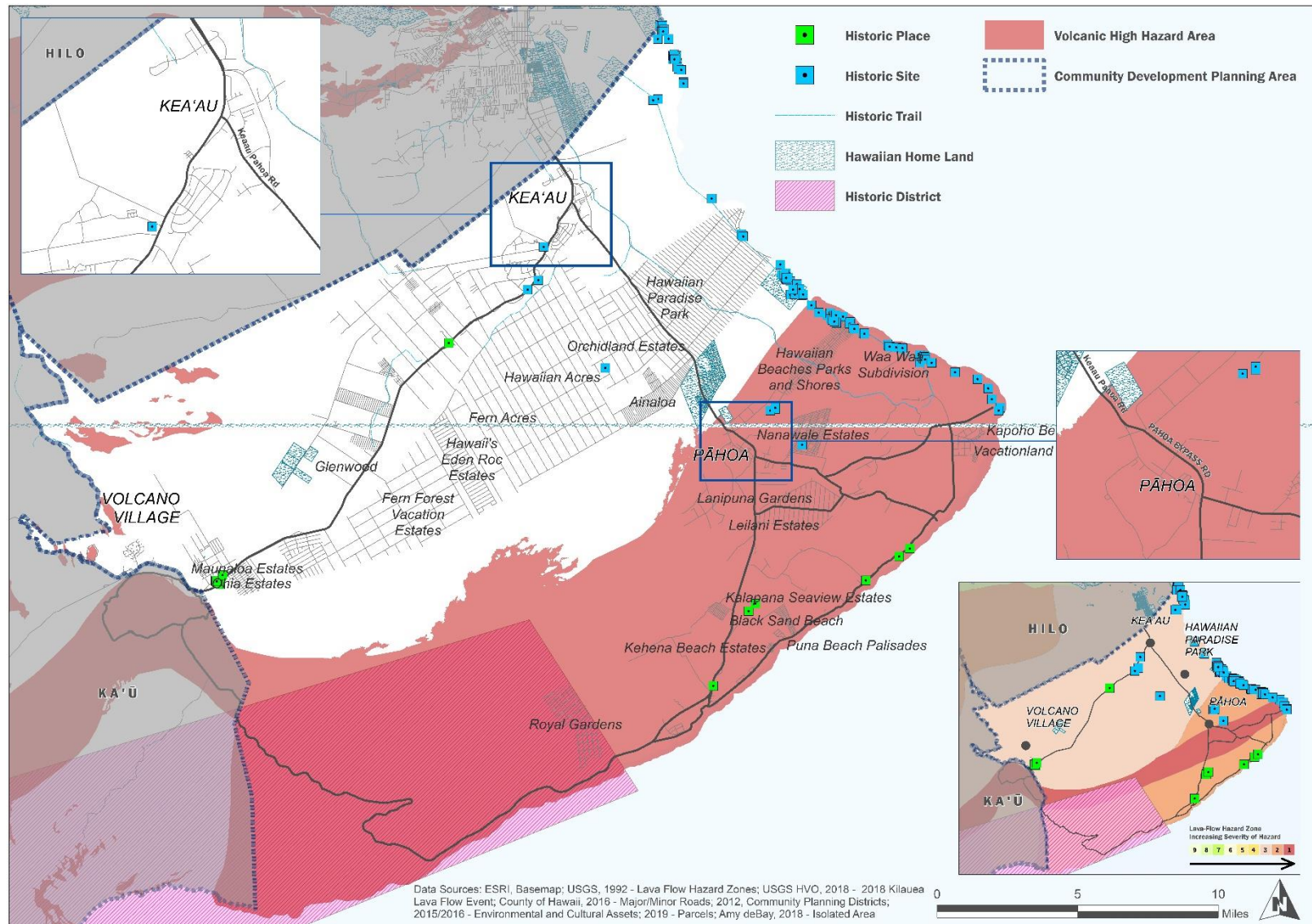


Figure 4-155. Cultural Assets in Puna and Volcanic Hazards



4.7.9 FUTURE LAND USE AND DEVELOPMENT

Puna is comprised of mixed land use classifications as categorized by the Land Use Pattern Allocation Guide (LUPAG) (see **Figure 4-156**). While LUPAG designations guide decisions related to future land use, County zoning determines a parcel's current permitted land use and development entitlements.

The majority of the western half of Puna is conservation land, which includes the Hawai'i Volcanoes National Park, representing 44.6% of all Puna land. A substantial portion of the remaining land in Puna is classified as agricultural land (43.6%), either extensive agriculture or important agricultural lands. Important agricultural lands are lands that are highly capable of producing significant yields of important agricultural outputs; whereas extensive agriculture includes lands that are not capable of producing sustained high agricultural yields without intensive application of farming methods and technologies. The remaining 12% of Puna is classified as a mix of urban expansion, industrial, urban, rural, or open area. According to the 2005 County of Hawai'i General Plan, urban expansion is described as allowing for a mix of high density, medium density, low density, industrial, industrial-commercial and/or open designations in areas where new settlements may be desirable, but where the specific settlement pattern and mix of uses have not been determined (CHPD 2005).

Kea'au is located in lava zone 3 with 428 acres classified as urban expansion, along with additional areas classified as industrial, medium and low density urban. The HPP is also located in lava zone 3; largely classified as rural. Pāhoā is located in the Volcanic High Hazard Area with 155.1 acres classified as urban expansion located in lava zone 2. See **Figure 4-157** for additional details about the classifications of Pāhoā's land relative to the volcanic hazard areas.

Overall, the land in lava zone 1 is mainly classified as conservation land (61%) and extensive agriculture land (25.7%) (see **Table 4-101**). There are 554 acres of land identified for urban expansion, and 486 acres identified as medium-density urban in the Volcanic High Hazard Area; these totals are exclusively in lava zone 2. All land designated as industrial is located outside of the Volcanic High Hazard Area in lava zone 3 (670 acres). Land identified for urban expansion may also be susceptible to other natural hazards. For example, the Kea'au area, located in lava zone 3, is adjacent to areas of high risk for landslides and flooding and includes a large area of land categorized for urban expansion.

Table 4-101. Puna Land Use (LUPAG classification) in the Volcanic High Hazard Area and Lava Zones 1 through 3

LUPAG Classification	Total Area (acres)	Volcanic High Hazard Area (acres)	Lava Zone 1 (acres)	Lava Zone 2 (acres)	Lava Zone 3 (acres)
Conservation	144,490	82,110	26,715	53,608	69,647
Extensive Agriculture	93,102	36,823	11,263	27,643	57,234
Important Agricultural Lands	48,204	19,766	2,777	18,546	28,466
Industrial	670	0	0	0	670
Low-Density Urban	7,710	4,514	170	4,499	3,193
Medium-Density Urban	1,285	486	0	486	799
Open Area	2,465	1,591	136	1,522	849
Rural	29,259	3,359	2,702	679	25,891
Urban Expansion	5,347	554	0	554	4,791

LUPAG Land Use Pattern Allocation Guide

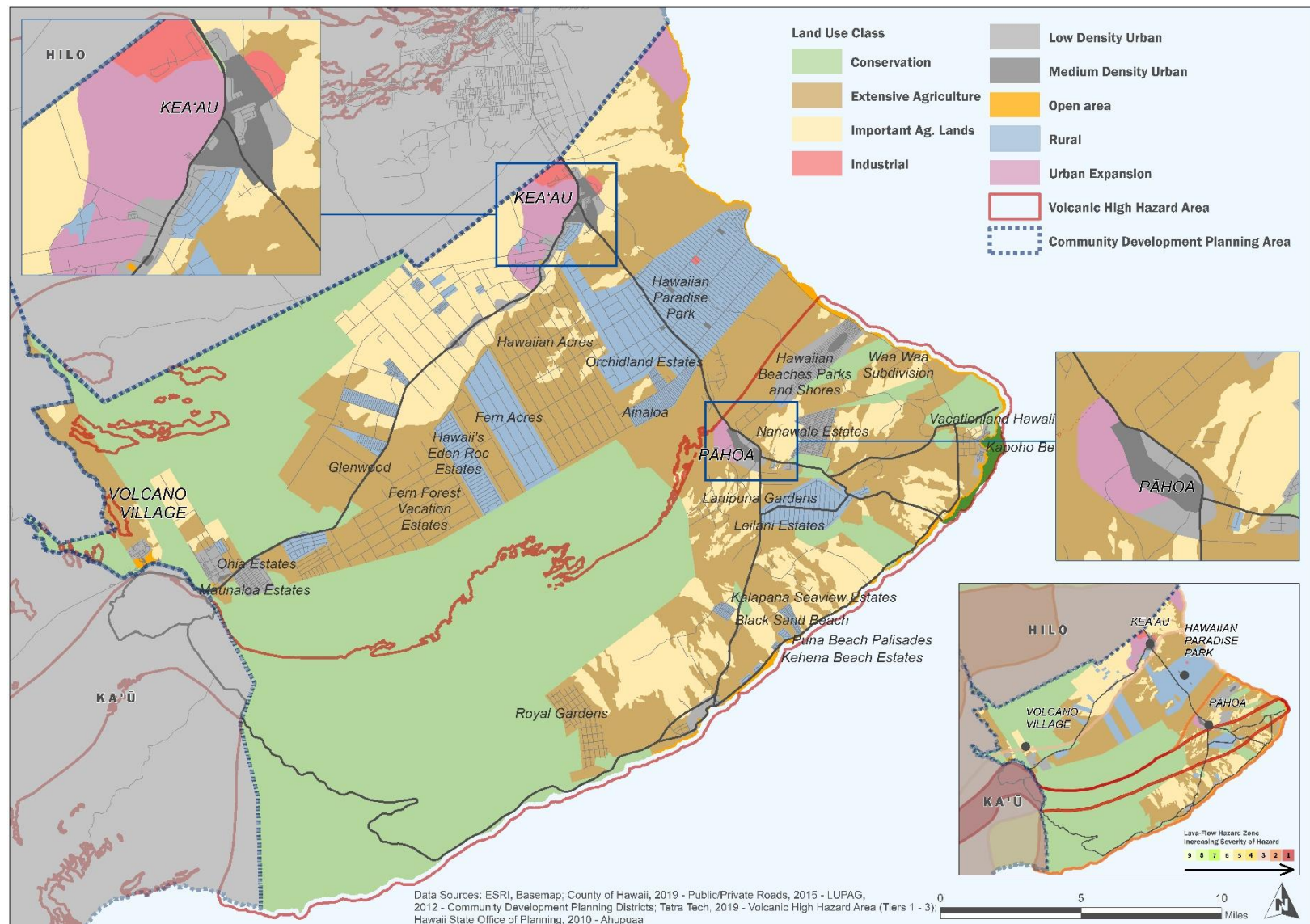


Figure 4-156. Puna Land Use Pattern Allocation Guide (LUPAG) Classifications and the Volcanic High Hazard Areas



Future land use decisions and future policies may consider the location of the volcanic and additional high hazards prior to or as part of future development decisions. In preparation for the County General Plan update, a build-out analysis was conducted to determine residential and non-residential capacity. Puna has the greatest total number of identified residential greenfield parcels in the County (35,888 parcels) illustrating the high potential for future development.

In Puna, there are 12,446 residential parcels identified for potential future development located in the Volcanic High Hazard Area; of these 2,047 are in lava zone 1, and 10,398 are in lava zone 2. In terms of non-residential development, there are 17 non-residential parcels located in the Volcanic High Hazard Area and 35 parcels identified for potential non-residential redevelopment. All non-residential parcels identified are in lava zone 2.

As discussed earlier, the exposure to other natural hazards should also be taken into consideration when considering future development decisions. Nearly 20% of parcels identified for residential redevelopment located in lava zone 1 also have the presence of another high hazard area. Refer to **Table 4-102** for additional statistics regarding parcels identified for future development and their location relative to the volcanic hazard areas and other high hazards.

Table 4-102. Puna Build-out Analysis Results and Hazard Areas

Hazard Area	Residential Greenfield (parcels / %*)	Residential Potential Redevelopment (parcels / %*)	Non-Residential Greenfield (parcels %*)	Non-Residential Potential Redevelopment (parcels / %*)
Volcanic High Hazard Area (VHHA)	12,446 / 34.7%	850 / 19.9%	17 / 16.7%	35 / 44.3%
VHHA with Additional Natural High Hazard Area	2,171 / 2%	224 / 26.4%	0 / 0%	0 / 0%
Lava Zone 1	2,047 / 5.7%	283 / 6.6%	0 / 0%	0 / 0%
Lava Zone 1 with Additional Natural High Hazard Area	86 / 4.2%	54 / 19.1%	0 / 0%	0 / 0%
Lava Zone 2	10,398 / 29%	567 / 13.3%	17 / 16.7%	35 / 44.3%
Lava Zone 2 with Additional Natural High Hazard Area	502 / 4.8%	170 / 30%	0 / 0%	0 / 0%

*The percentage of parcels relative to the total number in the Puna District.

Note: Parcels in each hazard area were calculated separately as distinct and separate areas; therefore, individual hazard area totals do not equate to the VHHA total.

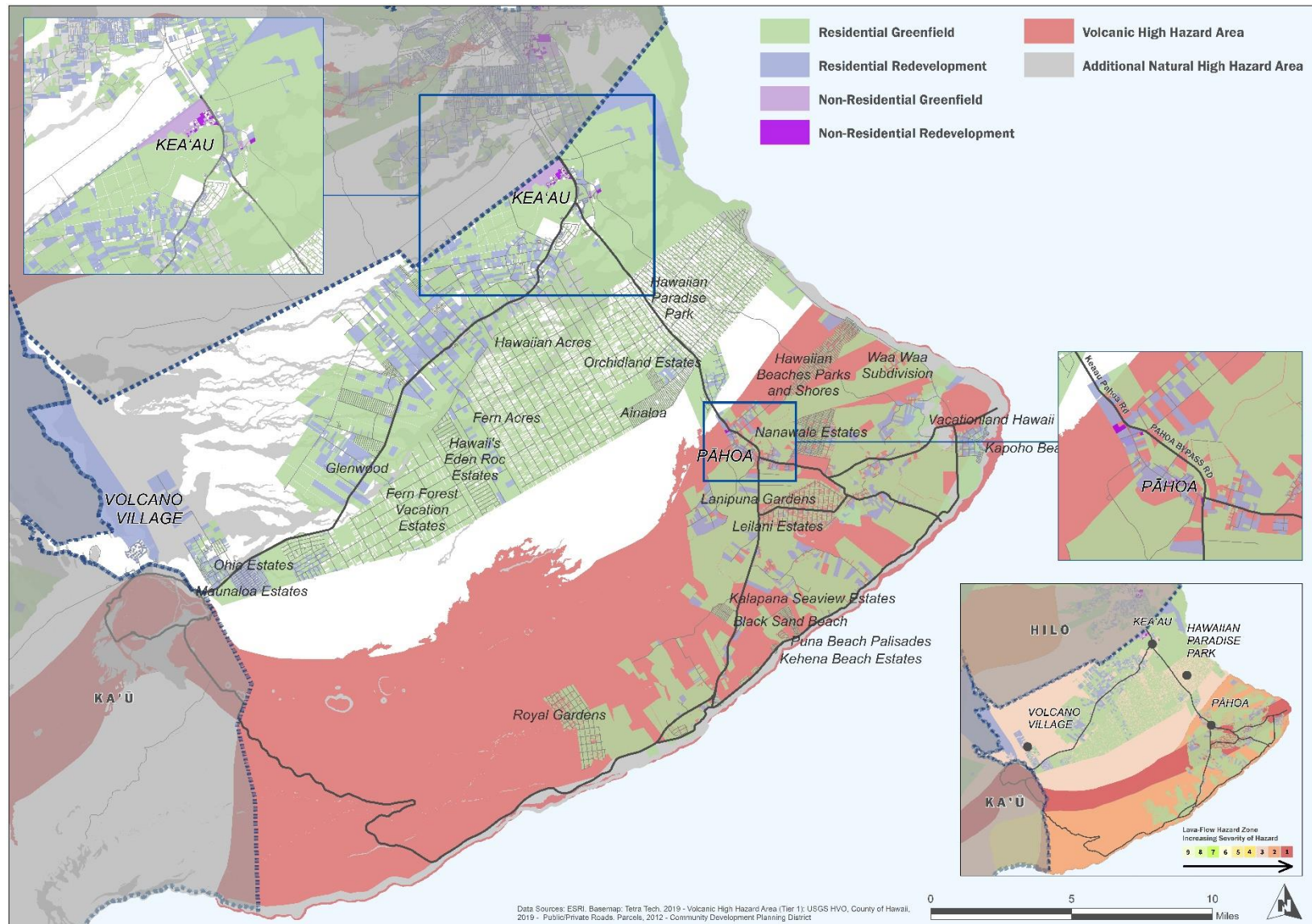


Figure 4-157. Puna Greenfield and Redevelopment Areas, and Volcanic Hazard Areas



Alongside Puna's significant exposure to volcanic high hazards, there is a significant lack of insurance for many structures, across the County. In 1991, State of Hawai'i lawmakers created a nonprofit collection of insurance companies called the Hawai'i Property Insurance Association to address this gap. The State assembled the nonprofit to provide basic property insurance for people who are unable to buy coverage in the private market, due to insurers being uncomfortable with Hawaii's significant volcano risk (Weiss 2018).

Looking to the future, high hazard risk combined with limited or high-cost insurance, when available, is a considerable factor when planning for the continued growth of Puna. Critical questions that need to be addressed prior to moving forward with future plans for development/re-development and decisions about future population centers in Puna are:

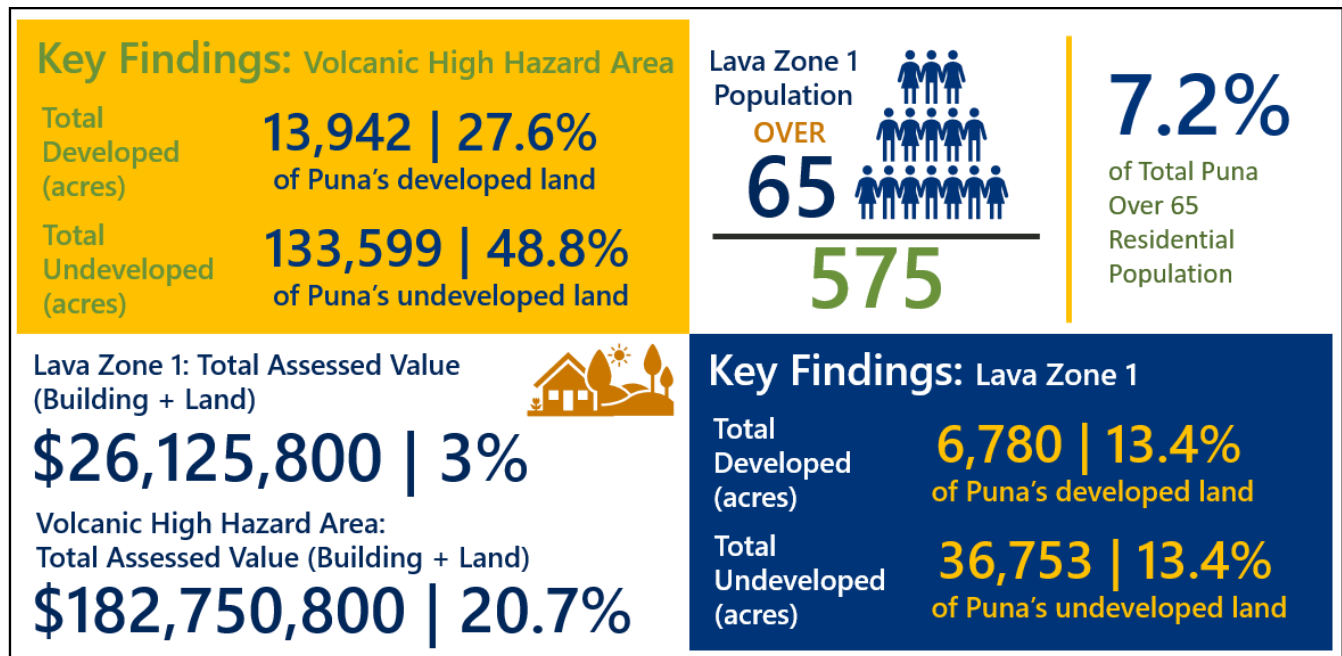
- Who will be able to afford to live in an area that is vulnerable to lava flow and other volcano-related risks?
- Physical exposure to a range of Puna's hazards has made certain areas more affordable to live. What are the choices available to Puna's economically vulnerable households?
- Will they remain and bear the burden when the next event takes place?
- What strategies do the County and community need to develop to manage residential development and infrastructure development relative to the expected demand on emergency services and repetitive losses in an area with high exposure to hazards?

It may be determined that redevelopment or continued development is not always the preferred option as the County and Puna community address the aforementioned questions. In fact, Hilo took an approach to some of their past damaged land to not rebuild, but rather turned the damaged land into a park—looking to other low hazard exposure land for development and population growth. The scale of the 2018 Kīlauea eruption requires all to consider the feasibility of this type of strategy and alternative solutions for future land use in Puna and other areas of high exposure to volcanic hazards.

An additional, yet related factor is the prevalence of informal houses or settlements within Puna. These settlements represent people that are often left out of traditional population surveys (i.e. U.S. Census) with homes that are not officially documented or recorded. This makes evacuation and emergency messages (or even evacuation teams) difficult (Romero 2018). In high hazard areas like Puna it's important to determine ways in which to account for the under-counted population and informal structures.



4.7.10 KEY FINDINGS



Note: All percentages are relative to the Puna District

Figure 4-158. Puna Key Findings

Understanding what is at risk to natural hazards can assist in planning for future development, and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The following summarizes the key findings for the Puna CDP District:

- Puna has the greatest number of parcels located in lava zone 1 (3,489) in the County
- Puna has the greatest building assessed value located in lava zone 1 (\$81,279,200) in the County
- 14,201 parcels (24.7%), 2,252 households (11.8%), and 4,852 residents (10.2%) have been inundated and impacted by historic lava flows, including the 2014-2015 Pu'u 'Ō'ō and the 2018 Kīlauea events
- Puna has 43,762 acres in lava zone 1; 12,096 acres (27.6%) have been inundated by recorded historic lava flows (including the 2014-2015 Pu'u 'Ō'ō and the 2018 Kīlauea events)
- Puna has 97,088 acres in lava zone 2; 25,573 acres (26.3%) have been inundated by recorded historic lava flows (including the 2014-2015 Pu'u 'Ō'ō and the 2018 Kīlauea events)
- 155.1 acres in Pāhoa that are classified as urban expansion are in the Volcanic High Hazard Area and lava zone 2 (with buffer).

Looking to the future, Puna is most immediately confronted with significant decisions about life safety, development, recovery, rebuilding, and general land use. The impacts from the 2018 Kīlauea event are still being felt district-wide, and many decisions still need to be made by residents and local government. Particularly, the population, sacred places and important agricultural land located in lava zone 1 is at greatest risk. Future redevelopment and greenfield development should be carefully considered with a full understanding and assessment of the implications of adding new uses and potentially new population in an area of Puna with exposure to the volcanic and other high hazard areas.



Alternatively, there are locations within Puna that are located outside of the Volcanic High Hazard Area, the area with the greatest risk to the volcanic hazard. These areas are located in the northern portion of Puna and should be assessed for future growth and redevelopment. Puna's regional town centers, Volcano, Kea'au, HPP, and Pāhoā have been and will continue to be important places and determinants of the future growth. All urban-expansion areas identified in Pāhoā (estimated 155.1 acres) are located in the Volcanic High Hazard Area and lava zone 2. Kea'au is located in lava zone 3; however, is proximate to other high hazards such as landslides and flooding (to the south). HPP is located in lava zone 3 and contains residential greenfield parcels which are classified for potential future growth. Furthermore, considerations for Puna's most vulnerable populations need to be made and prioritized, in support of reducing volcanic risk and exposure. Strategic policy decisions and priorities should be identified to target the District's most vulnerable, to reduce risk to future volcanic events and other hazard events.



4.8 South Kohala

4.8.1 OVERVIEW

The South Kohala Community Development Plan district (CDP), herein referred to as South Kohala, lies in the northwest portion of the Island of Hawai'i. Neighboring districts include North Kohala to the north, Hāmākua to the east, and Kona to the south. The Pacific Ocean defines the District's western border. South Kohala is approximately 176,500 acres and makes up approximately 6.8% of the land area of the County of Hawai'i. It is the second smallest CDP in the County, following North Kohala. South Kohala has the following three towns: Waimea, Puakō, and Waikōloa Village.

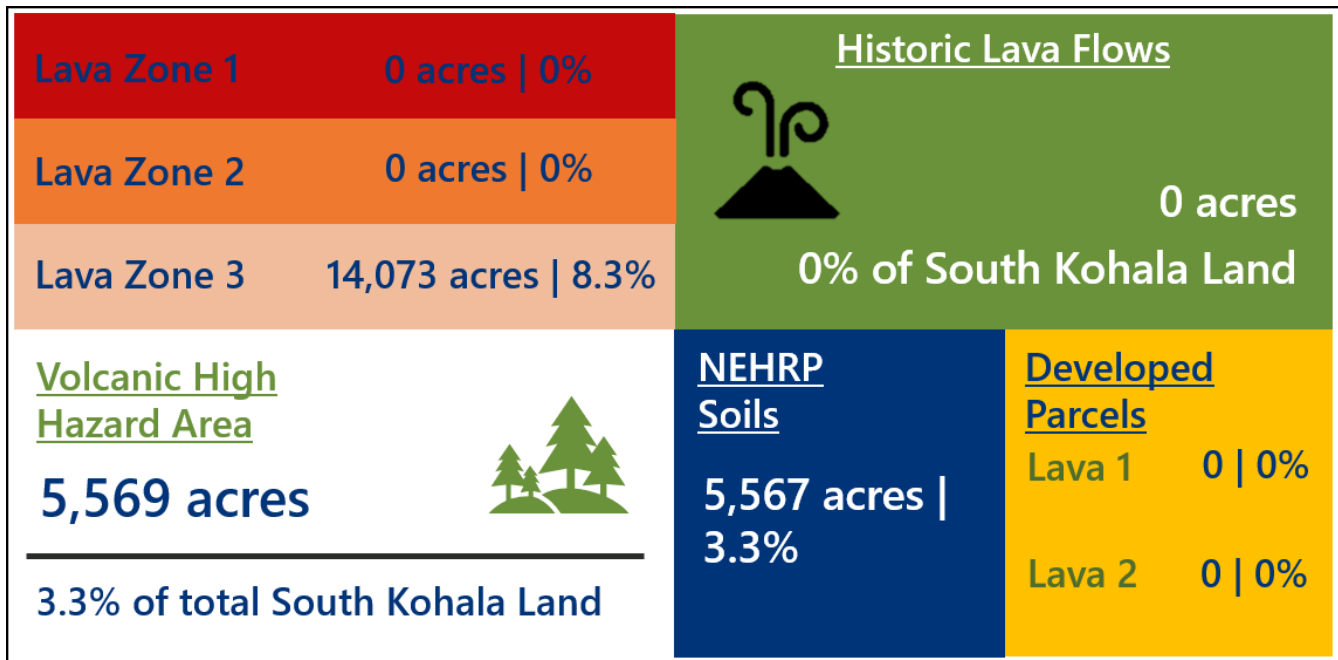


South Kohala has many sites and landscapes that have significant cultural and historical value to the Native Hawaiian people. According to the 2008 South Kohala CDP plan, the District is home to one of the fastest growing communities in the County, Waikōloa Village. Several notable white sand beaches on the island are located on South Kohala's coast and are frequent tourist destinations. Three popular resorts are located in South Kohala: Mauna Kea, Mauna Lani, and Waikōloa Resorts. In addition, one of the two commercial harbors in the County is located in South Kohala (Kawaihae Harbor). The second commercial harbor is located on the eastern shore of Hilo.

South Kohala has two distinct environmental landscapes: green and lush mountainous region in the northern half and a rugged, dry landscape in the southern half. The two largest population centers in South Kohala, Waimea Town (in the north) and Waikōloa Village (in the south) represent an additional duality that exists in the District. Waimea Town is a rural community situated in the mountainous plateau of the Kohala volcano. Waikōloa Village is a relatively new, more urban residential community. It was originally developed in the early 1970s to serve as a retirement community but evolved into a suburban community for a mix of resident ages. Today, Waikōloa Village has expanded and now includes luxury resorts, restaurants, and shopping, including some housing for service industry employees (CHPD 2008).



4.8.2 VOLCANIC HAZARDS



Note: All percentages are relative to the South Kohala CDP District

Figure 4-159. South Kohala Volcanic Hazard Exposure Overview

One of the County's five volcanoes is located within South Kohala's boundaries. The Kohala volcano is the County's oldest volcano and is located near the shared border between North Kohala and South Kohala. The Kohala volcano, often referred to as the Kohala Mountain, has not erupted in the last 60,000 years (U.S. Geological Survey [USGS] 2014).

South Kohala is located in lava zone 3 (8.3%), lava zone 8 (70.6%) and lava zone 9 (21.1%) (**Figure 4-160**). South Kohala's lava zone 8 is comprised of the oldest part of the dormant Mauna Kea. A small portion of lava zone 8 has been covered by lava in the past 10,000 years. Lava zone 9 is comprised of the Kohala volcano area and is the lowest lava-flow hazard zone. Lava zone 3 is located in the southernmost section of coastline. According to USGS, lava zone 3 contains areas less hazardous than lava zone 2 because of greater distance from recently active vents and (or) because of topography with moderate risk to future lava flows. According to USGS lava zone definitions, one to five percent of lava zone 3 land has been covered by historic lava flows since 1800, and 15 to 75 percent has been covered within the past 750 years (USGS 1992).

South Kohala contains over 5,000 acres of land located in the Volcanic High Hazard Area (3.3% of total South Kohala land). Of the Volcanic High Hazard Area, 2,504 acres are developed, and 3,064 acres are undeveloped. Of the individual volcanic hazard layers that comprise the Volcanic Hazard High Area, 100% of South Kohala's is the National Earthquake Hazard Reduction Program (NEHRP) D and E soils (refer to **Figure 4-161**).

Only 41.7% of South Kohala's land is considered "developed" (or parcels with a building assessment value according to County assessor records), and 3.5% of developed land is located within the Volcanic High Hazard Area (**Table 4-103**). For the purposes of this assessment, developed and undeveloped land has been calculated at the parcel level, regardless of private or public ownership.

**Table 4-103. South Kohala Developed vs. Undeveloped Parcel Area by Lava Zone**

	Total Area (acres)	Lava Zone 1 (acres)	Lava Zone 2 (acres)	Lava Zone 3 (acres)	Lava Zone 4 (acres)	Lava Zone 5 (acres)	Lava Zone 6 (acres)	Lava Zone 7 (acres)	Lava Zone 8 (acres)	Lava Zone 9 (acres)
South Kohala District	170,056	0	0	14,073	0	0	0	0	120,058	35,863
Developed	70,997	0	0	5,257	0	0	0	0	45,744	19,986
Undeveloped	99,058	0	0	8,816	0	0	0	0	74,314	15,877

Note: Developed parcels reflect a parcel that contains a building assessment value per the County assessor records.



Figure 4-160. Lava Zones in South Kohala



Lava is not the only volcanic hazard faced by South Kohala. Soil conditions have a profound influence on the characteristics of ground shaking during an earthquake, and parcels within South Kohala have some exposure to seismic activity. South Kohala has 301 parcels (or 3.7% of total parcels) located on softer soils (NEHRP types D and E, such as fill, mud and sand) that amplify ground shaking.

South Kohala is also vulnerable to the vog hazard. Vog conditions in the County of Hawai'i vary and depend on wind direction (northeasterly trade winds, southerly Kona winds) and emission source. As discussed in **Section 2 - Volcanic Hazard**, during prevailing trade winds, vog produced by Kīlauea is blown to the southwest and west, where wind patterns send it up to the eastern coast. Once wind reaches the eastern coast, it can become trapped by daytime and nighttime sea breezes (USGS 2000).

As discussed in **Section 3 - Methodology**, geographic information system (GIS)-based volcanic hazard areas were aggregated into a single category to identify those areas throughout the County with the greatest volcanic hazard risk: Volcanic High Hazard Area. The Volcanic High Hazard Area includes: lava zones 1 and 2, historic lava flow events (1790-2018), and NEHRP D and E soils. This risk assessment focuses on South Kohala's exposure to the Volcanic High Hazard Area and lava-flow hazard zones 1, 2, and 3. 3.7% of South Kohala is located within the Volcanic High Hazard Area with the remainder located in lava zones 3, 8, and 9. Refer to **Table 4-104** and **Figure 4-161** for a summary of South Kohala's land area in each volcanic hazard area.

Table 4-104. South Kohala Land by Volcanic High Hazard Area and Lava Zones 1, 2, 3, 8, and 9

Hazard Area	Total Land Area (acres)	Developed Parcel Area (acres)	Undeveloped Parcel Area (acres)
Volcanic High Hazard Area (VHHA)	5,569 (3.3%)	2,504 (3.5%)	3,064 (3.1%)
Lava Zone 1	0 (0%)	0 (0%)	0 (0%)
Lava Zone 2	0 (0%)	0 (0%)	0 (0%)
Lava Zone 3	14,073 (8.3%)	5,257 (7.4%)	8,816 (8.9%)
Lava Zone 8	120,058 (70.6%)	45,744 (64.4%)	74,314 (75%)
Lava Zone 9	35,863 (21.1%)	19,986 (28.2%)	15,877 (16%)

Note: Acres in each hazard area was calculated separately as distinct and separate areas; therefore, individual hazard area totals do not equate to the VHHA total.

South Kohala is prone to additional natural hazards. These hazards include, but are not limited to, sea level rise, landslides, high wildfire risk, and floods. In addition to examining the assets exposed to the volcanic hazards, it is important to determine if those assets are in additional natural high hazard zones to inform the identification of recovery and mitigation strategies. **Figure 4-162** illustrates the location of additional natural high hazard areas located in South Kohala and **Figure 4-163** illustrates the additional high hazard areas relative to the lava zones and Volcanic High Hazard Area.

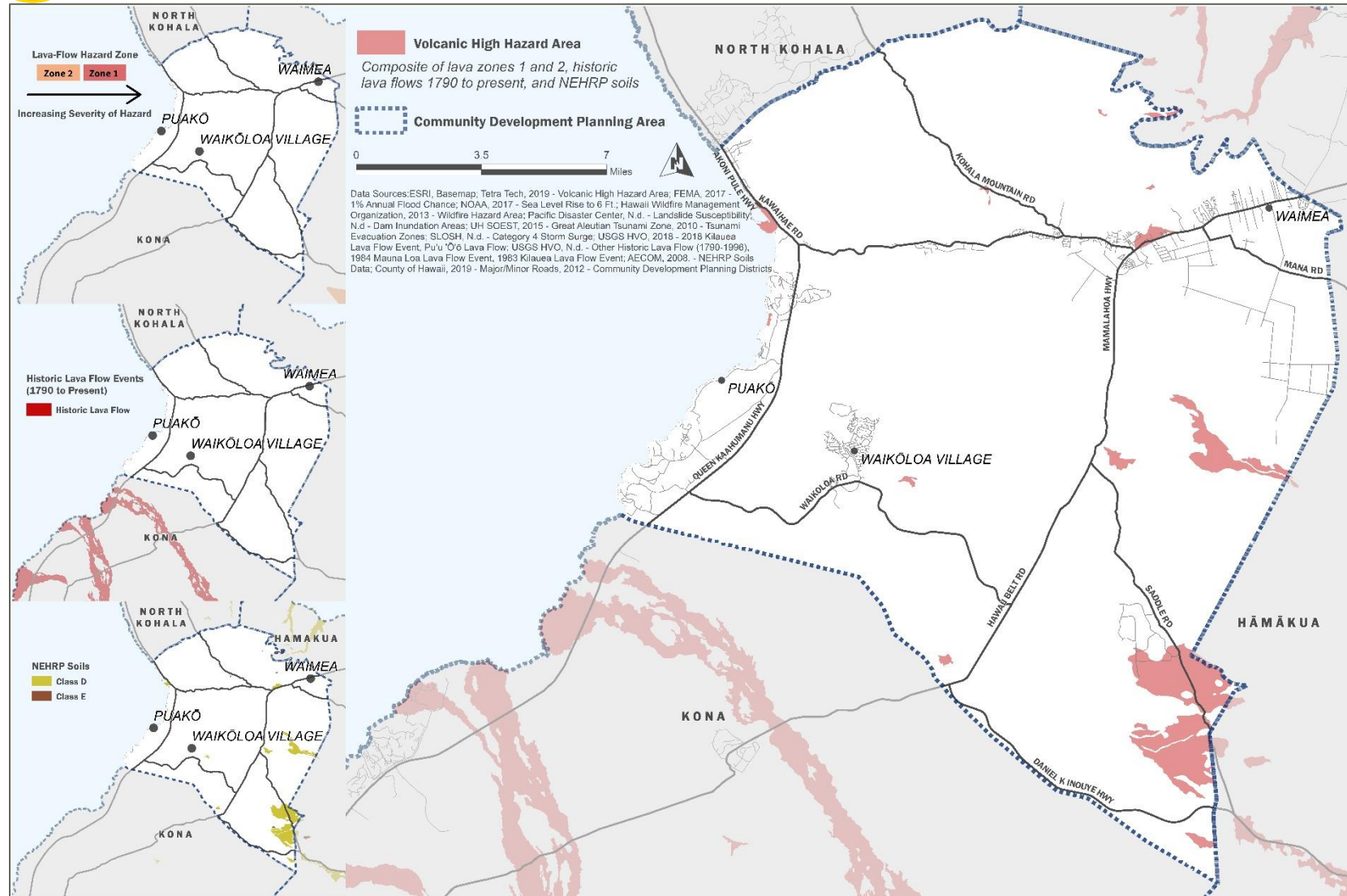


Figure 4-161. Volcanic High Hazard Area in South Kohala



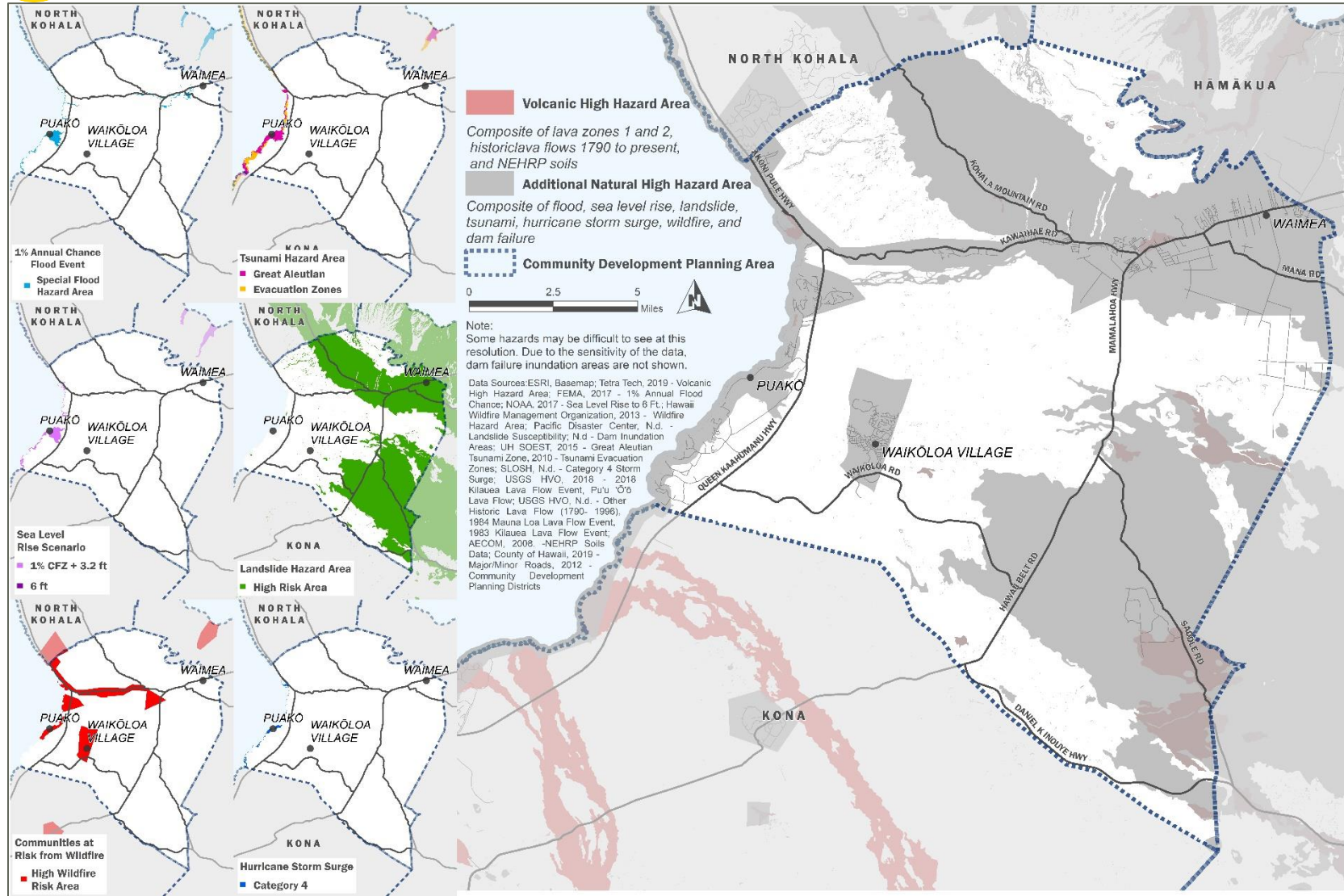
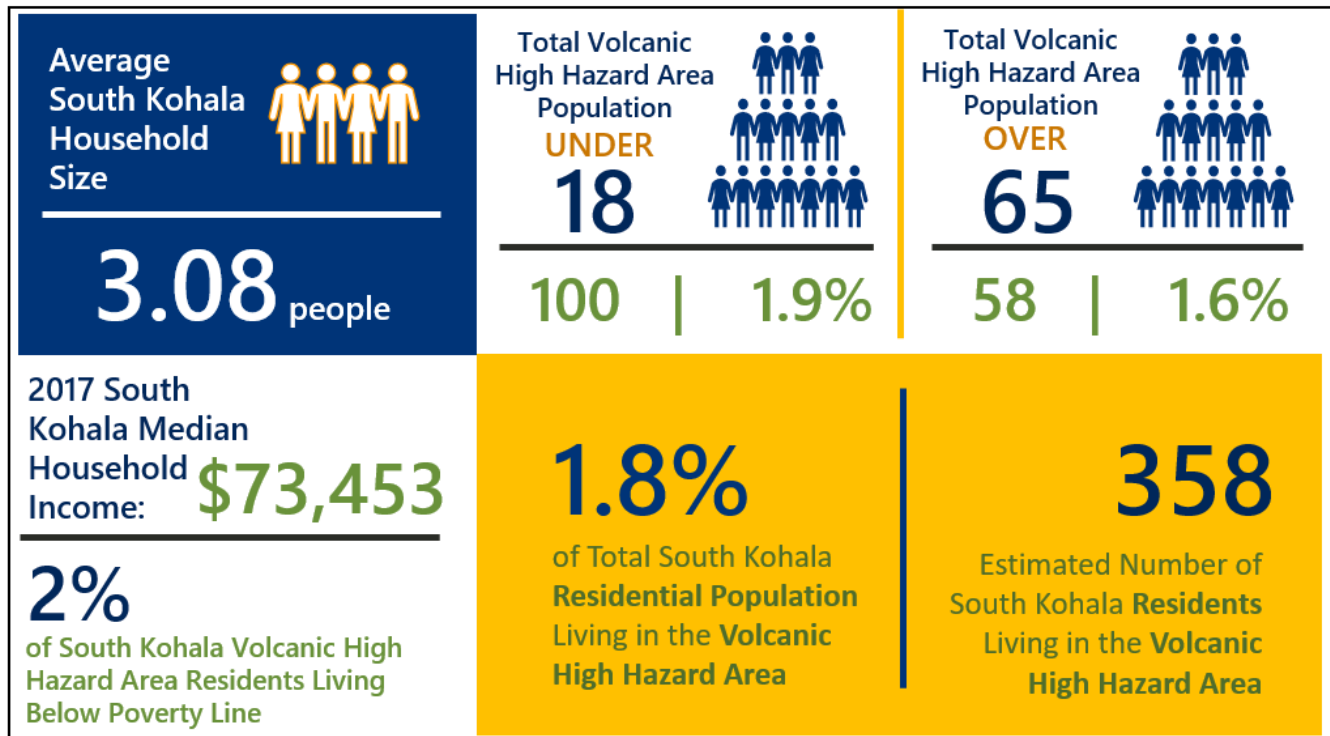


Figure 4-163. Volcanic High Hazard and Additional Natural High Hazard Areas in South Kohala



4.8.3 POPULATION



Note: All percentages are relative to the South Kohala CDP District

Figure 4-164. South Kohala Population Exposure to the Volcanic High Hazard Areas

As of 2017, South Kohala's total population was 20,123, which represents 10.2% of the County's total population (American Community Survey [ACS] 2017). In 2000, South Kohala was the fourth most populated CDP in the County and remains fourth according to updated 2017 ACS data. Between 1980 and 2000 South Kohala's population nearly tripled (CHPD 2008).

South Kohala's population is centered around several recognized towns, distributed from the north to the south of the District (see **Figure 4-166**). The northernmost town, Waimea, is located in lava zone 8, Puakō is located in lava zone 3, and Waikōloa Village is located in lava zone 8.

As noted in **Section 3 – Methodology**, examining resident and household exposure to the volcanic hazard is challenging because parcel-level demographic data is generally not available. Instead, demographic statistics from the 2017 ACS were collected for each U.S. Census tract within the County. Each tract's 2017 population count and the number of 2019 residential parcels in the tract were used to calculate the average number of persons per household. This data was then used to conduct the population exposure assessment using each parcel's estimated household size. The results of this analysis are limited based upon the data available and should only be used for planning purposes until higher resolution data is available.

The majority of South Kohala District residents live in lava zone 8 (82.1%) with a relatively low exposure to the lava-flow hazard. As previously noted, there is no calculated probability associated with each lava-flow hazard zone. zones,



ranked from 1 through 9, represent a scale of increasing hazard as the numbers decrease, based on the probability of coverage by lava flows. Meaning, land classified as lava zone 1 is the most hazardous (USGS 2019).

Figure 4-165 summarizes the number of South Kohala residents living in lava zones 3, 8, and 9, with the majority in lava zone 8.

Figure 4-166 illustrates the population density throughout South Kohala relative to the Volcanic High Hazard Area. The greatest population density is centered around Waimea and Waikōloa Village. Note, these resident totals do not reflect the number of undocumented residents, tourists and visitors residing in the District either permanently or temporarily. In summary, the South Kohala CDP has the greatest total number of households in the County located in lava zone 8, totaling 6,644 (67.2% of total South Kohala households).

At the individual resident level, estimated results indicate that South Kohala has more than 350 residents living in the Volcanic High Hazard Area (1.8% of total South Kohala residents). Interestingly, 100% of South Kohala's Volcanic High Hazard Area residents are also exposed to another high hazard area (i.e. tsunami, sea level rise, landslide, etc.). Puakō, a coastal community, is vulnerable to coastal hazards such as tsunami, surge, erosion and sea level rise.

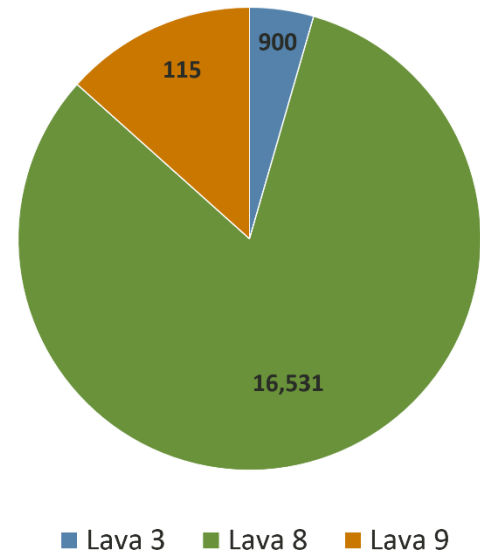


Figure 4-165. Number of Residents in South Kohala's Lava Zones

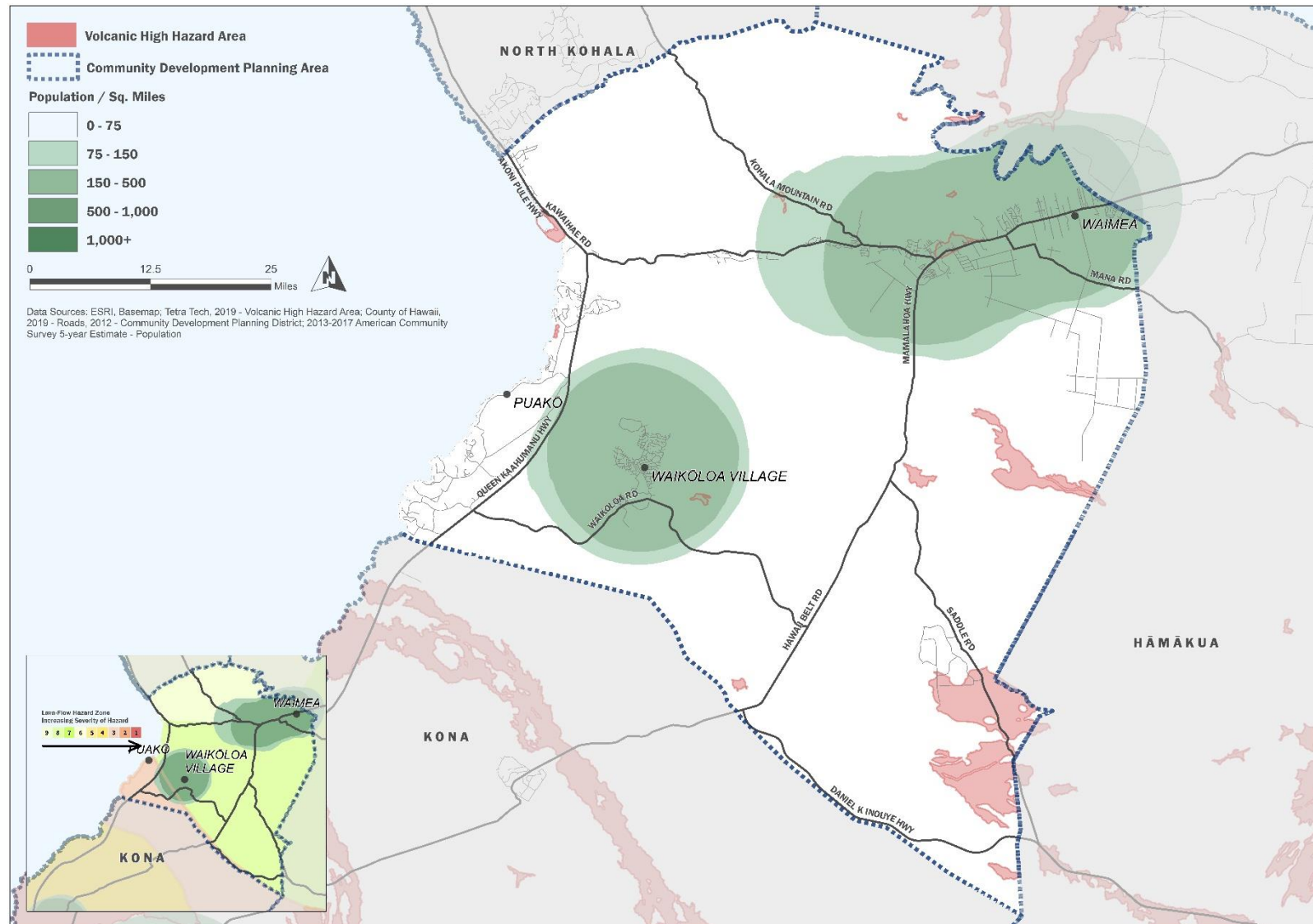


Figure 4-166. South Kohala Population Density Relative to the Volcanic High Hazard



Research has shown that some populations, while they may not have more hazard exposure, may experience exacerbated impacts and prolonged recovery if/when impacted (Donner 2011). This is due to many factors including their physical and financial ability to react or respond during a hazard. This population is referred to as socially vulnerable to hazard events. At the same time, County residents are unique and although may be faced with exposure to a greater number of natural hazard events, this may have increased their overall level of resilience. This is likely due to factors including, but not limited to: institutional knowledge of hazard events, intimate knowledge of the natural elements of the County (particularly for those residents who have lived in the County for an extended period of time), and varying levels of existing self-sufficiency. In 2019, the Pacific Disaster Center released the Kīlauea Eruption Risk Assessment (KERA) report that identified key social drivers of volcanic hazard vulnerability: 1. socioeconomic status; 2. access to information; and 3. household composition (Pacific Disaster Center 2019). To align with the KERA report, the County examined the exposure of these vulnerable populations to the volcanic hazard.

Table 4-105 summarizes the estimated total number of vulnerable population statistics in South Kohala. Just over 10% of the District's residents live below the poverty line. South Kohala's 2017 median annual income in Waimea (\$72,759) and Waikōloa Village (\$73,453) are higher than the County's median annual income of \$56,395 (ACS 2017). South Kohala's median annual incomes represent some of the highest in the County.

In terms of total number of residents, those residents under 18, over 65, and recipients of Supplemental Nutrition Assistance Program (SNAP) benefits represent the top three vulnerable population categories within the South Kohala CDP. The County may consider the high rate and density of residents under 18 in future hazard planning efforts, particularly with a focus on education and awareness raising campaigns.

It is estimated that 44.1% of South Kohala residents living in the Volcanic High Hazard Area are either under 18 years of age or over 65 years of age. Additionally, over 20% of residents in South Kohala living in the Volcanic High Hazard Area are recipients of SNAP benefits. The following summarizes the estimated number of residents living in the Volcanic High Hazard Area and considered the most vulnerable to the volcanic hazard:

- 100 people under 18 years of age
- 58 people over 65 years of age
- 68 single parents
- 41 people living with a disability
- 46 people with no internet access
- 12 people with no vehicle access
- 4 people with no phone access
- 9 people who are unemployed
- 74 people utilizing SNAP
- 41 people living below the poverty line

**Table 4-105. South Kohala
Vulnerable Population**

South Kohala District: Vulnerable Populations [total residents]	
Under 18	5,141
Over 65	3,589
SNAP	3,367
Single Parent	3,351
No Internet	2,350
Disability	2,177
Below Poverty Line	2,040
Non-English Speaking	1,709
No Health Insurance	1,063
No Diploma	804
No Vehicle	558
Unemployed	522
No Phone	301

As previously discussed, resident exposure to hazards is based on U.S. Census tract data because this information is not available at the parcel level. Refer to **Section 3 - Methodology** for more details on the methodology used to generate



these estimates. The limitations of this analysis are recognized, and results should be used for planning purposes only and updated when higher resolution data is available.

Table 4-106 through **Table 4-109** summarize the exposure of vulnerable residents in South Kohala by socioeconomic factor to the volcanic hazard, as well as where the volcanic hazard area overlaps with another natural high hazard zone.

Table 4-106. South Kohala Household Composition by Volcanic Hazard Area - A measure of households containing one or more vulnerable groups susceptible to the negative impacts of natural disasters.

Hazard Area	Total Residents (number / %)	Under 18 (number / %)	Over 65 (number / %)	Single-Parent Household (number / %)	Persons with Disability (number / %)
Volcanic High Hazard Area (VHHA)	358 / 1.8%	100 / 1.9%	58 / 1.6%	68 / 2%	41 / 1.9%
VHHA with Additional Natural High Hazard Area	358 / 100%	100 / 100%	58 / 100%	68 / 100%	41 / 100%
Lava Zone 1	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%
Lava Zone 1 with Additional Natural High Hazard Area	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%
Lava Zone 2	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%
Lava Zone 2 with Additional Natural High Hazard Area	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%

Note: Total residents in each hazard area were calculated separately as distinct and separate; therefore, individual hazard area totals do not equate to the VHHA total.

Table 4-107. South Kohala Household Member Health and Transportation by Volcanic Hazard Area - A measure of households with increased vulnerability due to the lack of a vehicle (i.e. evacuation). A measure of the population's access to critical services such as access to transportation routes and medical services.

Hazard Area	No Vehicle (number / %)	No Health Insurance (number / %)
Volcanic High Hazard Area (VHHA)	12 / 2.1%	18 / 1.7%
VHHA with Additional Natural High Hazard Area	12 / 100%	18 / 100%
Lava Zone 1	0 / 0%	0 / 0%
Lava Zone 1 with Additional Natural High Hazard Area	0 / 0%	0 / 0%
Lava Zone 2	0 / 0%	0 / 0%
Lava Zone 2 with Additional Natural High Hazard Area	0 / 0%	0 / 0%

Note: Total residents in each hazard area were calculated separately as distinct and separate; therefore, individual hazard area totals do not equate to the VHHA total.



Table 4-108. South Kohala Resident Access to Information by Volcanic Hazard Area - A measure of the ability to receive, comprehend and appropriately act on complex messaging with regard to natural disasters.

Hazard Area	No High School Diploma, Over 25 Years Old (number / %)	Non-English Speaking (number / %)	No Internet (number / %)	No Phone (number / %)
Volcanic High Hazard Area (VHHA)	16 / 2%	37 / 2.2%	46 / 2%	4 / 1.3%
VHHA with Additional Natural High Hazard Area	16 / 2%	37 / 100%	46 / 100%	4 / 100%
Lava Zone 1	0 / 0%	0 / 0%	0 / 0%	0 / 0%
Lava Zone 1 with Additional Natural High Hazard Area	0 / 0%	0 / 0%	0 / 0%	0 / 0%
Lava Zone 2	0 / 0%	0 / 0%	0 / 0%	0 / 0%
Lava Zone 2 with Additional Natural High Hazard Area	0 / 0%	0 / 0%	0 / 0%	0 / 0%

Note: Total residents in each hazard area were calculated separately as distinct and separate; therefore, individual hazard area totals do not equate to the VHHA total.

Table 4-109. South Kohala Resident Socioeconomic Status, by Volcano Hazard Area - A measure of the population that is less likely to have the necessary economic resources to adequately prepare for or recover from a natural disaster.

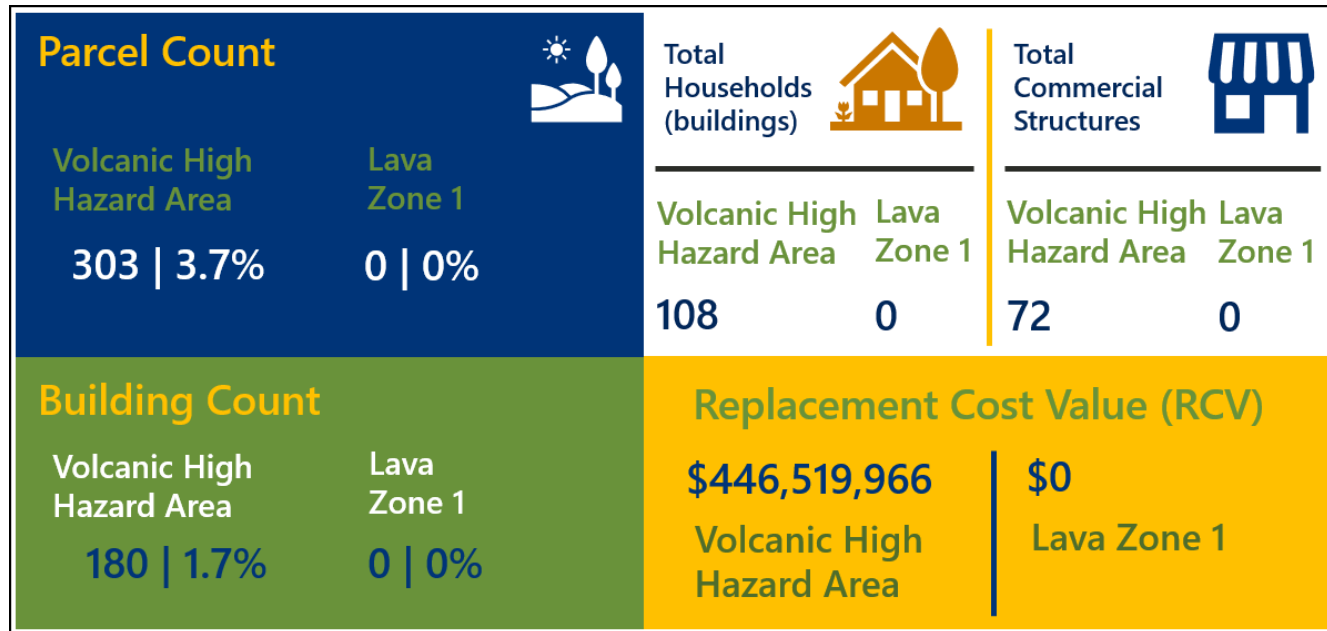
Hazard Area	Unemployed (number / %)	Receiving SNAP (number / %)	Below Poverty Line (number / %)
Volcanic High Hazard Area (VHHA)	9 / 1.7%	74 / 2.2%	41 / 2%
VHHA with Additional Natural High Hazard Area	9 / 100%	74 / 100%	41 / 100%
Lava Zone 1	0 / 0%	0 / 0%	0 / 0%
Lava Zone 1 with Additional Natural High Hazard Area	0 / 0%	0 / 0%	0 / 0%
Lava Zone 2	0 / 0%	0 / 0%	0 / 0%
Lava Zone 2 with Additional Natural High Hazard Area	0 / 0%	0 / 0%	0 / 0%

SNAP Supplemental Nutrition Assistance Program

Note: Total residents in each hazard area were calculated separately as distinct and separate; therefore, individual hazard area totals do not equate to the VHHA total.



4.8.4 PARCELS AND BUILDINGS



Note: All percentages are relative to the South Kohala CDP District

Figure 4-167. South Kohala Parcels and Buildings Located in a Volcanic High Hazard Area (VHHA)

A total of 2,504 acres of developed land (representing 3.5% of South Kohala's total developed land) and 180 buildings (1.7%) in the South Kohala District are in the Volcanic High Hazard Area. **Figure 4-168** illustrates the distribution of developed parcels by Volcanic High Hazard Area and lava zone.

For the purposes of this analysis, the total assessed value (land and building) located in the volcanic hazard areas is reported to illustrate the potential future loss to existing parcels and development. The total assessed value of parcels located in the Volcanic High Hazard Area is an estimated \$465,572,000 which represents 17.8% of the South Kohala District's total assessed values (land and structure). In terms of the replacement cost value of buildings (estimated structure and contents), an estimated \$446,519,966 exists in South Kohala's Volcanic High Hazard Area (see **Table 4-110**).

**Table 4-110. South Kohala Parcels and Buildings Exposed to Volcanic Hazards**

Hazard Area	Total Number of Parcels (number / %)	Total Assessed Value (land and structure)	Total Number of Buildings (number / %)	Replacement Cost Value (structure and contents)	Total Households (buildings / %)	Total Commercial Units (buildings / %)
Volcanic High Hazard Area (VHHA)	303 / 3.7%	\$465,572,000	180 / 1.7%	\$446,519,966	108 / 1.1%	72 / 13.5%
VHHA with Additional Natural High Hazard Area	303 / 3.7%	\$465,572,000	180 / 100%	\$446,519,966	108 / 100%	72 / 100%
Lava Zone 1	0 / 0%	\$0	0 / 0%	\$0	0 / 0%	0 / 0%
Lava Zone 1 with Additional Natural High Hazard Area	0 / 0%	\$0	0 / 0%	\$0	0 / 0%	0 / 0%
Lava Zone 2	0 / 0%	\$0	0 / 0%	\$0	0 / 0%	0 / 0%
Lava Zone 2 with Additional Natural High Hazard Area	0 / 0%	\$0	0 / 0%	\$0	0 / 0%	0 / 0%

Note: Data in each hazard area were calculated separately as distinct and separate areas; therefore, individual hazard area totals do not equate to the VHHA total.

Replacement cost value calculated using 2019 RS Means data.

Source: June 2019 Real Property Tax (RPT) database and 2019 County parcel dataset; buildings determined on parcels using the DWELDAT and COMDAT tables.

The County of Hawai'i did not adopt the 1982 Uniform Building Code (UBC) until 1985, meaning the County did not start requiring seismic building standards until 1985 (meeting the 1982 UBC standards). Therefore, all structures built prior to 1985 are considered to be unreinforced and susceptible to earthquake and hurricane damage due to the lack of uplift ties and a complete load path of connections (Martin and Chock, Inc. 2015). The frequency and location of South Kohala's structures built prior to 1985 (both residential and commercial) is illustrated on **Figure 4-169** with some clusters overlapping with Volcanic High Hazard Areas near Waimea, located to the west of the town. In total, there are 2,181 pre-1985 structures located in South Kohala, but 0 in the Peak Ground Acceleration (PGA) 120%g zone. Refer to Section 3 - Methodology for more details on the PGA 120%g seismic zone. The Volcanic High Hazard Area contains 86 pre-1985 structures located on NEHRP D and E soil. Overall, structures built prior to 1985 are more vulnerable to seismic impacts when compared to structures built post-1985.

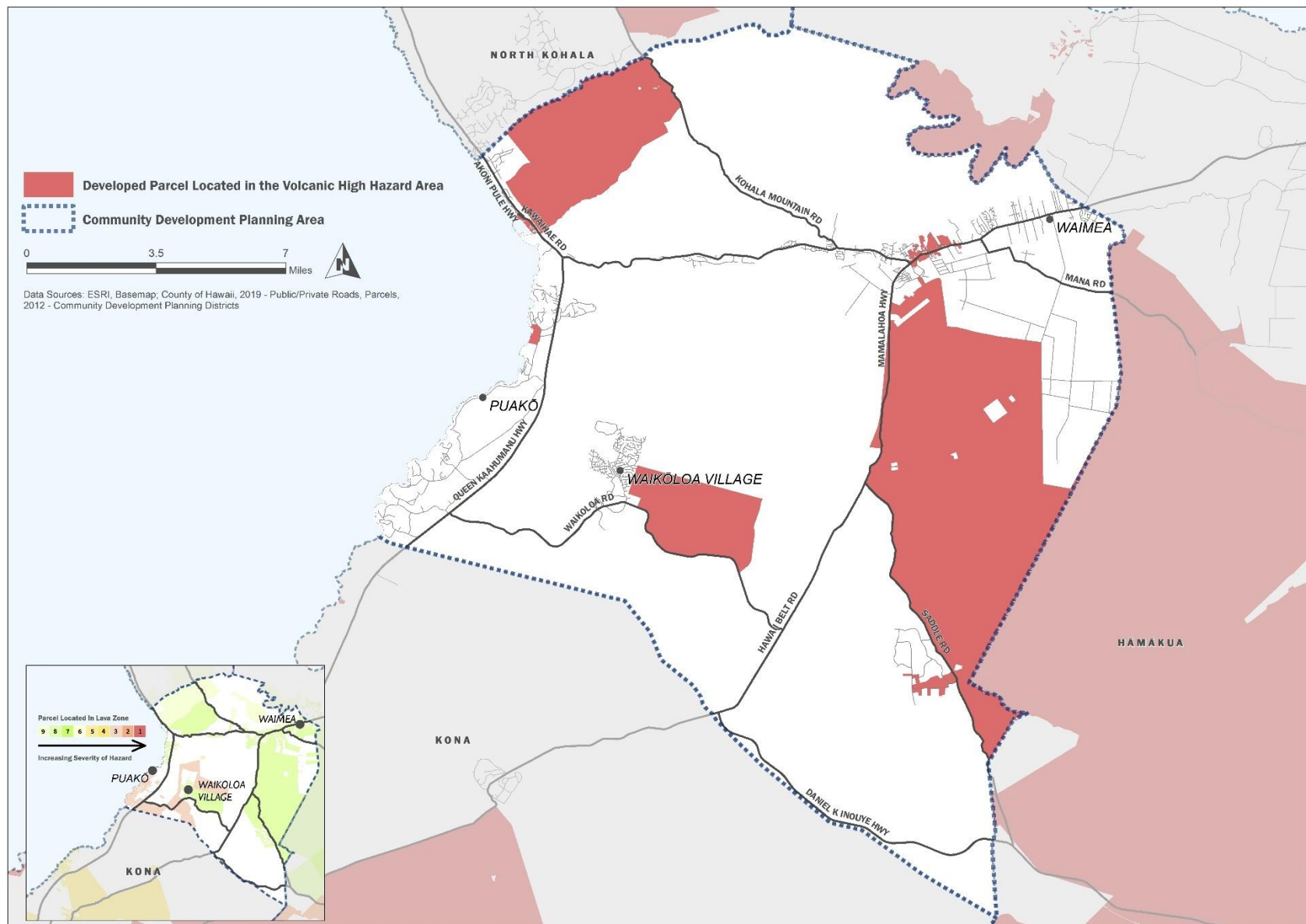


Figure 4-168. Developed Parcels in South Kohala by Volcanic High Hazard Area and Lava Zone

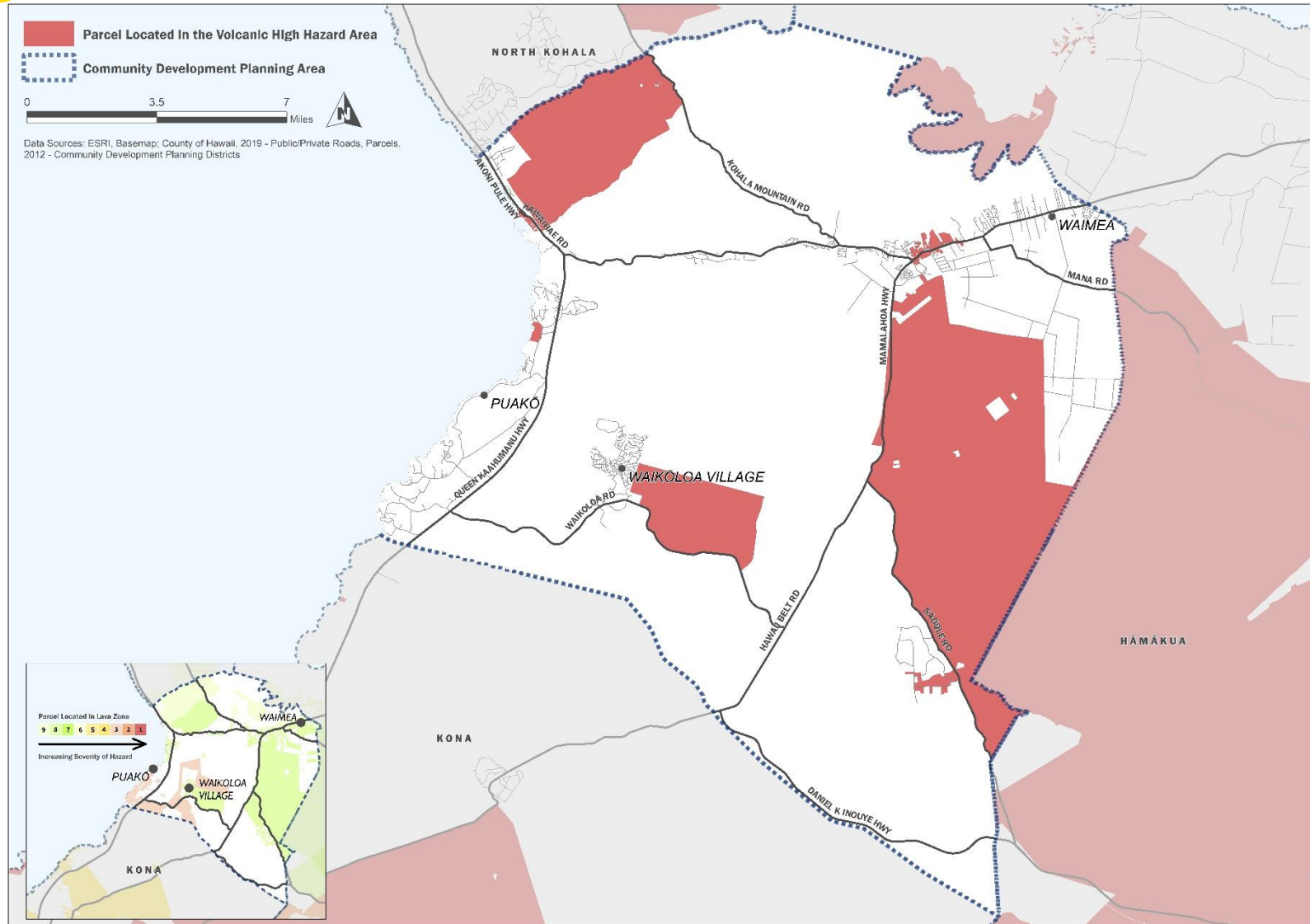


Figure 4-169. South Kohala Parcels with Structures Constructed Pre-1985 in the Volcanic High Hazard Area



4.8.5 CRITICAL FACILITIES AND LIFELINES

Critical Facilities + Lifelines		Safety + Security Assets	Socially Vulnerable Assets
Volcanic High = 7 8.5% Hazard Area		4 Volcanic High Hazard Area	0 Volcanic High Hazard Area
Lava Zone 1 = 0 0%		0 Lava Zone 1	0 Lava Zone 1
Utility Assets	Food, Water, + Shelter Assets	Transportation Assets	Recovery Support Assets
1 Volcanic High Hazard Area	1 Volcanic High Hazard Area	1 Volcanic High Hazard Area	0 Volcanic High Hazard Area
0 Lava Zone 1	0 Lava Zone 1	0 Lava Zone 1	0 Lava Zone 1

Note: All percentages are relative to the South Kohala District

Figure 4-170. South Kohala Critical Facilities and Lifelines Located in the Volcanic High Hazard Area and Lava Zone 1

Through the development of the volcanic risk assessment, 82 critical facilities and lifelines were identified in South Kohala. The critical facility and lifeline categories align with the 2015 County Hazard Mitigation Plan asset categories.

Table 4-111 summarizes the exposure of these critical facilities to volcanic hazards. Overall, 8.5% of South Kohala's critical facilities are located in the Volcanic High Hazard Area, and therefore susceptible to impacts during seismic events (**Figure 4-171**). Of the 7 critical assets located in the Volcanic High Hazard Area, 100% are also located in another natural high hazard area. Over 75% of South Kohala's critical facilities are in lava zone 8.

Infrastructure provides connectivity between communities and resources, as well as emergency access to keep residents safe. It is closely tied to housing providing livable spaces with services needed for communities to thrive. The miles of road that intersect the Volcanic High Hazard Area and lava zones 1 and 2 were determined in an effort to understand their exposure and where potential future losses may be incurred. There are 8.9 miles of roadway located in the Volcanic High Hazard Area which includes State, County and publicly accessed private roads.

Similar to the discussion on structures constructed pre-1985, there are a number of critical facilities in South Kohala constructed prior to 1985 and therefore more vulnerable to earthquake damage (during a volcanic eruption or occurring separately). Based on year-built data, 64.4% of South Kohala's critical facilities and lifelines were constructed prior to 1985. Depending upon the specific facility's design and mitigation measures installed post construction, earthquake damage prior to an eruption or during an eruption could have significant implications of life safety and the resilience of infrastructure systems


**Table 4-111. South Kohala Critical Facilities by Volcanic Hazard Area**

Hazard Area	Number of Critical Facilities (number / %)	Built Prior to 1985 (number / %)	Safety and Security Assets (number / %)	Food, Water and Shelter Assets (number / %)	Recovery Support Assets (number / %)	Socially Vulnerable Assets (number / %)	Utility Assets (number / %)
Volcanic High Hazard Area (VHHA)	7 / 8.5%	3 / 6.7%	4 / 25%	1 / 11.1%	0 / 0%	0 / 0%	1 / 4.5%
VHHA with Additional Natural High Hazard Area	7 / 100%	4 / 4.8%	4 / 100%	1 / 100%	0 / 0%	0 / 0%	1 / 100%
Lava Zone 1	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%
Lava Zone 1 with Additional Natural High Hazard Area	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%
Lava Zone 2	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%
Lava Zone 2 with Additional Natural High Hazard Area	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%

Note: Critical facilities in each hazard area were calculated separately as distinct and separate areas; therefore, individual hazard area totals do not equate to the VHHA total.



4.8.6 ENVIRONMENT

Environmental Resources: Federal + State Protected Lands		SLUD Conservation Land (acres)	Endangered + Threatened Habitat (acres)
Volcanic High Hazard Area = 2,161 acres 5.8%		102	72
 Lava Zone 1 = 0 acres 0%		Volcanic High Hazard Area	Volcanic High Hazard Area
		0	0
		Lava Zone 1	Lava Zone 1
County Parks (acres)	State Parks (acres)	National Parks (acres)	Open Space: General + Protected (acres)
13	3	3	3,429
Volcanic High Hazard Area	Volcanic High Hazard Area	Volcanic High Hazard Area	Volcanic High Hazard Area
0	0	0	0
Lava Zone 1	Lava Zone 1	Lava Zone 1	Lava Zone 1

Note: All percentages are relative to the South Kohala District

Figure 4-172. South Kohala Environmental Resources Located in the Volcanic High Hazard Area and Lava Zone 1

Over half (58.3%) of South Kohala land is categorized as undeveloped (determined at the parcel level), meaning according to the County assessor no (0) structures exist on the parcel. Outside of the developed areas, the District maintains a distinct rural and agricultural context. South Kohala's undeveloped land contains the following environmental resources: open space (149,584 acres), pastureland (99,598 acres), critical habitat (17,584 acres), and agricultural land of importance (66,971 acres). Of South Kohala's County Parks, 35% are located in the Volcanic High Hazard Area. Agriculture in South Kohala includes majority diversified crops (98.8%) with a very small percentage (1.2%) of flowers/foilage/landscape acreage (*see Figure 4-174 and Figure 4.8-7*).

Environmental assets identified as part of the County of Hawai'i General Plan update (in progress) were used for this risk assessment (*Table 4-112*). *Figure 4-174* and *Figure 4-175* illustrate the environmental resources relative to the Volcanic High Hazard Areas.

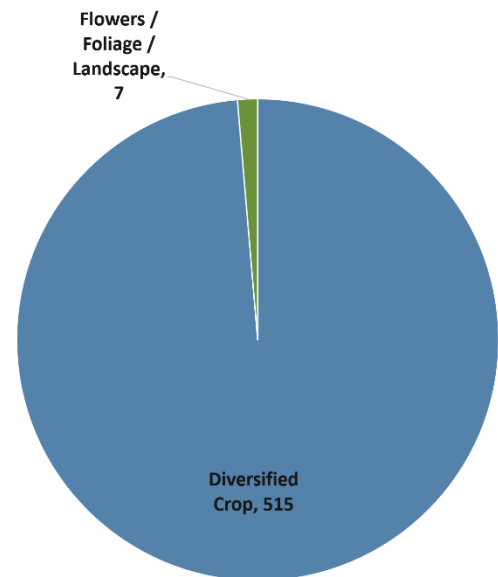


Figure 4-173. South Kohala Crop Land (Acres)

**Table 4-112. South Kohala Environmental Resources**

Agricultural Land of Importance (acres)	Crop Land (acres)	Pasture Land (acres)	Hunting Areas (acres)	Wetlands (acres)
66,971	521	99,598	13,611	8,043

Federal Reserves (acres)	State Reserves (acres)	Exceptional Trees (number)	Anchialine Pools (number)	Reservoirs (number)	Endangered and Critical Habitats (acres)
7,520	5,806	0	54	27	17,584

In summary, although there are environmental resources located in the Volcanic High Hazard Area, the most vulnerable are those in which structures and infrastructure are present due to the presence of NEHRP D and E soils (**Figure 4-172**).

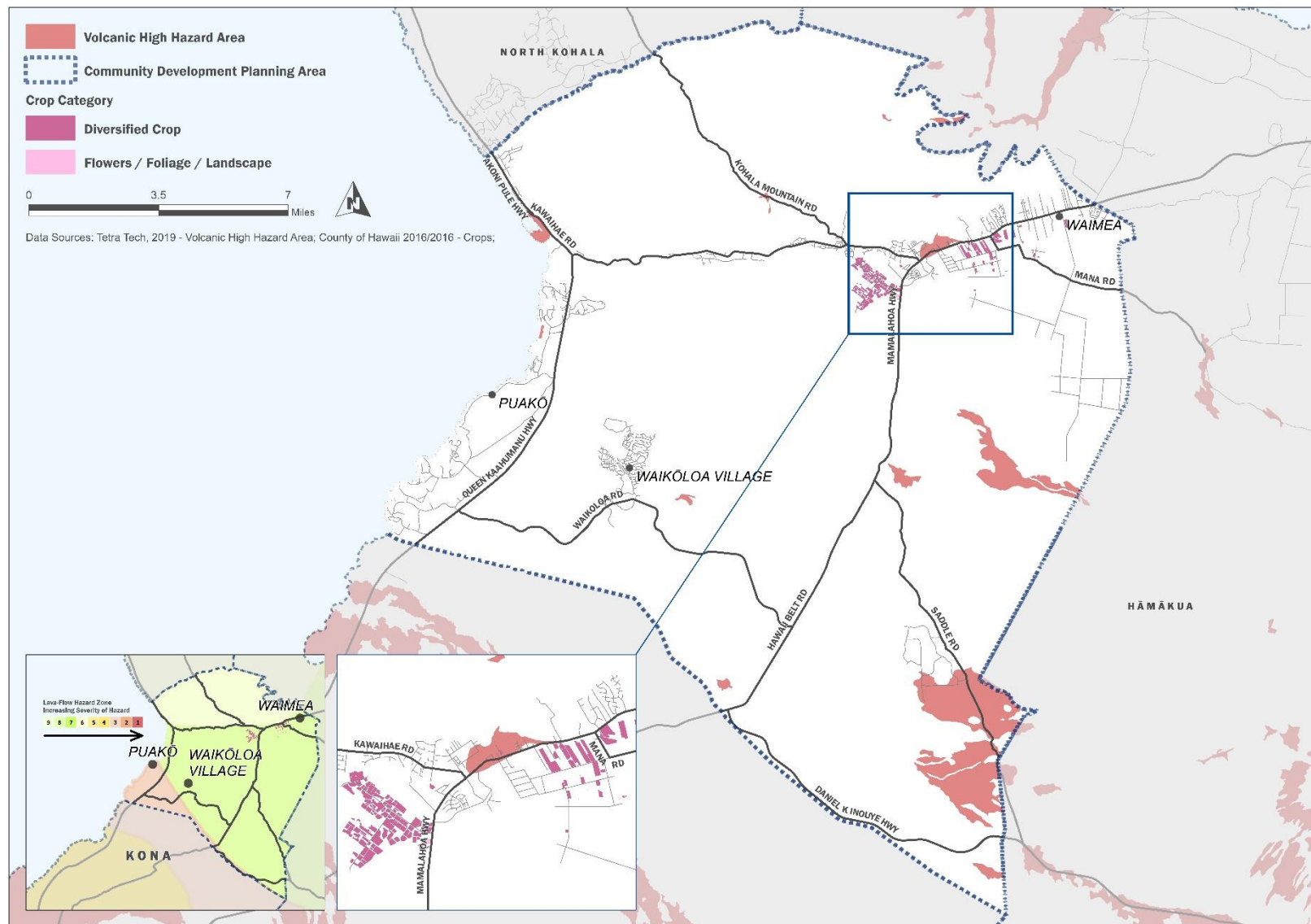


Figure 4-174. South Kohala Important Agricultural Crops Located in Lava Zones and Volcanic High Hazard Area

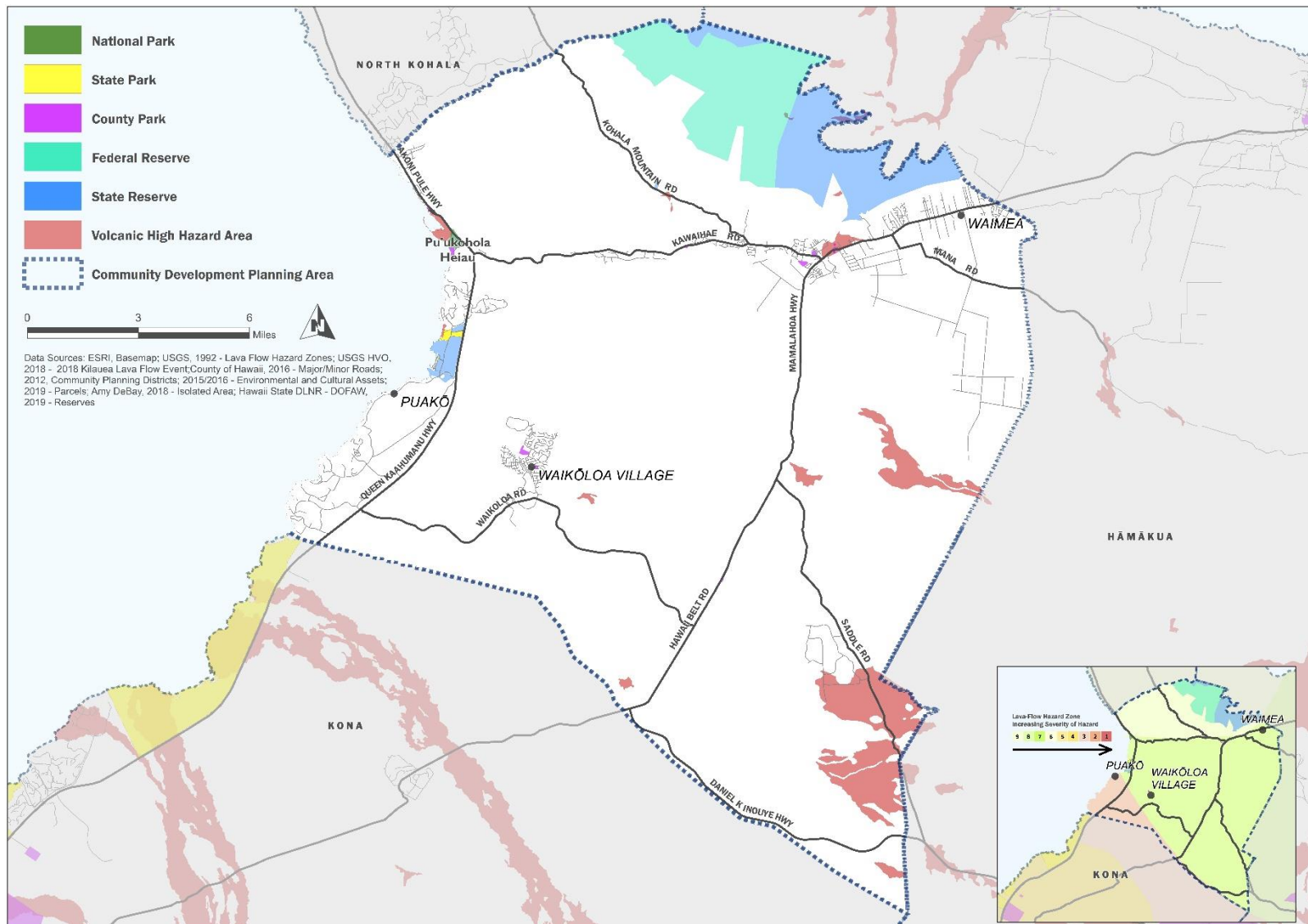


Figure 4-175. Protected Environmental Land in South Kohala Located in Lava Zones and Volcanic High Hazard Area



Table 4-113. South Kohala Environmental Resources

Hazard Area	Total Protected Land (acres / %)	SLUD Conservation Land (acres / %)	Endangered and Threatened Habitat (acres / %)	Exceptional Trees (number / %)	Open Space: General and Protected (acres / %)	Agricultural Land of Importance (acres / %)
Volcanic High Hazard Area	2,161 / 5.8%	102 / 0.7%	72 / 0.4%	0 / 0%	3,429 / 2.3%	4,666 / 7%
Lava Zone 1	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%
Lava Zone 2	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%

SLUD State Land Use District

Note: Acres and total numbers of environmental resources in each hazard area were calculated separately as distinct and separate areas; therefore, individual hazard area totals do not equate to the Volcanic High Hazard Area total.

Hazard Area	Crop Land (acres / %)	Pasture Land (acres / %)	Hunting Areas (acres / %)	County Park (acres / %)	State Park (acres / %)	National Park (acres / %)
Volcanic High Hazard Area	1 / 0.2%	3,142 / 3.2%	191 / 1.4%	13 / 13.7%	3 / 4.5%	3 / 3.2%
Lava Zone 1	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%
Lava Zone 2	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%

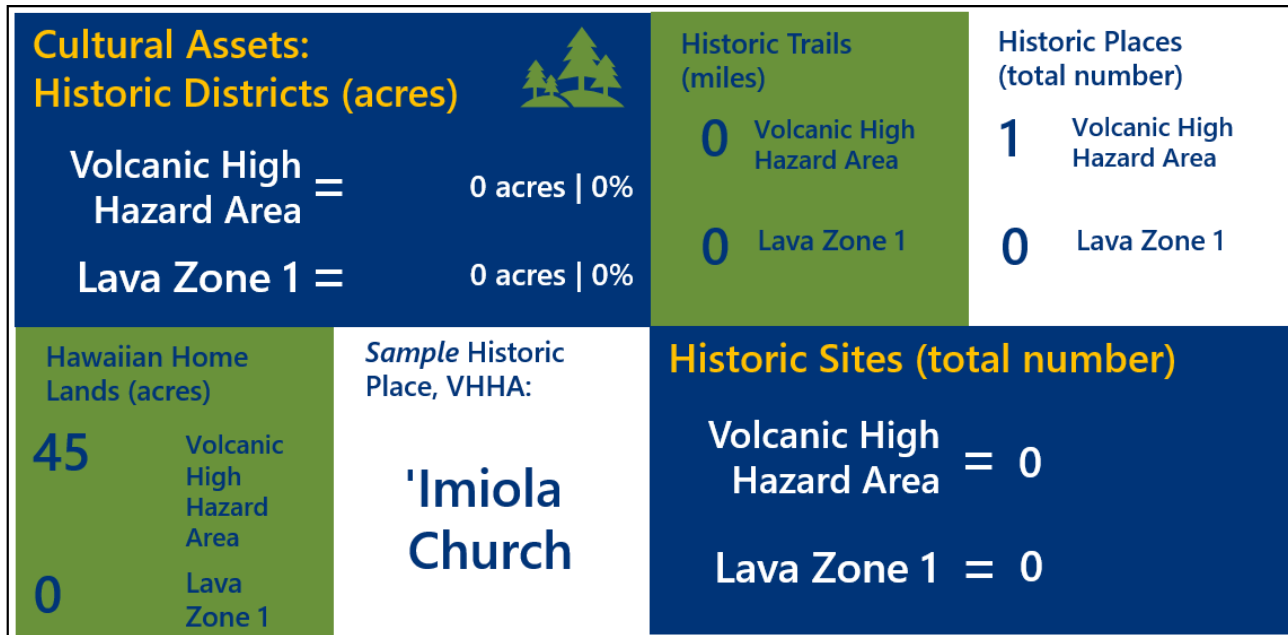
Note: Acres and total numbers of environmental resources in each hazard area were calculated separately as distinct and separate areas; therefore, individual hazard area totals do not equate to the Volcanic High Hazard Area total.

Hazard Area	Wetlands (acres / %)	Reservoirs (number / %)	Anchialine Pools (number / %)
Volcanic High Hazard Area	93 / 1.2%	0 / 0%	0 / 0%
Lava Zone 1	0 / 0%	0 / 0%	0 / 0%
Lava Zone 2	0 / 0%	0 / 0%	0 / 0%

Note: Acres and total numbers of environmental resources in each hazard area were calculated separately as distinct and separate areas; therefore, individual hazard area totals do not equate to the Volcanic High Hazard Area total.



4.8.7 CULTURAL ASSETS



Note: All percentages are relative to the South Kohala District

Figure 4-176. South Kohala Cultural Assets Located in the Volcanic High Hazard Area and Lava Zone 1

South Kohala is home to many formally designated and locally recognized cultural assets, historic places, and sites that are important because they help to shape the identity of the place and the people of South Kohala, as well as the County. A location-based database of culturally significant sites to Native Hawaiians was not available for use in this risk assessment; disclosure of the location of sacred and otherwise culturally significant sites is prohibited, in some instances, by federal law. To align with the County General Plan update, Hawaiian Home Lands, historic sites and trails were used for this analysis.

Cultural assets are considered non-renewable resources. Lava flows can isolate or cover cultural sites and native land. A total of 45 acres of Hawaiian Home Lands (0.2% of South Kohala's total Hawaiian Home Lands), 1 historic place (14.3%), no historic sites (0%) and no miles (0%) of historic trail are located in the Volcanic High Hazard Area (see **Table 4-114**).

It is important to note that many of the cultural assets are located along the western coast and overlap with other known South Kohala hazard areas including tsunami, flood, sea level rise; while several are located more inland and with high susceptibility to landslide risk, wildfire and dam failure inundation (see **Figure 4-177**).

Table 4-114. South Kohala Cultural Resources by Volcanic Hazard Area

Hazard Area	Hawaiian Home Lands (acres / %)	Historic Districts (acres / %)	Historic Places (number / %)	Historic Sites (number / %)	Historic Trail (miles / %)
Volcanic High Hazard Area (VHHA)	45 / 0.2%	0 / 0%	1 / 14.3%	0 / 0%	0 / 0%
VHHA with Additional Natural High Hazard Area	45 / 100%	0 / 0%	1 / 100%	0 / 0%	0 / 0%
Lava Zone 1	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%
Lava Zone 2	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%

Note: Acres and total numbers of cultural resources in each hazard area were calculated separately as distinct and separate areas; therefore, individual hazard area totals do not equate to the VHHA total.

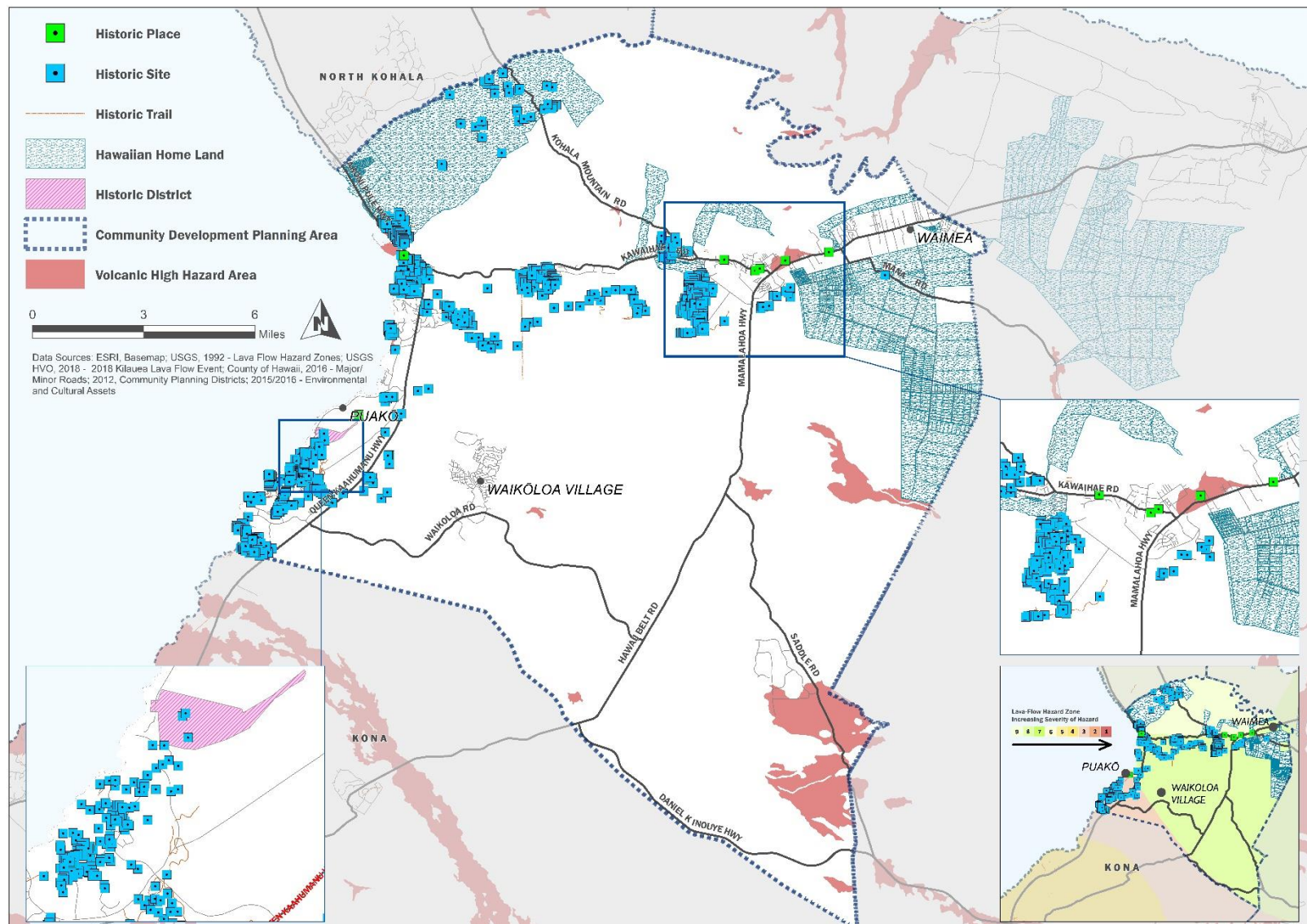


Figure 4-177. Cultural Assets in South Kohala and Volcanic Hazards



4.8.8 FUTURE LAND USE AND DEVELOPMENT

South Kohala is comprised of mixed land use classifications as categorized by the Land Use Pattern Allocation Guide (LUPAG) (see **Figure 4-178**). While LUPAG designations guide decisions related to future land use, County zoning determines a parcel's current permitted land use and development entitlements.

The majority of South Kohala is designated extensive agriculture, representing a total of 71,304 acres or 40.4% of all South Kohala land. Extensive agriculture land is defined as "extensive agriculture includes lands that are not capable of producing sustained high agricultural yields without intensive application of farming methods and technologies." Following extensive agriculture, important agricultural lands (29.2%) and open area (8%) are present in the district. Important agricultural lands are lands that are highly capable of producing significant yields of important agricultural outputs. Open area is land containing parks and other recreational areas, historic sites, and open shoreline areas (CHPD 2019). The remaining 22.4% of South Kohala is classified as a mix of conservation, urban expansion, low-density urban, resort node, rural, industrial, and medium-density urban.

Overall, the land in the Volcanic High Hazard Area is mainly classified as agricultural lands (91.4%), both extensive agriculture and important agricultural land (see **Table 4-115 and Figure 4-178**). As previously discussed, NEHRP soils D and E comprise this high hazard area in South Kohala so structures located on this land are vulnerable to damage as a result of seismic events.

Table 4-115. South Kohala Land Use (LUPAG classification) in the Volcanic High Hazard Area and Lava Zones

LUPAG Classification	Total Area (acres)	Volcanic High Hazard Area (acres)	Lava Zone 1 (acres)	Lava Zone 2 (acres)
Conservation	13,957	97	0	0
Extensive Agriculture	71,304	2,543	0	0
Important Agriculture Lands	51,498	2,683	0	0
Industrial	1,869	81	0	0
Low-Density Urban	5,098	76	0	0
Medium-Density Urban	1,281	142	0	0
Open area	14,045	93	0	0
Resort Node	3,212	0	0	0
Rural	1,909	0	0	0
Urban Expansion	12,262	0	0	0

LUPAG Land Use Pattern Allocation Guide

While the Volcanic High Hazard Area represents the area with the greatest volcanic risk in the County, it is not the target for the vast majority of future urban development in South Kohala. According to the LUPAG data, there are 76 acres of low density urban and 142 acres of medium density urban designated in the District, located in a Volcanic High Hazard Areas. Future development here should consider their increased risk and potential impacts from volcanic hazards. Land that has been identified for future urban expansion may also be susceptible to other natural high hazards. For example, the tsunami evacuation zone on the coastline and flooding risk areas near Puakō. Projected sea level rise on the coast appears to directly impact Puakō and should be considered as this area will be permanently flooded in the future.

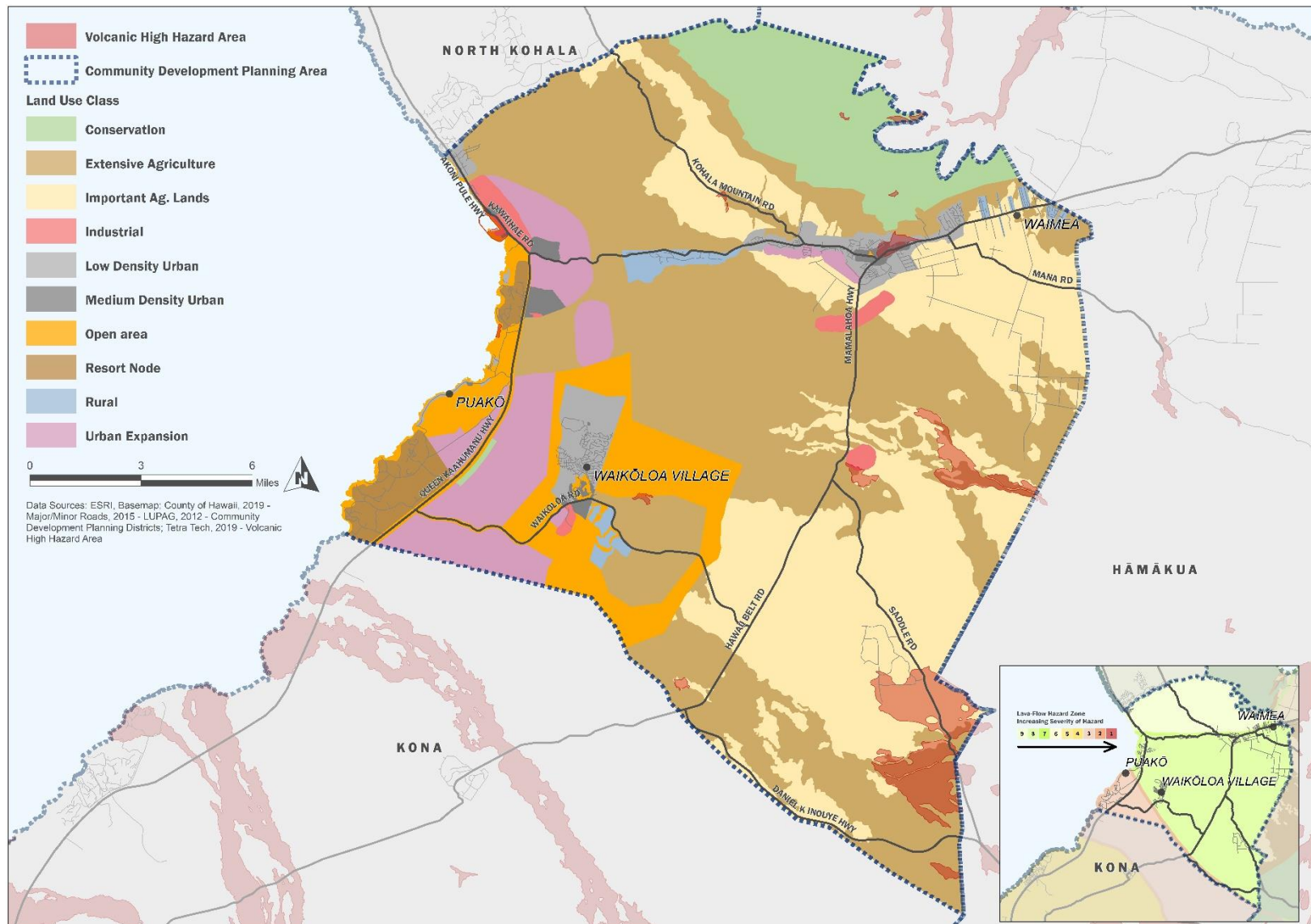


Figure 4-178. South Kohala Land Use Pattern Allocation Guide (LUPAG) Classifications



In preparation for the County General Plan update, a build-out analysis was conducted to determine residential and non-residential capacity. South Kohala has 113,622 acres of identified residential greenfield area (66.8%) illustrating the scale of potential future targeted development. Future land use decisions and future policy should consider the location of the volcanic and additional natural high hazards prior as part of future development decisions.

In South Kohala, there are 59 residential greenfield parcels identified for potential future development located in the Volcanic High Hazard Area (see **Table 4-116** and **Figure 4-179**). In terms of non-residential greenfield parcels, there are 25 non-residential parcels located in the Volcanic High Hazard Area and 25 parcels identified for potential non-residential redevelopment in the Volcanic High Hazard Area. Again, the greatest risk is due to amplified ground shaking due to seismic soils; therefore, mitigation measures should be considered as part of future development design.

The exposure to other natural hazard impacts should also be taken into consideration when considering future development decisions. One hundred percent of parcels identified for non-residential greenfield development and non-residential redevelopment are located in the Volcanic High Hazard Area also have the presence of another natural high hazard. Refer to **Table 4-116** for additional statistics regarding parcels identified for future development and their location relative to the volcanic hazard areas and other high hazards.

Table 4-116. South Kohala Build-out Analysis Results and Hazard Areas

Hazard Area	Residential Greenfield (parcels / %*)	Residential Potential Redevelopment (parcels / %*)	Non-Residential Greenfield (parcels / %*)	Non-Residential Potential Redevelopment (parcels / %*)
Volcanic High Hazard Area (VHHA)	59 / 4.5%	92 / 2.6%	25 / 27.8%	25 / 32.9%
VHHA with Additional Natural High Hazard Area	59 / 100%	92 / 100%	25 / 100%	25 / 100%
Lava Zone 1	0 / 0%	0 / 0%	0 / 0%	0 / 0%
Lava Zone 1 with Additional Natural High Hazard Area	0 / 0%	0 / 0%	0 / 0%	0 / 0%
Lava Zone 2	0 / 0%	0 / 0%	0 / 0%	0 / 0%
Lava Zone 2 with Additional Natural High Hazard Area	0 / 0%	0 / 0%	0 / 0%	0 / 0%

*The percentage of parcels relative to the total number in the South Kohala District.

Note: Parcels in each hazard area were calculated separately as distinct and separate areas; therefore, individual hazard area totals do not equate to the VHHA total.

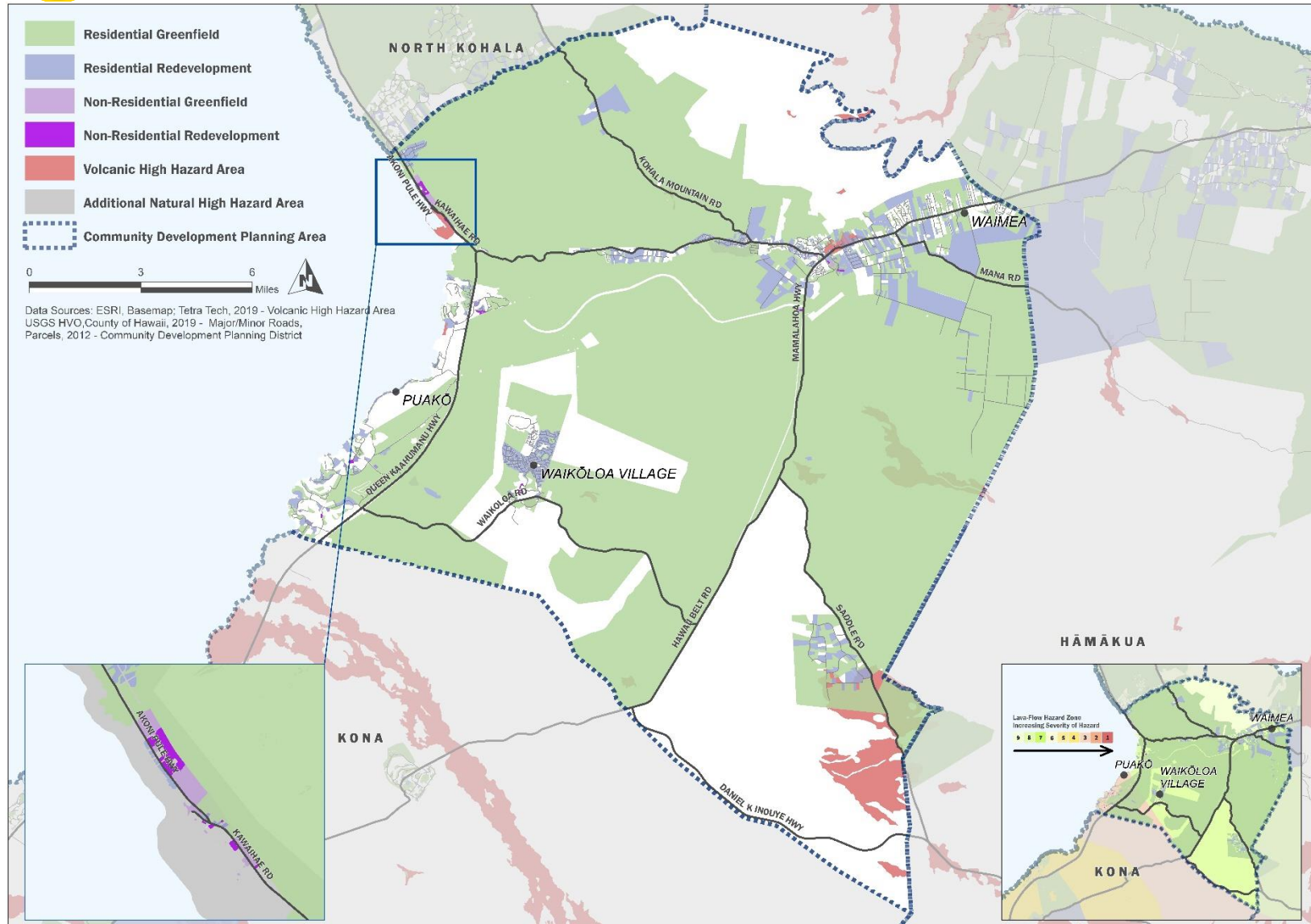


Figure 4-179. South Kohala Greenfield and Redevelopment Areas and Volcanic Hazard Area



There is a significant lack of hazard insurance for many structures, across the County. In 1991, State of Hawai'i lawmakers created a nonprofit collection of insurance companies called the Hawai'i Property Insurance Association to address this gap. The State assembled the nonprofit to provide basic property insurance for people who are unable to buy coverage in the private market, due to insurers being uncomfortable with Hawaii's significant volcano risk (Weiss 2018).

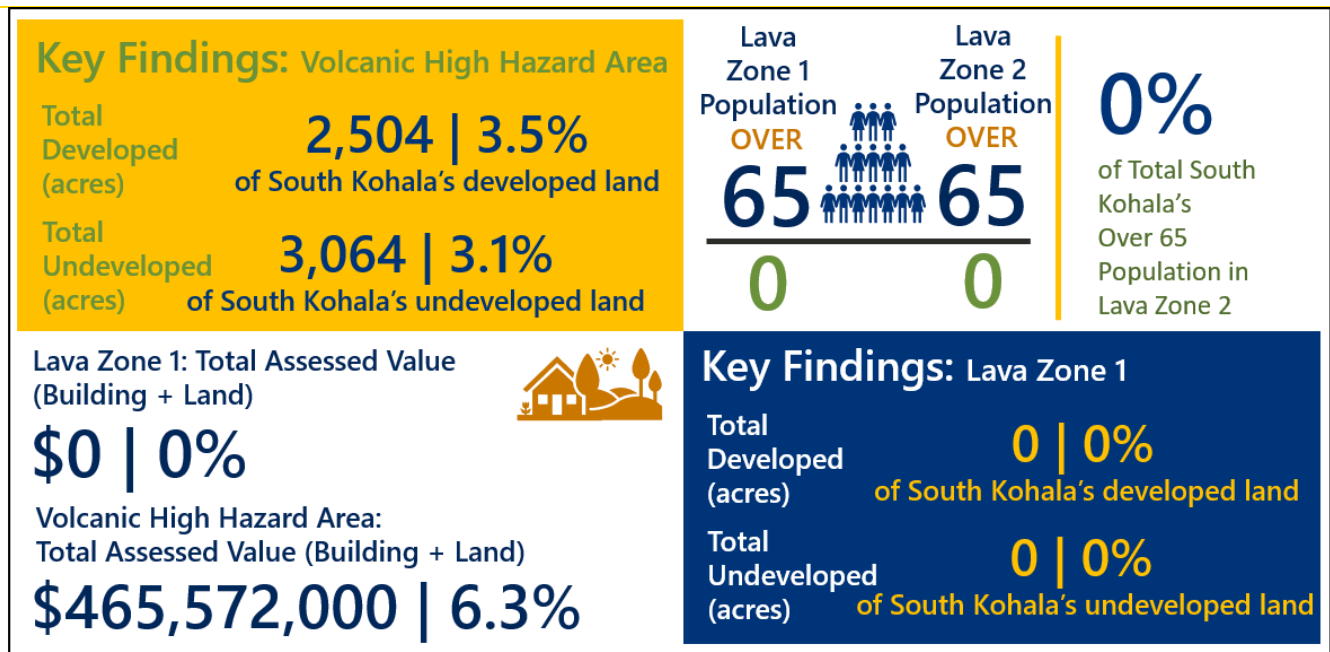
Volcanic hazard risk, and other natural hazard risks, combined with limited insurance is a considerable factor when planning for the continued growth of South Kohala. Critical questions that need to be addressed prior to moving forward with future plans for development/re-development and decisions about future population centers are:

- Who will be able to afford to live in an area that is vulnerable to volcano- and other natural hazard-related risks?
- Physical exposure to a range of hazards may cause certain areas to be more affordable to live. What are the choices available to economically vulnerable households?
- Will the most vulnerable be forced to move to other less vulnerable districts?
- Will they remain and bear the burden when the next event takes place?
- What strategies do the County and community need to develop to manage residential development and infrastructure development relative to the expected demand on emergency services and repetitive losses in an area with high exposure to hazards?

These questions will be critical to address moving forward with all plans for future development/re-development and decisions about future population growth in South Kohala. Development or redevelopment is not always the preferred option. In fact, Hilo has already been leading the way in the County when they took an approach to some of their past damaged land to not rebuild after the 1946 tsunami, but rather turned the damaged land into a park—looking to other low-hazard exposure land for development and population growth.



4.8.9 KEY FINDINGS



Note: All percentages are relative to the South Kohala District. According to the analysis, there are 0 residents located in lava zone 1.

Figure 4-180. South Kohala Key Findings

Understanding what is at risk from natural hazards and future changes that impact vulnerability can assist in South Kohala's planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The following summarizes the key findings for the South Kohala CDP:

- South Kohala has the greatest number of households in the County located in lava zone 8 (67.2% of total South Kohala households)
- Based on year-built data, 64.4% of South Kohala's critical facilities and lifelines were constructed prior to 1985 increasing their vulnerability to seismic impacts
- South Kohala has 8.3% of parcels are located in lava zone 3; a moderate risk lava-flow hazard zone
- 2% of South Kohala's population lives in a Volcanic High Hazard Area (41 residents), or on soft soils (NEHRP D and E)
- Over 90% of South Kohala's Volcanic High Hazard Area is categorized as agricultural land, totaling 5,226 acres (the highest percentage in the County)

South Kohala is confronted with important future decisions pertaining to life safety, development, redevelopment, and general land use. Perhaps most significant is population, sacred places and agricultural land located within the Volcanic High Hazard Area. An understanding and assessment of risk, exposure, and implications of redevelopment and/or greenfield development, which could create new land uses and potentially increased population within South Kohala, should be carefully considered. There are existing locations within South Kohala with significantly less exposure to volcano hazard risk; however, there are several other natural high hazard areas to consider. An all-hazards approach should be used to assess future growth and redevelopment targets, providing an option for keeping up with the demand of living safely in South Kohala.



SECTION 5. RECOMMENDATIONS

The most recent volcanic event, the 2018 Kīlauea eruption, impacted natural and cultural resources, housing, infrastructure, the economy, health and social services, and community planning and capacity building. The next volcanic hazard event cannot be predicted; however, scientists agree, it is imminent. Understanding what natural hazards the County is at risk to, volcanic or otherwise, and the assets exposed and vulnerable to future impacts, will guide future decision making and inform the following: 1) 2018 Kīlauea eruption recovery investments; 2) identification of mitigation strategies; and 3) guide land-use planning. This risk assessment provides the data and tools to serve as the foundation to risk-informed decision making.

The results of the volcanic risk assessment provide a detailed understanding of the County's exposure to the volcanic hazard using best available data. Not only are communities, natural and cultural resources at risk to future volcanic events, some have already been impacted by historic lava flows and other volcanic hazards. The additional exposure to other natural hazards only increases the risk to future losses.

It is recommended that the County recognize the Volcanic High Hazard Area (VHHA) as a county-wide hazard zone to inform future development and land use decisions. Although there is no current probability associated with U.S. Geological Survey (USGS) lava-flow zones, the VHHA is based on best available data and delineates the geographic area that is at greatest risk to lava flow, building and infrastructure damage from seismic events and has been impacted by historic lava flows. Similar to a Federal Emergency Management Agency (FEMA) flood zone designation, the VHHA can be used as a hazard overlay to identify volcanic hazard high risk areas and inform decision making. ***It is recommended that the County incorporate the VHHA as a hazard overlay in the General Plan update to reduce future land use development in high hazard areas and develop regulatory tools and incentives to reallocate existing and potential development to less hazardous areas in the County. It is also recommended to utilize the VHHA hazard overlay to support the land use decisions guiding the 2018 Kīlauea eruption recovery strategies and projects and also to implement mitigation strategies in advance of future volcanic hazard events.***

Recommendations

1. *Formally recognize the Volcanic High Hazard Area (VHHA) as a hazard overlay to inform future development and land use decisions.*
2. *Incorporate the VHHA as a hazard overlay in the General Plan update to reduce future land use development in high hazard areas and develop regulatory tools and incentives to reallocate existing and potential development to less hazardous areas in the County.*
3. *Utilize the VHHA hazard overlay to support the land use decisions guiding the 2018 Kīlauea eruption recovery strategies and projects.*
4. *Update the VHHA when new and revised volcanic data becomes available.*
5. *Incorporate the VHHA and Additional Natural High Hazard Area together as high-risk hazard areas when identifying and designing mitigation projects.*
6. *Integrate the VHHA into other planning mechanisms.*
7. *Use a multi-hazard lens when identifying recovery and mitigation projects, regardless of the hazard type of the event, to increase the County's resilience to natural hazards.*

USGS continues to collect and enhance their knowledge of the volcanic hazard on the Island. In addition, vog data and associated climatology will soon be available in a format that can be used to further inform the VHHA. ***It is recommended that the VHHA be updated as new data becomes available to align with best available science, and***



any future lava flow events be integrated into the spatial overlay. In addition, the asset inventories used in the risk assessment should be maintained and continuously updated and used to inform planning and emergency management.

Natural hazard disasters cannot be prevented however current and future land use decisions can reduce potential future losses. The County will be faced with future development and redevelopment decisions in the future. An all-hazards approach should be used to assess future growth and redevelopment targets. ***It is recommended that both the VHHA and the Additional Natural High Hazard Area identified in this risk assessment be defined as high-risk hazard areas and considered to inform land use decisions.***

The County faces multiple natural hazards and may experience impacts from multiple hazard events at one time. This was most recently demonstrated by the Kīlauea eruption (DR-4366) and Hurricane Lane (DR-4395). During the recovery to these events, the County has an opportunity to identify mitigation measures to reduce future impacts to people, property and the environment to multiple hazards. As the County continues on its path to achieving natural disaster resilience, it is critical to consider all natural hazards when identifying mitigation strategies. ***It is recommended that both the VHHA and the Additional Natural High Hazard Area identified in this risk assessment be considered to inform the identification, design and prioritization of mitigation measures. In addition, regardless of the disaster event's hazard type, a multi-hazard lens should be applied when identifying recovery and mitigation projects to increase the County's overall hazard resilience. These projects should continue to be identified in the County Multi-Hazard Mitigation Plan update.***

The County can utilize the unique opportunity afforded by the development of the Volcanic Risk Assessment and Recovery Strategic Plan to integrate and align hazard risk information and risk reduction policies across the County's network of plans. Plan integration is a critical task for reducing risk and improving resilience that involves a two-way exchange of information between hazard mitigation plans and other community plans (U.S. Department of Homeland Security 2017). ***It is recommended that the results of the risk assessment and the VHHA overlay be integrated, at minimum, into the following plans: County General Plan, Community Development Plans, and Multi-Hazard Mitigation Plan.***



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