4.3.8 FUTURE LAND USE AND DEVELOPMENT

Hilo is comprised of mixed land use classifications as categorized by the Land Use Pattern Allocation Guide (LUPAG) (see ***Figure 4-68***). 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 Hilo is designated as conservation, representing a total of 127,701 acres or 71% of all Hilo land. Conservation land is defined as "forest and water reserves, natural and scientific preserves, areas in active management for conservation purposes, areas to be kept in a largely natural state, with minimal facilities consistent with open space uses, such as picnic pavilions and comfort stations, and lands within the State Land Use Conservation District" (CHPD 2016). Following conservation land, extensive agricultural lands (12%) and important agricultural lands (6.3%) come in second and third for largest area in the District. 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 10% of Hilo is classified as a mix of low-density urban, rural, medium-density urban, open area, high-density urban, university use, and urban expansion.

Overall, the land in the Volcanic High Hazard Area is mainly classified as conservation land (86.5%), extensive agriculture (5.3%), and important agricultural land (4.9%) (see ***Table 4-46*** and ***Figure 4-68***). The analysis indicates designated high-, medium- and low-density urban land is located in the Volcanic High Hazard Area; however not in lava zones 1 and 2. Seismic mitigation measures should be considered when considering new development in the Volcanic High Hazard Area. In addition, land that has been identified for future urban expansion may also be susceptible to other hazards (i.e., tsunami, flood, sea level rise) and should be considered as well to inform future development decisions.

Table 4-46. Hilo 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)*
Breakwater	7	0	0	0
Conservation	127,782	64,501	0	59,041
Extensive Agriculture	21,618	3,990	0	3,265
High-Density Urban	849	177	0	0
Important Agriculture Lands	11,421	3,647	0	0
Industrial	4,160	0	0	0
Low-Density Urban	8,992	1,329	0	0
Medium-Density Urban	1,377	415	0	0
Open area	1,154	110	0	0
Ponds	18	0	0	0
Resort	77	0	0	0
Resort Node	6	3	0	0
Rural	1,705	361	0	0
University Use	665	52	0	0
Urban Expansion	122	2	0	0

LUPAG Land Use Pattern Allocation Guide

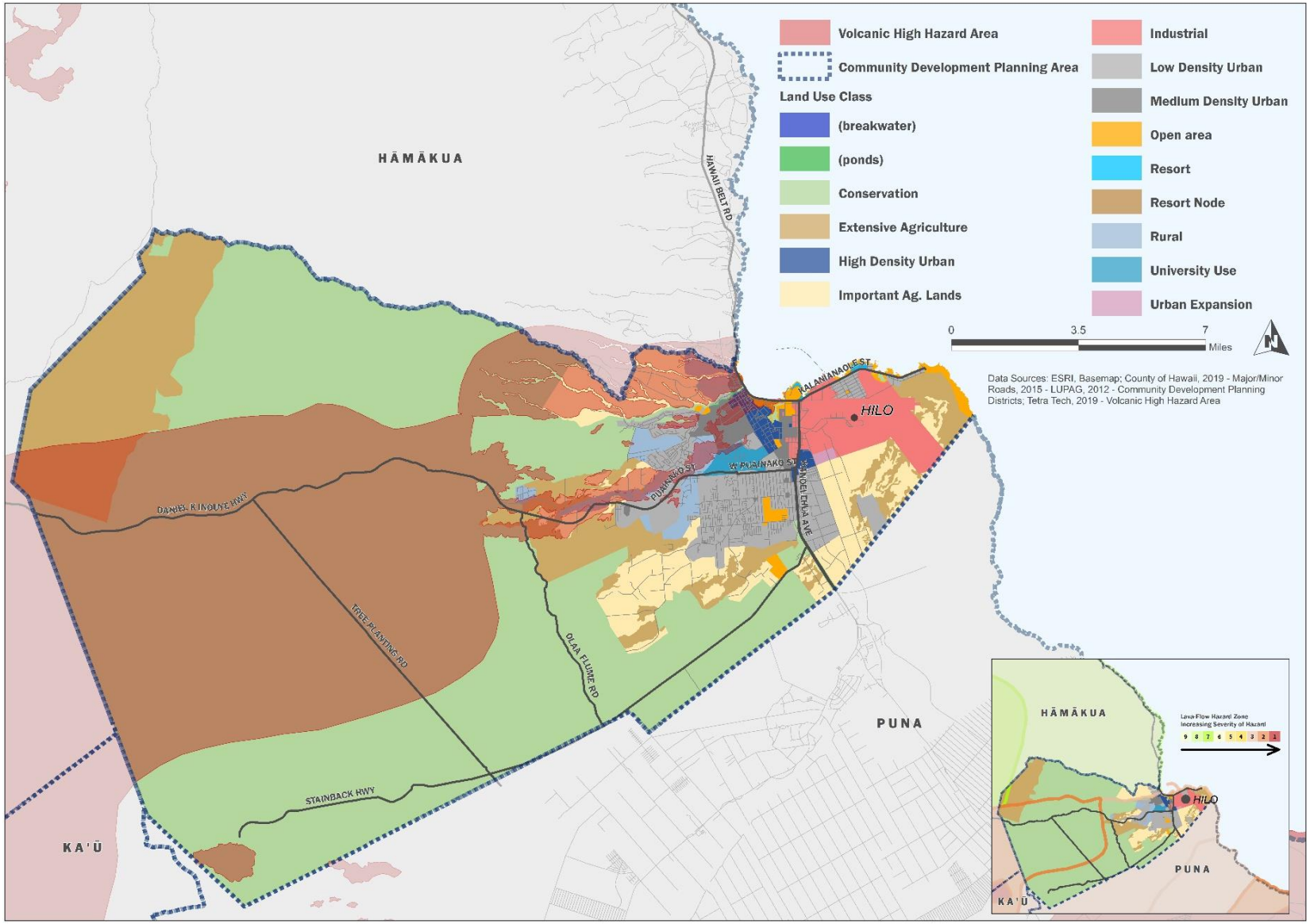


Figure 4-68. Hilo Land Use Pattern Allocation Guide (LUPAG) Classifications

In preparation for the County General Plan update, a build-out analysis was conducted to determine residential and non-residential capacity. Hilo has 28,395 acres of identified residential greenfield area (16%) 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 Hilo, there are 347 residential greenfield parcels identified for potential future development located in the Volcanic High Hazard Area; of these no parcels are in lava zone 1, 3 parcels are in lava zone 2, and 135 parcels are located in historic lava flow areas. In terms of non-residential greenfield parcels, there are 75 non-residential parcels located in the Volcanic High Hazard Area and 114 parcels identified for potential non-residential redevelopment.

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 high hazard. Refer to ***Table 4-47*** for additional statistics regarding parcels identified for future development and their location relative to the volcanic hazard areas and other high hazards.

Table 4-47. Hilo 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)	347 / 22.8%	835 / 10.1%	75 / 27.4%	114 / 23.8%
VHHA with Additional Natural High Hazard Area	271 / 78.1%	509 / 61%	75 / 100%	113 / 99.1%
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	3 / 0.2%	0 / 0%	0 / 0%	0 / 0%
Lava Zone 2 with Additional Natural High Hazard Area	2 / 66.7%	0 / 0%	0 / 0%	0 / 0%

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

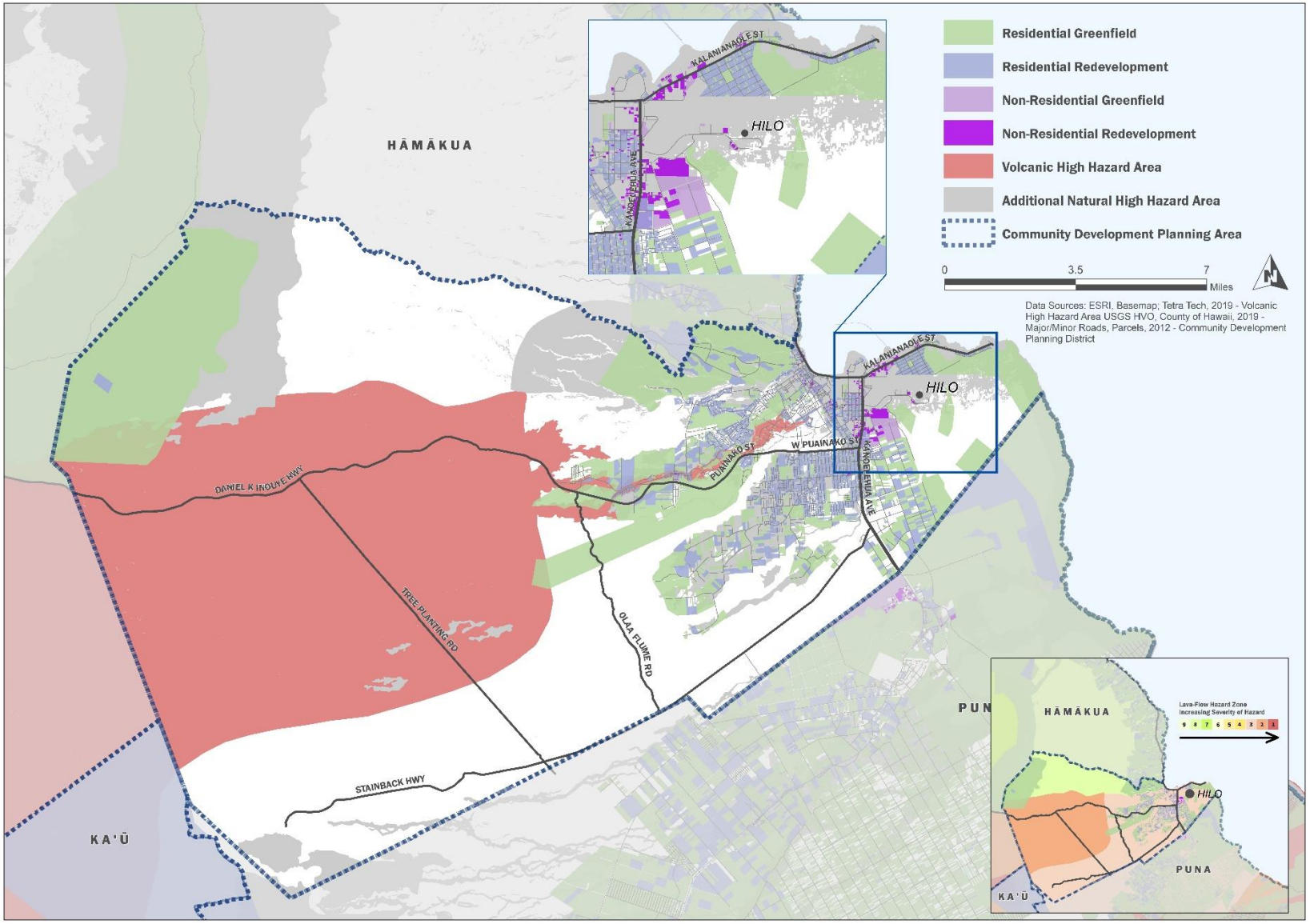


Figure 4-69. Hilo Greenfield and Redevelopment Areas and Volcanic Hazard Area

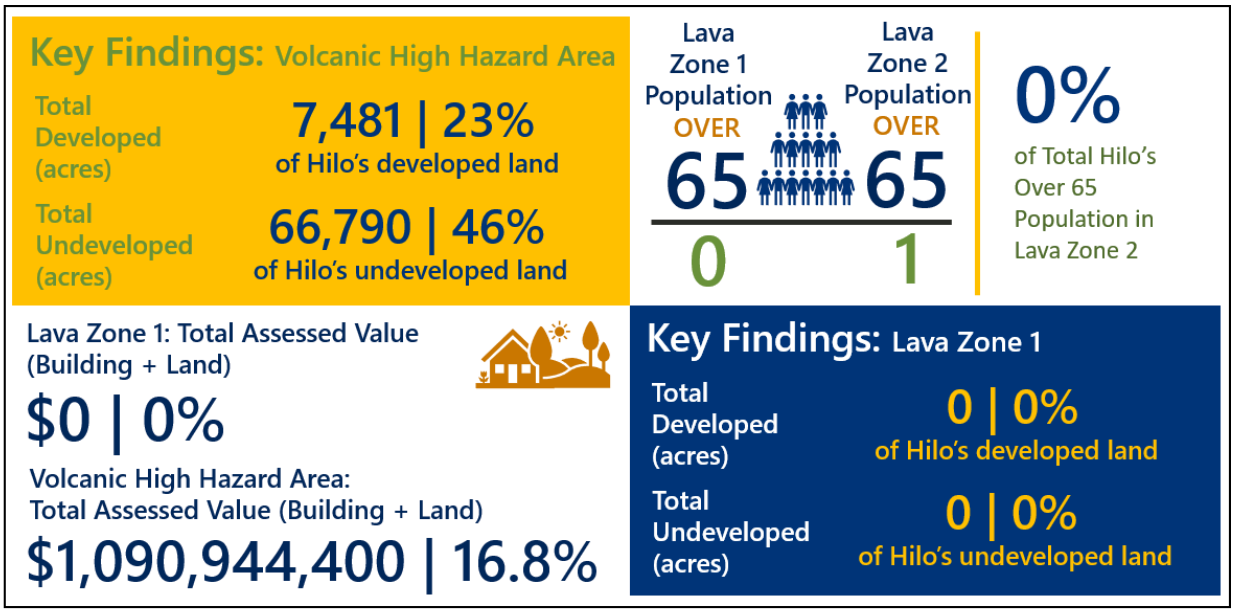
There is a significant lack of hazard insurance for many structures, across the County. In 1991, State of Hawai'i lawmakers created a nonprofit collection of insurance companies called the Hawai'i Property Insurance Association to address this gap. The State assembled the nonprofit to provide basic property 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 combined with limited or high cost insurance, where available, is a considerable factor when planning for the continued growth of Hilo. 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 lava flow and other volcano-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 Hilo. 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.

4.3.9 KEY FINDINGS



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

Figure 4-70. Hilo Key Findings

Understanding what is at risk from natural hazards and future changes that impact vulnerability can assist in Hilo'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 Hilo District:

- Hilo has the greatest percentage of households in the County located in lava zone 3 (96.7% of total Hilo households) which is considered a moderate lava-flow risk area
- Based on year-built data, 74% of Hilo's critical facilities and lifelines were constructed prior to 1985 (the second highest percentage in the County) and thus vulnerable to seismic impacts
- Hilo has the County's third highest percentage of federal and/or state reserve land located in the Volcanic High Hazard Area (50.2%)
- Utilizing current data, 1,115 parcels (6.6%), 766 households (4.9%), and 2,415 residents (5.2%) are located in historic lava flow areas (1790-1996)
- Hilo has no acres in lava zone 1, 62,015 acres in lava zone 2, and 77,635 acres in lava zone 3
- Over 10% of Hilo's population lives in a Volcanic High Hazard Area (11.3%)
- Over 65% of Hilo's agricultural crop land is in a Volcanic High Hazard Area, totaling 1,175 acres (the highest percentage in the County)

Hilo 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 Hilo, should be carefully considered. There are existing locations within Hilo with significantly less exposure and volcano risk, such as the central and downtown areas currently populated by the majority of Hilo's residents. This area should be assessed for future growth and redevelopment targets, providing an option for keeping up with the demand of living safely in Hilo.

Considerations for Hilo's most vulnerable populations need to 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 and prioritize safe evacuations when needed.

4.4 Ka'ū

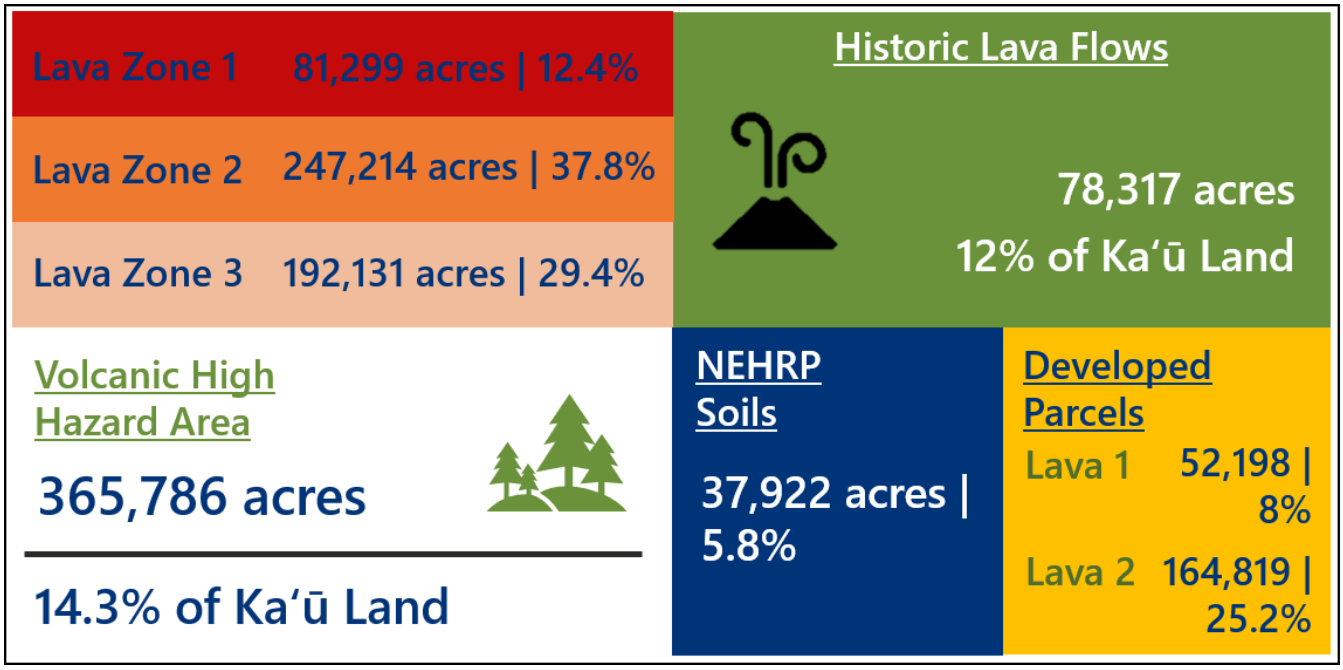
4.4.1 OVERVIEW

Ka'ū Community Development Plan district, (CDP), herein referred to as Ka'ū, is the southernmost district on the Island of Hawai'i. It represents the largest in land area within the County. Ka'ū is bordered by both the Kona CDP district and Hāmākua CDP district to the north, the Puna CDP district to the east, and is defined by the Pacific Ocean to the southwest and southern borders. Mauna Loa, Kīlauea, and many historic volcanic events significantly influence Ka'ū's identity.

One of the six original districts of ancient Hawai'i on the island, known as moku, Ka'ū's landscape is largely rural, dominated by the forest reserves and volcanic landforms (including Hawai'i Volcanoes National Park), stretching from Kīlauea's summit west to the ocean. Ka'ū 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), as well as several town centers: Pāhala, Nā'ālehu, and Hawaiian Ocean View. Additionally, Ka'ū possesses one of the most famous beaches in the State, Punalu'u Black Sand Beach, and features a number of important cultural resources like ancient Hawaiian warrior footprints trapped in volcanic ash long ago as a result of one of Kīlauea's rare explosive eruptions.

While Ka'ū was one of the original settled areas in the Hawaiian Islands, it remains a relatively remote landscape. The modern district of Ka'ū encompasses 922 square miles, with over 80 miles of virtually undeveloped coastline. Nearly two-thirds of its total land area is within the Conservation District, a fraction of a percent is settled, and the remainder is largely agricultural (CHPD 2017c). Present day, Ka'ū's character and settlement patterns are largely rural, with most development being in subdivisions lining the oceanfront portion of the District. Its history runs deep with a rich context of irreplaceable cultural and environmental resources. Despite its overwhelming rural characteristics, Ka'ū grew from 5,827 people in 2000, to 8,451 people in 2010, and to 8,948 people in 2017 (U.S. Census 2017).

4.4.2 VOLCANIC HAZARDS



Note: All percentages are relative to the Ka'ū CDP District

Figure 4-71. Ka'ū Volcanic Hazard Exposure Overview

Present day, 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).

Ka'ū is located within lava-flow hazard zones 1, 2, 3, 5, and 6 (***Figure 4-72***), the largest of which is lava zone 2, representing 37.8% of land area. Lava zone 2 is comprised of those areas adjacent to and downslope of Mauna Loa's lava zone 1 and extends as far as the southwestern corner of the CDP where it meets the Pacific Ocean. The majority of Ka'ū's lava zone 3 areas are immediately adjacent to Kīlauea lava zone 1 but are categorized as lava zone 3 due to topography and historic flow directions (USGS 2019a).

More than 50% of Ka'ū is located within lava-flow hazard zones 1 and 2, which includes flows surrounding Mauna Loa and Kīlauea. These volcanos have a history of frequent lava flows within zone 1, or in areas adjacent to or downslope of lava zone 1 within lava zone 2 (Wright et al. 1992). Of the 54% of developed land within Ka'ū (or parcels with a building assessment value according to County assessor records), 217,017 acres, or 33.2%, is located within high-risk lava flow hazard zones 1 and 2 (***Table 4-48***). For the purposes of this assessment, developed and undeveloped land has been calculated at the parcel level, regardless of private or public ownership.

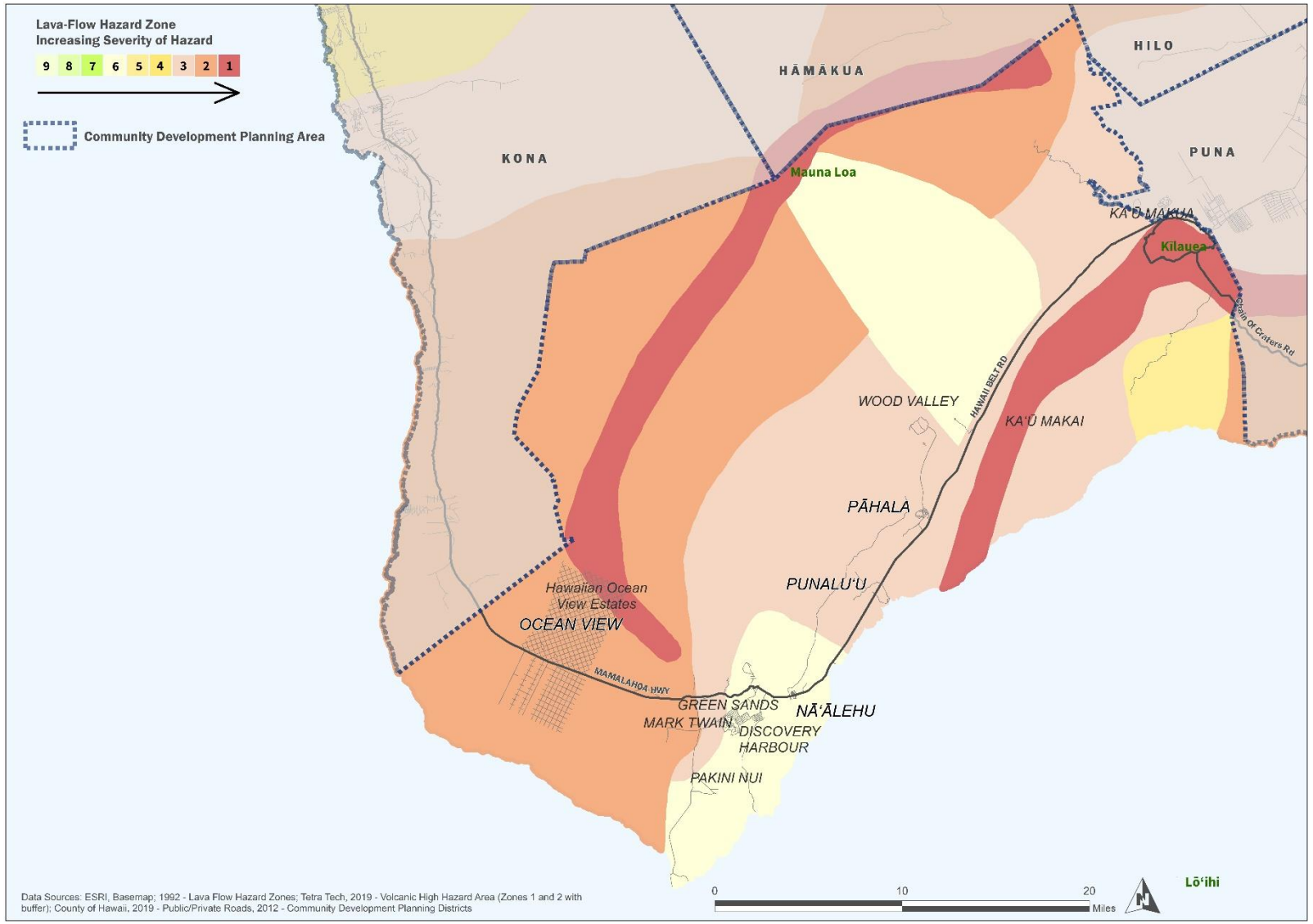


Figure 4-72. Lava Zones in Ka'ū

Table 4-48. Ka'ū 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)
Ka'ū District	**653,292**	**81,299**	**247,214**	**192,131**	**0**	**18,308**	**114,292**	**0**	**0**	**0**
Developed	352,175	52,198	164,819	103,672	0	4,640	26,842	0	0	0
Undeveloped	301,117	29,101	82,396	88,459	0	13,669	87,450	0	0	0

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

Lava zone 3 represents the second highest percentage of land area within Ka'ū (30%) and is primarily located near the eastern border of Puna and the Kīlauea volcano. According to the USGS, lava zone 3 is less hazardous than lava zone 2 due to its distance from recently active vents and topography. However, lava zone 3 has been inundated by past lava flows; 1% to 5% covered since 1800 and 15% to 75% covered within the past 750 years (Wright et al. 1992). Lava is not the only volcanic hazard faced by Ka'ū.

Soil conditions have a profound influence on the characteristics of ground shaking during an earthquake, and parcels within Ka'ū represent the highest exposure to seismic activity within the County. Ninty-seven percent of Ka'ū's parcels are located within peak ground acceleration (PGA) 120%g, which roughly corresponds to Seismic Design Category (SDC) E. The SDC E is the seismic hazard zone capable of producing the most intense shaking (USGS 2017). Refer to ***Section 3 - Methodology*** for more details on the PGA 120%g seismic zone. Ka'ū has 750 parcels (or 4.6% of total parcels) located on softer soils (National Earthquake Hazard Reduction Program [NEHRP] types D and E, such as fill, mud and sand) that amplify ground shaking.

Vog, a visible haze comprised of water vapor, carbon dioxide, sulfur dioxide (SO_2) and particulate matter produced during volcanic eruptions, can compromise air quality, especially for those areas downwind of volcanic emissions. It poses respiratory challenges for those exposed to it within the affected area. Vog impacts can be experienced hundreds, if not thousands, of miles away (Tetra Tech 2018). As was experienced during the 2018 Kīlauea eruption, regular ash emissions from the summit of Kīlauea, as well as acidic ocean entry plumes, generated by lava flows into the sea, also known as laze, also contribute to poor air quality in downwind locations (U.S. Department of the Interior Strategic Sciences Group 2018). Wind direction and speed are the two most critical factors that determine vog impacts within Ka'ū. For example, prevailing trade wind conditions, or winds that emanate from the northwest, can bring SO_2 and vog from Kīlauea's summit vent impacts Ka'ū communities from Pāhala to Ocean View (USGS 2019c).

The Ka'ū District may experience additional potential volcanic hazard impacts associated with Kīlauea including but not limited to the following:

- Eruptions or collapse without warning at near-vent areas
- 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
- 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 (USGS 2018)

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&E soils. This risk assessment focuses on Ka'ū's exposure to the Volcanic High Hazard Area and lava-flow hazard zones 1, 2, and 3. Over half of Ka'ū is located within the Volcanic High Hazard Area (56%) with the remainder located in lava zones 3, 5, and 6. Refer to ***Table 4-49*** and ***Figure 4-73*** for a summary of Ka'ū's land area in each volcanic hazard area.

Table 4-49. Ka'ū Land by Volcanic High Hazard Area and Lava Zones

Hazard Area	Total Land Area *(acres)*	Developed Parcel Area *(acres)*	Undeveloped Parcel Area *(acres)*
Volcanic High Hazard Area (VHHA)	365,786 (56%)	237,049 (67.3%)	128,737 (42.8%)
Lava Zone 1	81,299 (12.4%)	52,198 (14.8%)	29,101 (9.7%)
Lava Zone 2	247,214 (37.8%)	164,819 (46.8%)	82,396 (27.4%)
Lava Zone 3	192,131 (29.4%)	103,672 (29.4%)	88,459 (29.4%)
Lava Zone 5	18,308 (2.8%)	4,640 (1.3%)	13,669 (4.5%)
Lava Zone 6	114,292 (17.5)	26,842 (7.6%)	87,450 (29%)

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.

The Ka'ū District is prone to additional natural hazards. These hazards include tsunamis, earthquakes, floods, landslides, storm surge, coastal erosion, and sea level rise. There are significant flooding issues between Pāhala and Nā'ālehu on Highway 11 between mile markers 58 and 62, an area known as Kawa flats. In general, flooding causes road closures several times per year.

In addition to examining the assets exposed to the volcanic hazard areas, it is important to determine if those assets are located in additional natural high hazard zones to inform the identification of recovery and mitigation strategy development. ***Figure 4-73*** illustrates the location of additional natural high hazard areas located in Ka'ū and ***Figure 4-74 and 4-75*** illustrate the additional high hazard areas relative to the lava zones and Volcanic High Hazard Area.

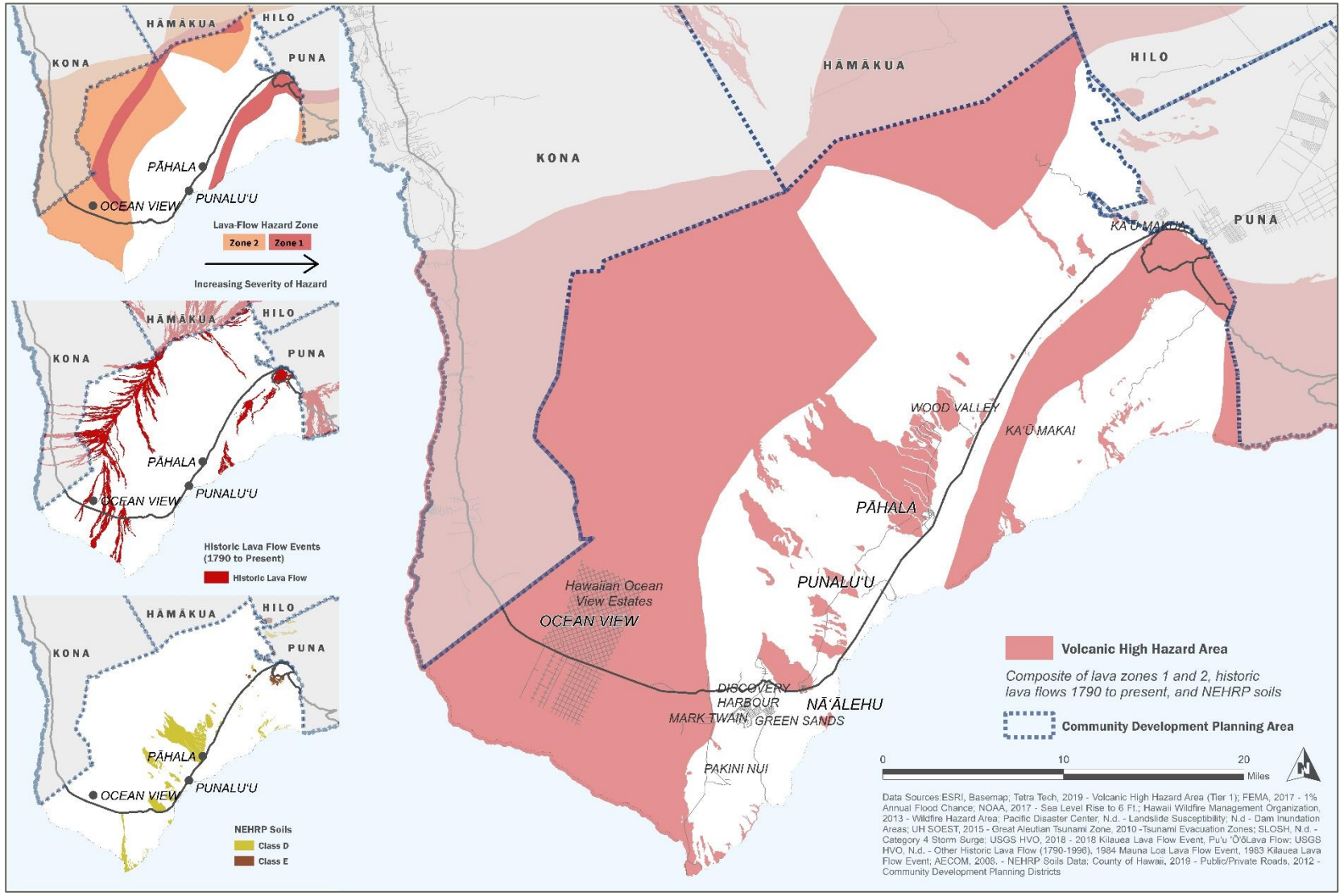


Figure 4-73. Volcanic High Hazard Areas in Ka'ū

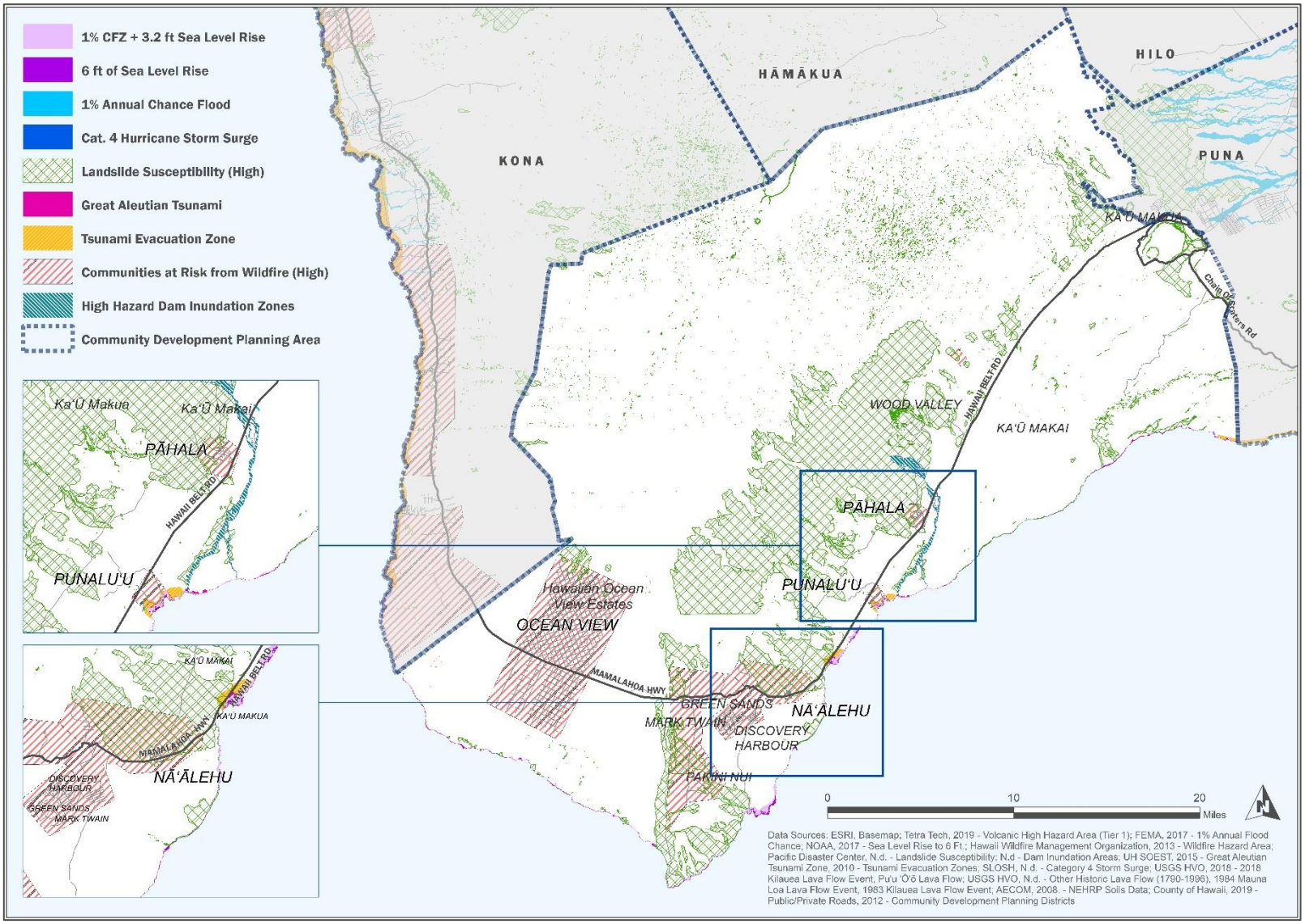


Figure 4-74. Additional Natural High Hazard Areas in Ka'ū

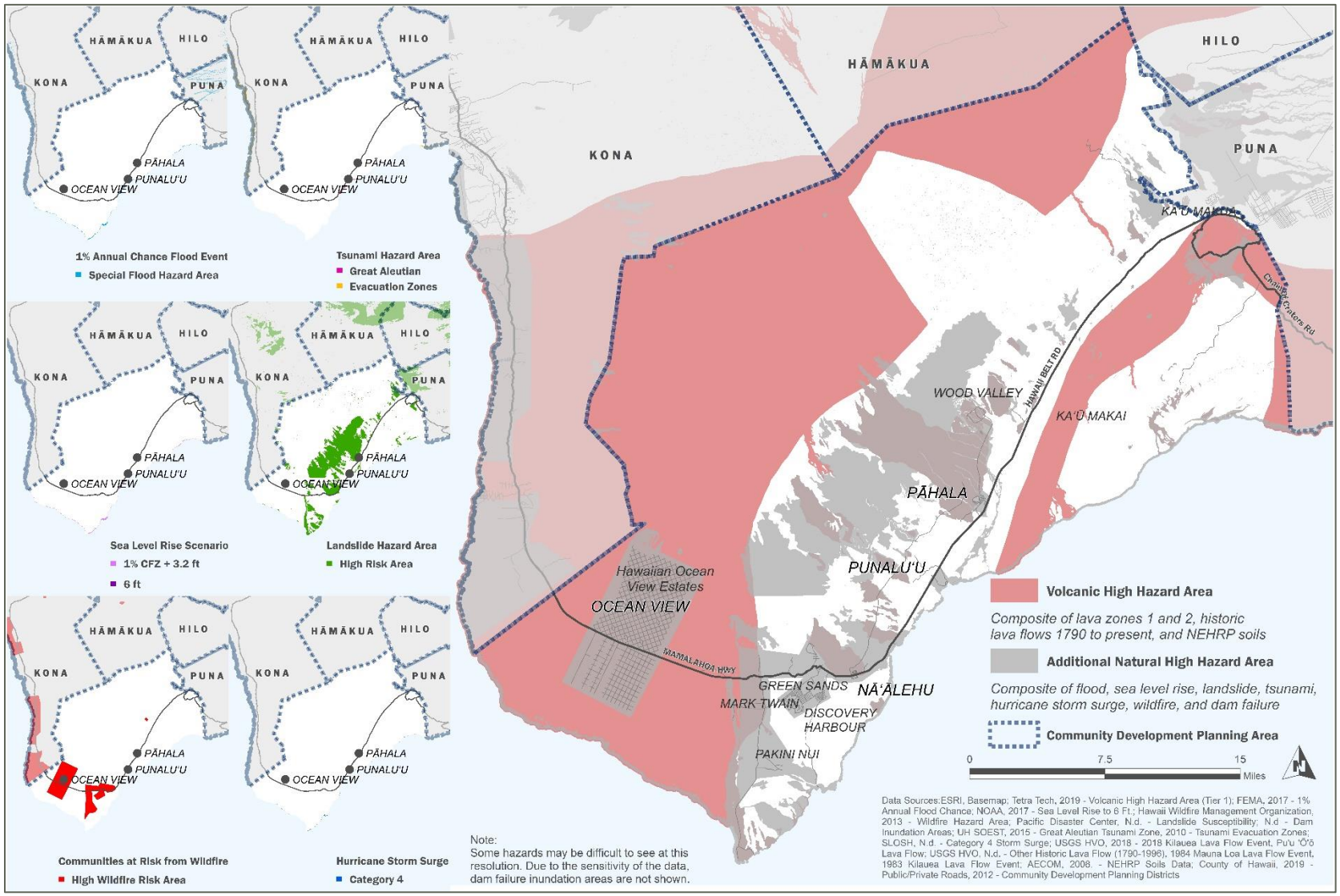
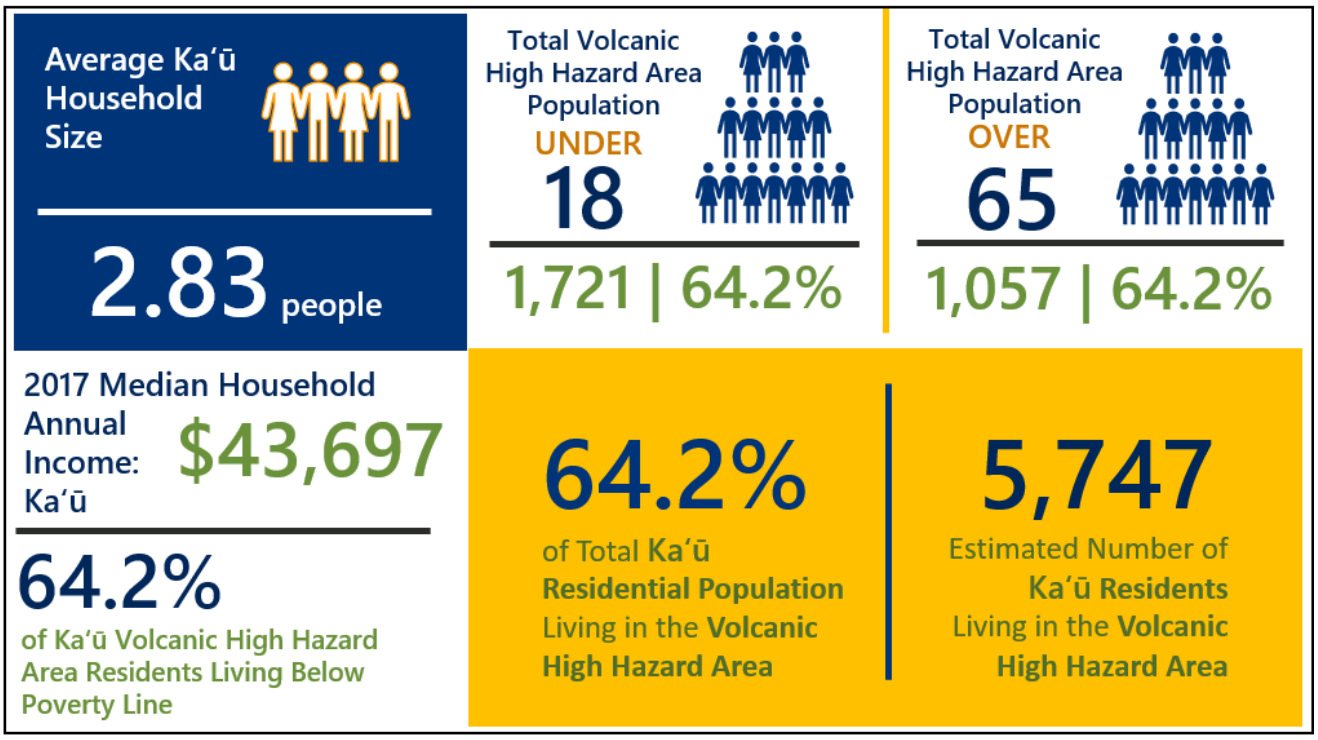


Figure 4-75. Volcanic High Hazard and Additional Natural High Hazard Areas Located in Ka'ū

4.4.3 POPULATION



Note: All percentages are relative to the Ka'ū District

Figure 4-76. Ka'ū Population Exposure to the Volcanic High Hazard Areas

As of 2017, Ka'ū's total population was 8,948, which represents 4.6% of the County's total population (ACS 2017). According to the 2019 draft County of Hawai'i General Plan, Ka'ū is expected to see a 93% growth rate (nearly the highest in the County, following 101% in Upper Puna). By 2030, the State of Hawai'i Department of Business, Economic Development and Tourism conservatively estimates that population will grow to approximately 11,952 (CHPD 2017c). According to the Ocean View Community Development Corporation (OVCDC), the population in Ocean View has doubled in ten years (from 2000 to 2010) and there are now more people in Ocean View than elsewhere in Ka'ū. According to OVCDC studies, Ka'ū may grow to as many as 20,000 people by 2030. As the Ka'ū District population increases, so too will the numbers of residents at risk to the volcanic hazard.

The Ka'ū CDP has several prominent population centers: Discovery Harbour, Mark Twain, Green Sands, Hawaiian Ocean View Estates (Ocean View), Pāhala, and Nā'ālehu (see ***Figure 4-78***). Hawaiian Ocean View Estates is Ka'ū's fastest growing development area (and largest, overall). Discovery Harbour, Mark Twain and Green Sands are all smaller in size yet located adjacent to each other and Nā'ālehu to the south.

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. Keep in mind the Ka'ū District has only one U.S. Census tract, therefore the population averages for Ka'ū are more uniform. For example, the relative majority of Ka'ū residents live in a Volcanic High Hazard Area and because of the average methodology appears that the individual population averages remain consistent across the board for Ka'ū. The limitations of this approach are recognized. It is recommended that as additional parcel-level population data becomes available, this analysis should be updated.

A majority of Ka'ū District residents live within lava zone 1, 2 or 3 (73.6%) and therefore, are exposed to the lava flow hazard. There is no calculated probability associated with each lava-flow hazard zone. The 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. Therefore, land classified as lava zone 1 is the most hazardous (USGS 2019a).

Figure 4-77 summarizes the number of Ka'ū residents living in lava zones 1, 2, 3, 5, and 6. Ka'ū's population lives only in lava zones 1 through 3, 5 and 6. As shown, the greatest number of residents live in lava zone 2 (representing over 50% of Ka'ū's total population).

Figure 4-78 illustrates the population density across Ka'ū relative to the Volcanic High Hazard Area. The greatest population density is in Ocean View and Discovery Harbour. 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 Ka'ū CDP has the greatest percentage of households in the County located in the Volcanic High Hazard Area (62.2% of total Ka'ū households) the greatest percentage of households located in lava zone 2 (50.4% of total Ka'ū households).

At the individual resident level, countywide, Ka'ū also ranks high for exposure with the greatest percentage of residents living in the Volcanic High Hazard Area (64.2% of total Ka'ū residents).

It also has the greatest number of residents residing in lava zone 2 (51.8% of total Ka'ū residents).

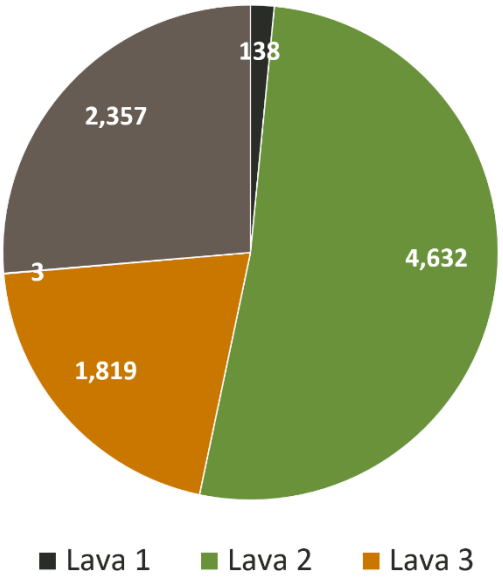


Figure 4-77. Number of Ka'ū Residents in Lava Zones

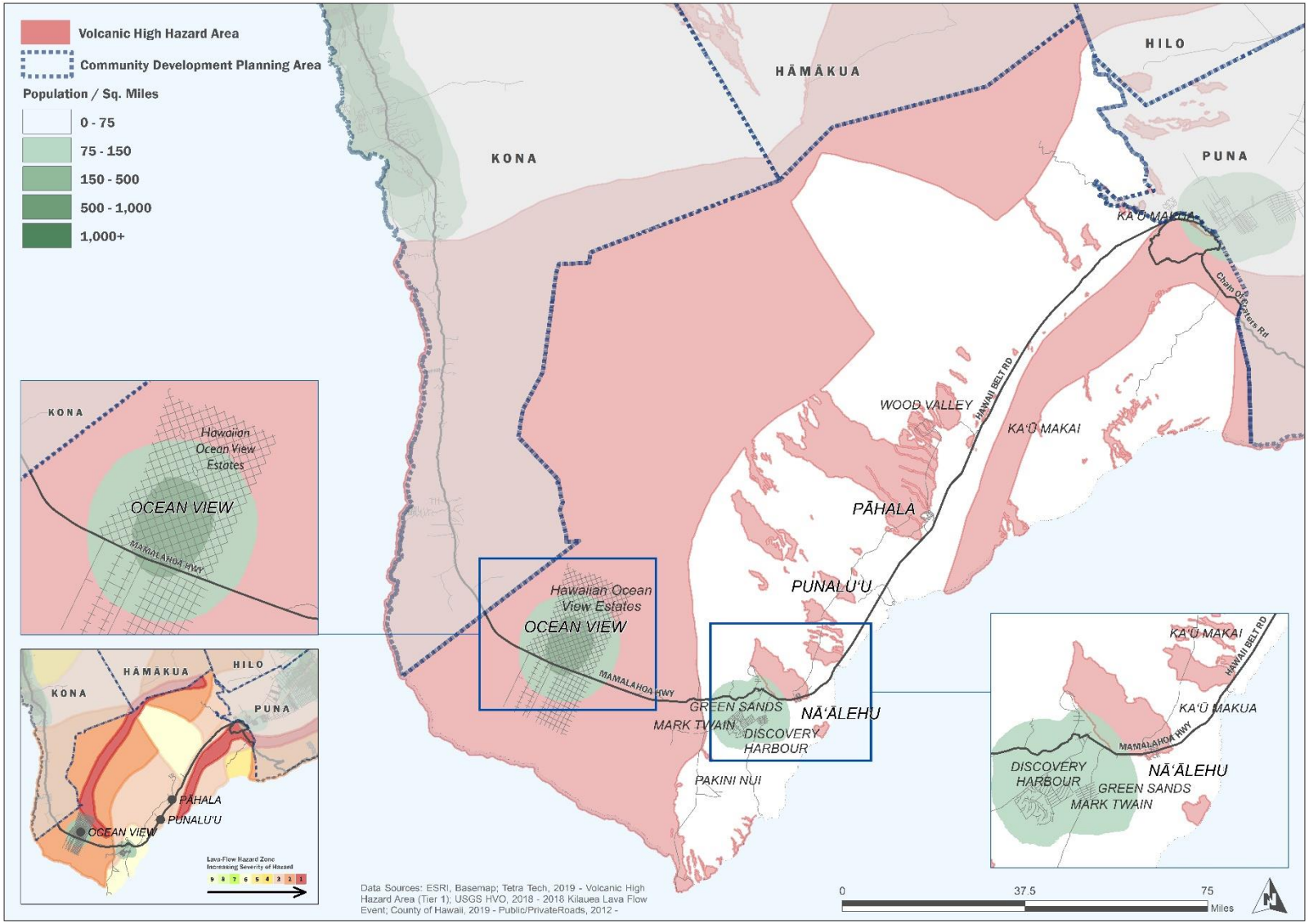


Figure 4-78. Ka'ū Population Density Relative to the Volcanic Hazards

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 4-50 summarizes the vulnerable population statistics in Ka'ū by number of residents. The District has a significant percentage of low-income residents. For example, the 2017 median annual income of residents in Ka'ū was $43,697 (the County's median annual income is $56,395) with 32% of residents living below the poverty line (ACS 2017). Additionally, many Ka'ū residents are considered cost-burdened, meaning these residents pay "more than 30 percent of their income for housing" and "may have difficulty affording necessities such as food, clothing, transportation, and medical care" (PD&R Edge No Date) by housing costs and do not live in adequate housing (i.e. lack complete plumbing facilities).

Table 4-50. Ka'ū Vulnerable Population

Estimated Vulnerable Populations	
No Internet	3,026
Below Poverty Line	2,864
Under 18	2,680
SNAP	2,323
Over 65	1,645
Single Parent	1,503
Disability	1,463
Non-English Speaking	902
No Health Insurance	704
No Diploma	650
No Vehicle	444
Unemployed	387
No Phone	190

In terms of total number of residents, those residents with no internet, living below the poverty line, and under 18 represent the top three vulnerable population categories within the Ka'ū District. 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.

Over 30% of Ka'ū residents living in the Volcanic High Hazard Area are either under 18 years of age or over 65 years of age. Additionally, over 60% of residents in Ka'ū with no phone service live within the Volcanic High Hazard Area. This means that they have limited connectivity which in turn limits their ability to receive standard hazard alerts and emergency evacuation notices. There are 64.2% of Ka'ū residents with physical limitations due to a disability living in the Volcanic High Hazard Area. The following summarizes the estimated number of residents living in the Volcanic High Hazard Area and considered the most vulnerable to the volcanic hazard:

- 1,721 people under 18 years of age
- 1,057 people over 65 years of age
- 965 single parents
- 940 people living with a disability
- 1,943 people with no internet access
- 285 people with no vehicle access
- 122 people with no phone access

- 249 people who are unemployed—representing nearly half of total unemployed in Ka'ū
- 1,492 people utilizing SNAP (Supplemental Nutrition Assistance Program)
- 1,839 people living below the poverty line—representing 64.2% of all those living below the poverty line in Ka'ū

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.

Many Ka'ū residents are dependent on a rainwater catchment system for water supply (Macomber 2010). 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 itself does not pose a health hazard, however acidic water has the potential to cause leaching of lead from building materials such as roof flashing, nails, and plumbing solder. This may result 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 the active 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). As the District is downwind of volcanic plumes, catchment system water in Ka'ū often have pH readings as low as 4, or as acidic as tomato juice (Macomber 2010).

Table 4-51 through Table 4-54 summarize the exposure of vulnerable residents in Ka'ū by socioeconomic factor to the volcanic hazard, as well as where the volcanic hazard area overlaps with another natural high hazard zone.

Table 4-51. Ka'ū 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)	5,747 / 64.2%	1,721 / 64.2%	1,057 / 64.2%	965 / 64.2%	940 / 64.2%
VHHA with Additional Natural High Hazard Area	5,744 / 100%	1,721 / 100%	1,056 / 100%	964 / 100%	939 / 100%
Lava Zone 1	138 / 1.5%	41 / 1.5%	25 / 1.5%	23 / 1.5%	23 / 1.5%
Lava Zone 1 with Additional Natural High Hazard Area	138 / 100%	41 / 100%	25 / 100%	23 / 100%	23 / 100%
Lava Zone 2	4,632 / 51.8%	1,387 / 51.8%	852 / 51.8%	778 / 51.8%	757 / 51.8%
Lava Zone 2 with Additional Natural High Hazard Area	4,630 / 99.9%	1,387 / 99.9%	851 / 99.9%	777 / 99.9%	757 / 99.9%

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 4-52. Ka'ū 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)	285 / 64.2%	452 / 64.2%
VHHA with Additional Natural High Hazard Area	285 / 100%	452 / 100%
Lava Zone 1	7 / 1.5%	11 / 1.5%
Lava Zone 1 with Additional Natural High Hazard Area	7 / 100%	11 / 100%
Lava Zone 2	230 / 51.8%	364 / 51.8%
Lava Zone 2 with Additional Natural High Hazard Area	229 / 99.9%	364 / 99.9%

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 4-53. Ka'ū 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)	417 / 64.2%	579 / 64.2%	1,943 / 64.2%	122 / 64.2%
VHHA with Additional Natural High Hazard Area	417 / 100%	579 / 100%	1,942 / 100%	122 / 100%
Lava Zone 1	10 /1.5 %	14 / 1.5%	47 / 1.5%	3 / 1.5%
Lava Zone 1 with Additional Natural High Hazard Area	10 / 100%	14 / 97.5%	47 / 100%	3 / 100%
Lava Zone 2	337 / 51.8%	467 / 51.8%	1,566 / 51.8%	98 / 51.8%
Lava Zone 2 with Additional Natural High Hazard Area	336 / 99.9%	467 / 99.9%	1,565 / 99.9%	98 / 99.9%

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.

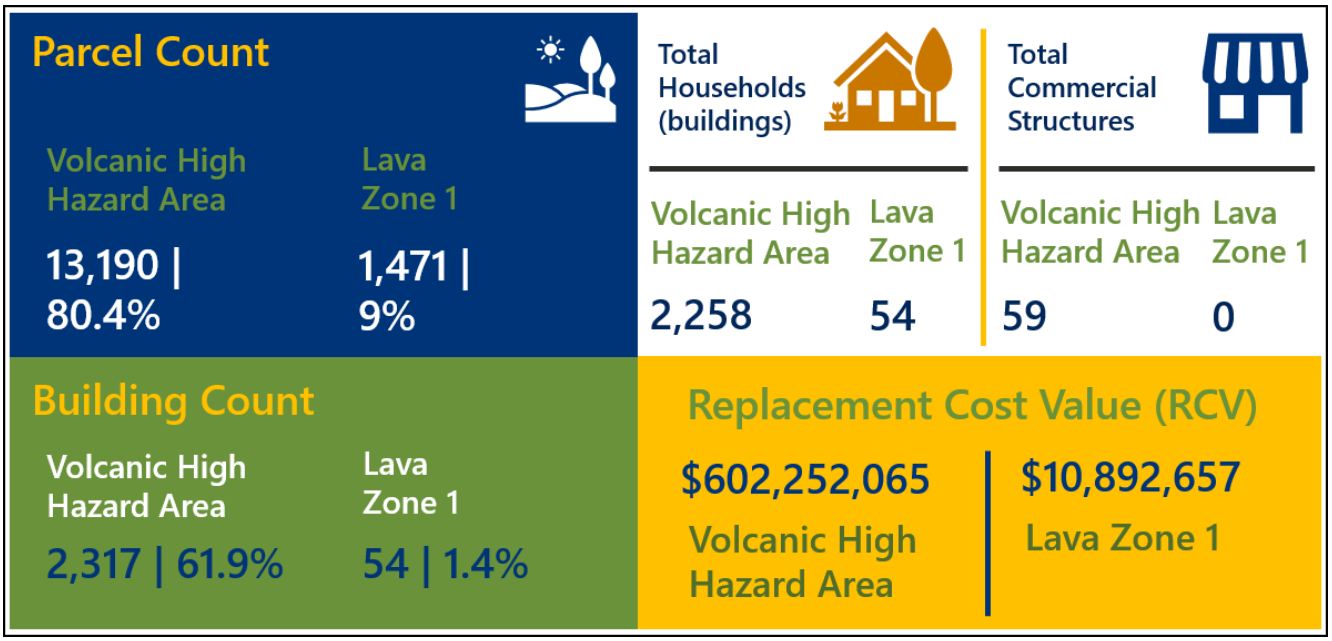
Table 4-54. Ka'ū Resident Socioeconomic Status, by Volcano Hazard Area - A measure of the population that is less likely to have the necessary economic resources to adequately prepare for or recover from a natural disaster.

Hazard Area	Unemployed *(number / %)*	Receiving SNAP *(number / %)*	Below Poverty Line *(number / %)*
Volcanic High Hazard Area (VHHA)	249 / 64.2%	1,492 / 64.2%	1,839 / 64.2%
VHHA with Additional Natural High Hazard Area	248 / 100%	1,492 / 100%	1,838 / 100%
Lava Zone 1	6 / 1.5%	36 / 1.5%	44 / 1.5%
Lava Zone 1 with Additional Natural High Hazard Area	6 / 100%	36 / 100%	44 / 100%
Lava Zone 2	200 / 51.8%	1,203 / 51.8%	1,482 / 51.8%
Lava Zone 2 with Additional Natural High Hazard Area	200 / 99.9%	1,202 / 99.9%	1,481 / 99.9%

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.

4.4.4 PARCELS AND BUILDINGS



Note: All percentages are relative to the Ka'ū CDP District

Figure 4-79. Ka'ū Parcels and Buildings Located in a Volcanic High Hazard Area (VHHA)

The recent pattern of development and growth in Ka'ū has been influenced by both "Traditional Neighborhood Development" (TND) community types and more recent Conventional Suburban Development (CSD). TNDs typically have a compact design that provides easy access to schools, restaurants, shopping, entertainment, and other amenities without over-reliance on a car. Ka'ū's CSD's depend upon a broader regional footprint of amenities to provide services and entertainment to the CSD. Ka'ū's fastest growing subdivision, Hawaiian Ocean View Estates, is a good example of a CSD (Ka'ū CDP 2013).

Overall, Ka'ū's building stock is significantly exposed to the Volcanic High Hazard Area. A total of 237,049 acres of developed land (representing 67.3% of Ka'ū's total developed land) and 2,317 buildings (61.9%) in the Ka'ū District are in the Volcanic High Hazard Area. At greatest risk to the lava-flow hazard are those developed parcels located in lava zone 1 (80 developed parcels and 54 buildings); and lava zone 2 (3,865 developed parcels and 1,847 buildings). ***Figure 4-80*** illustrates the developed parcels by lava-flow hazard zone.

Lava may burn structures and can 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 Volcanic High Hazard Areas is an estimated $770,721,400 which represents 69.5% of the Ka'ū District's total assessed values (land and structure). In terms of the replacement cost value of buildings (estimated structure and contents), an estimated $602,252,065 exists in Ka'ū's Volcanic High Hazard Area (see ***Table 4-55***).

Table 4-55. Ka'ū 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)	13,190 / 80.4%	$770,721,400	2,317 / 61.9%	$602,252,065	2,258 / 62.2%	59 / 51.3%
VHHA with Additional Natural High Hazard Area	13,182 / 99.9%	$768,339,100	2,313 / 99.8%	$601,145,629	2,254 / 99.8%	59 / 100%
Lava Zone 1	1,471 / 9.0%	$146,029,900	54 / 1.4%	$10,892,657	54 / 1.5%	0 / 0%
Lava Zone 1 with Additional Natural High Hazard Area	1,470 / 99.9%	$146,029,800	54 / 100%	$10,892,657	54 / 100%	0 / 0%
Lava Zone 2	10,975 / 66.9%	$506,729,000	1,847 / 49.3%	$458,912,481	1,827 / 50.4%	20 / 17.4%
Lava Zone 2 with Additional Natural High Hazard Area	10,969 / 99.9%	$506,563,600	1,843 / 99.8%	$457,806,045	1,823 / 99.8%	20 / 100%

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. All structures built prior to 1985 are therefore considered to be unreinforced and susceptible to earthquake and hurricane wind 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 4-81*** with many clustered very close or even overlapping with Ka'ū's Volcanic High Hazard Area. In total, there are 1,316 pre-1985 structures located in PGA 120%g, or greater than 35% of total structures in the District, regardless of year built. These structures are more vulnerable to seismic impacts when compared to structures built post-1985.

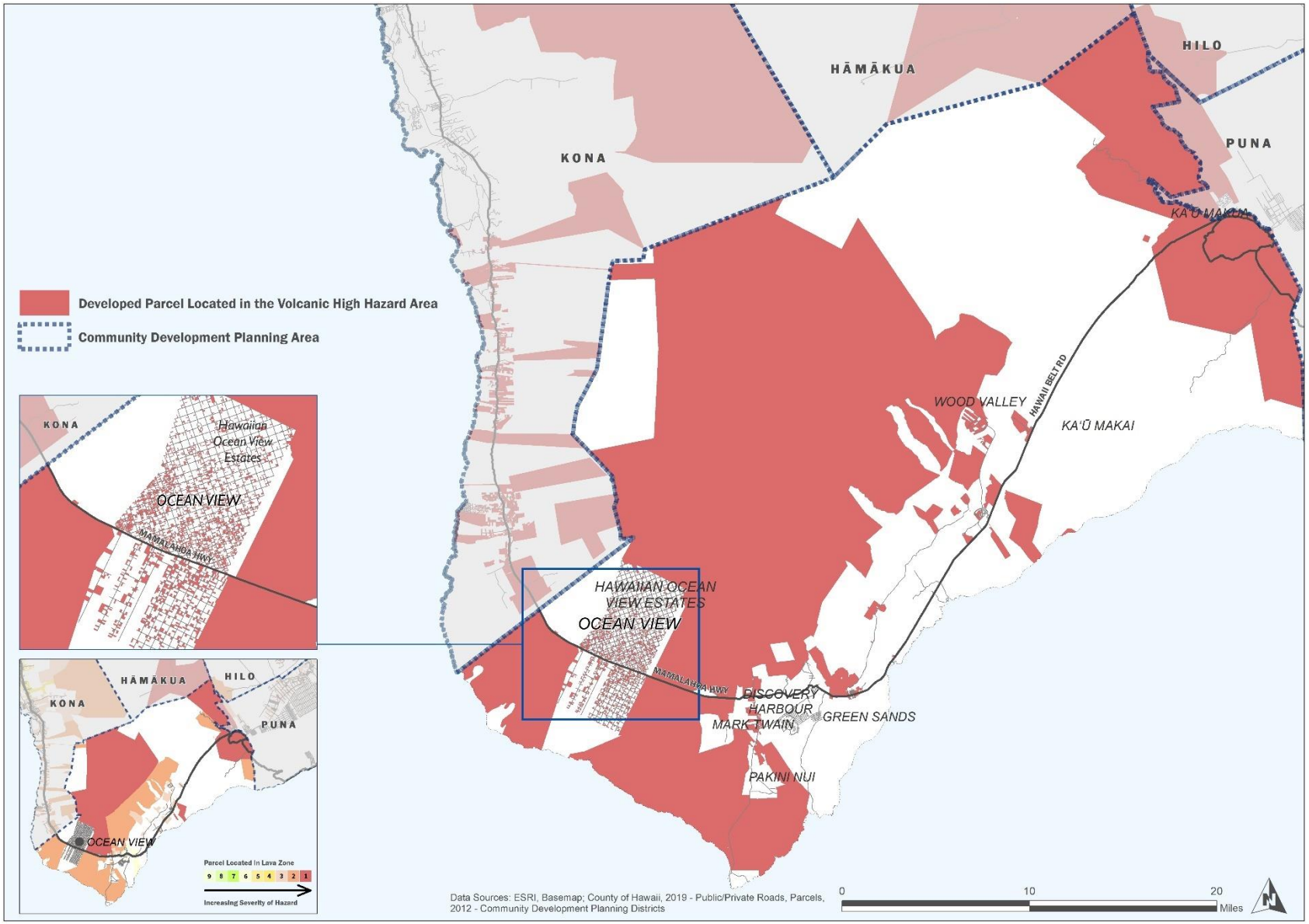


Figure 4-80. Developed Parcels in Ka'ū by Volcanic High Hazard Area and Lava Zone

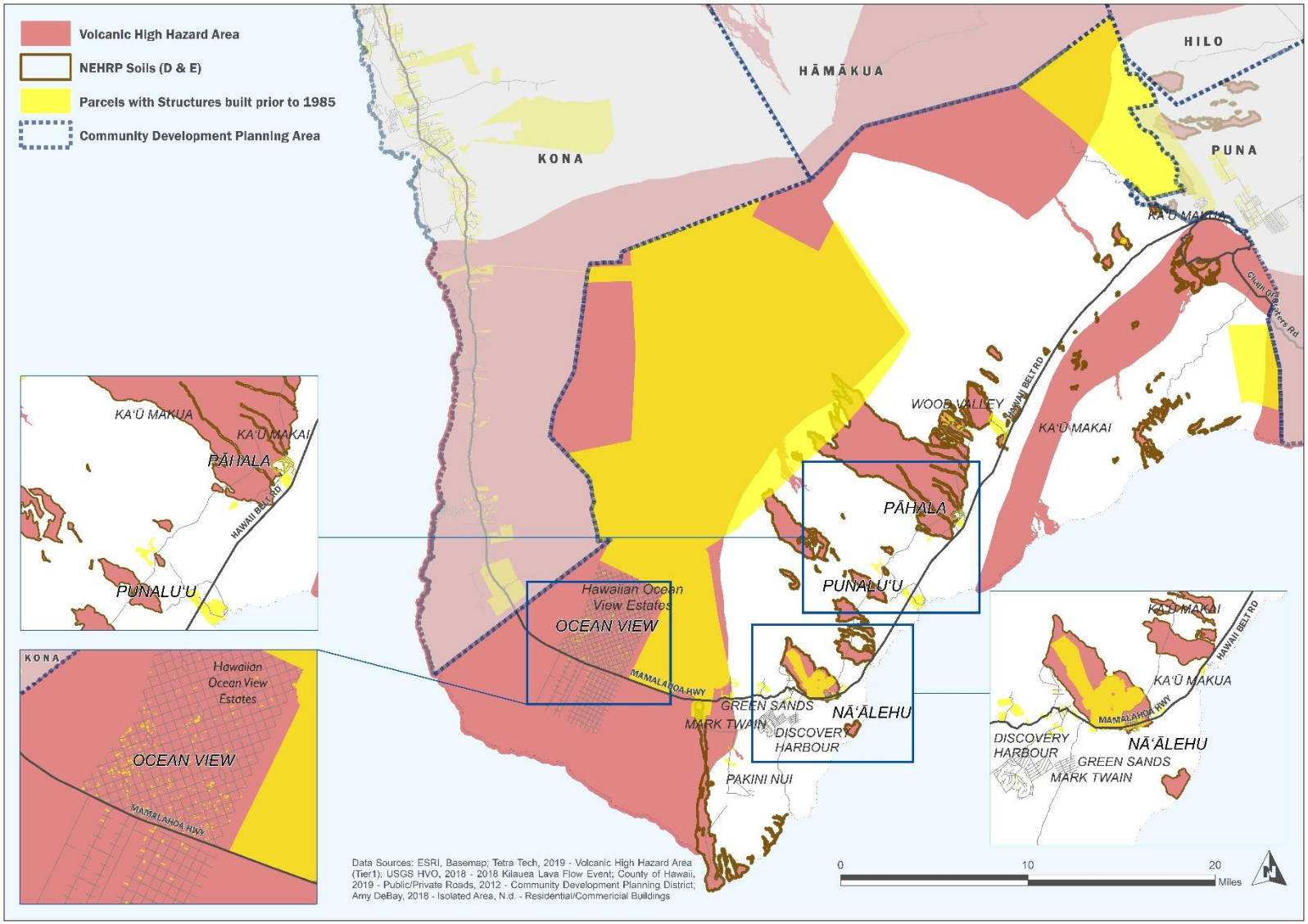
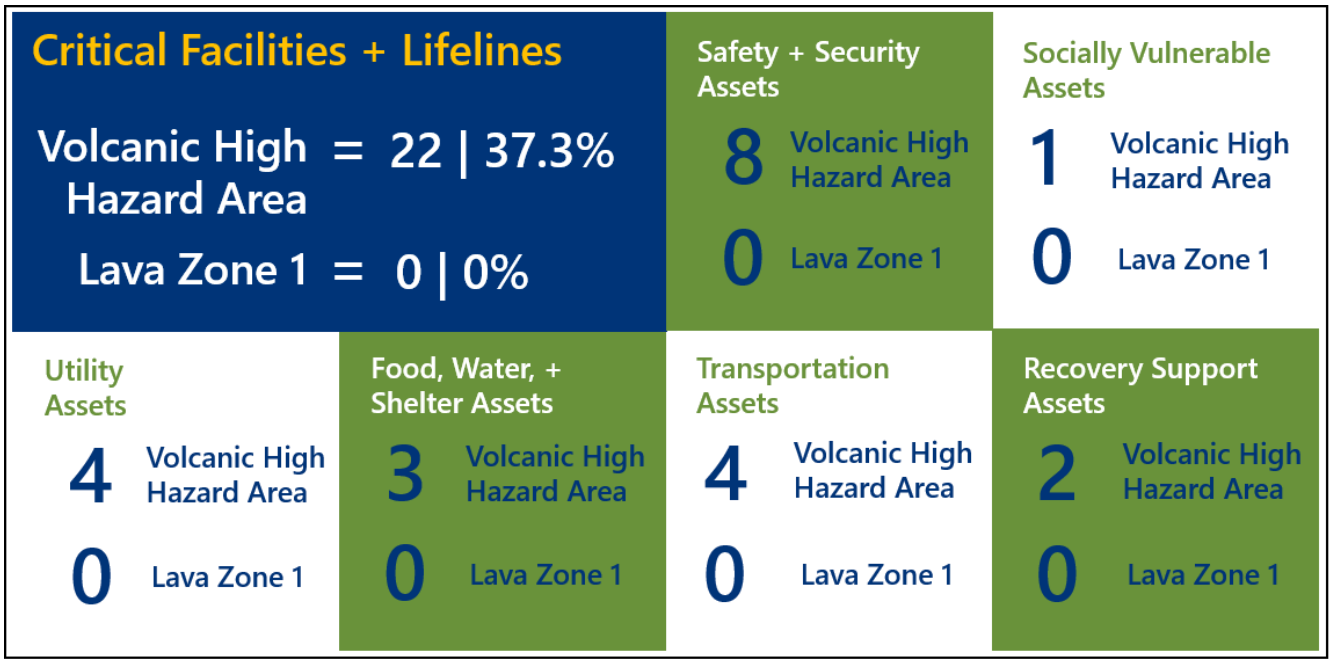


Figure 4-81. Ka'ū Parcels with Structures Constructed Pre-1985 in the Volcanic High Hazard Area

4.4.5 CRITICAL FACILITIES AND LIFELINES



Note: All percentages are relative to the Ka'ū District

Figure 4-82. Ka'ū Critical Facilities and Lifelines Located in the Volcanic High Hazard Area and Lava Zone 1

Through the development of the volcanic risk assessment, 59 critical facilities and lifelines were identified in Ka'ū. The critical facility and lifeline categories align with the 2015 County Hazard Mitigation Plan asset categories.

Table 4-56 summarizes the exposure of the critical facilities to the volcanic hazards. Overall, nearly 40% of Ka'ū's critical facilities are located in the Volcanic High Hazard Area, and therefore susceptible to impacts during volcanic events (***Figure 4-83***). Of the 22 critical assets located in the Volcanic High Hazard Area, 9 are located in lava zone 2 and 34 are located in lava zone 3 (Ka'ū has no critical facilities located in lava zone 1).

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. Ka'ū and Puna are the only CDPs with roadway that intersects lava zone 1. Ka'ū has more than 50% of its roads (greater than 275 miles) intersecting the Volcanic High Hazard Area with 33.6 miles of publicly accessed private and roads classified as 'other government' roads located in lava zone 1.

Similar to the discussion on structures constructed pre-1985, there are a number of critical facilities in Ka'ū constructed prior to 1985 and therefore more vulnerable to earthquake damage (during a volcanic eruption or occurring separately). Based on year-built data, 70% of Ka'ū's critical facilities and lifelines were constructed prior to 1985 (one of the highest percentages in the County). 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 4-56. Ka'ū 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)	22 / 37.3%	15 / 25.4	8 / 44.4%	3 / 37.5%	2 / 50%	1 / 25%	4 / 57.1%
VHHA with Additional Natural High Hazard Area	22 / 100%	15 / 100%	8 / 100%	3 / 100%	2/ 100%	1 / 100%	4 / 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	9 / 15.3%	3 / 5.1%	5 / 27.8%	0 / 0%	1 / 25%	0 / 0%	3 / 42.9%
Lava Zone 2 with Additional Natural High Hazard Area	9 / 100%	3 / 5.1%	5 / 100%	0 / 0%	1 / 100%	0 / 0%	3 / 100%

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.

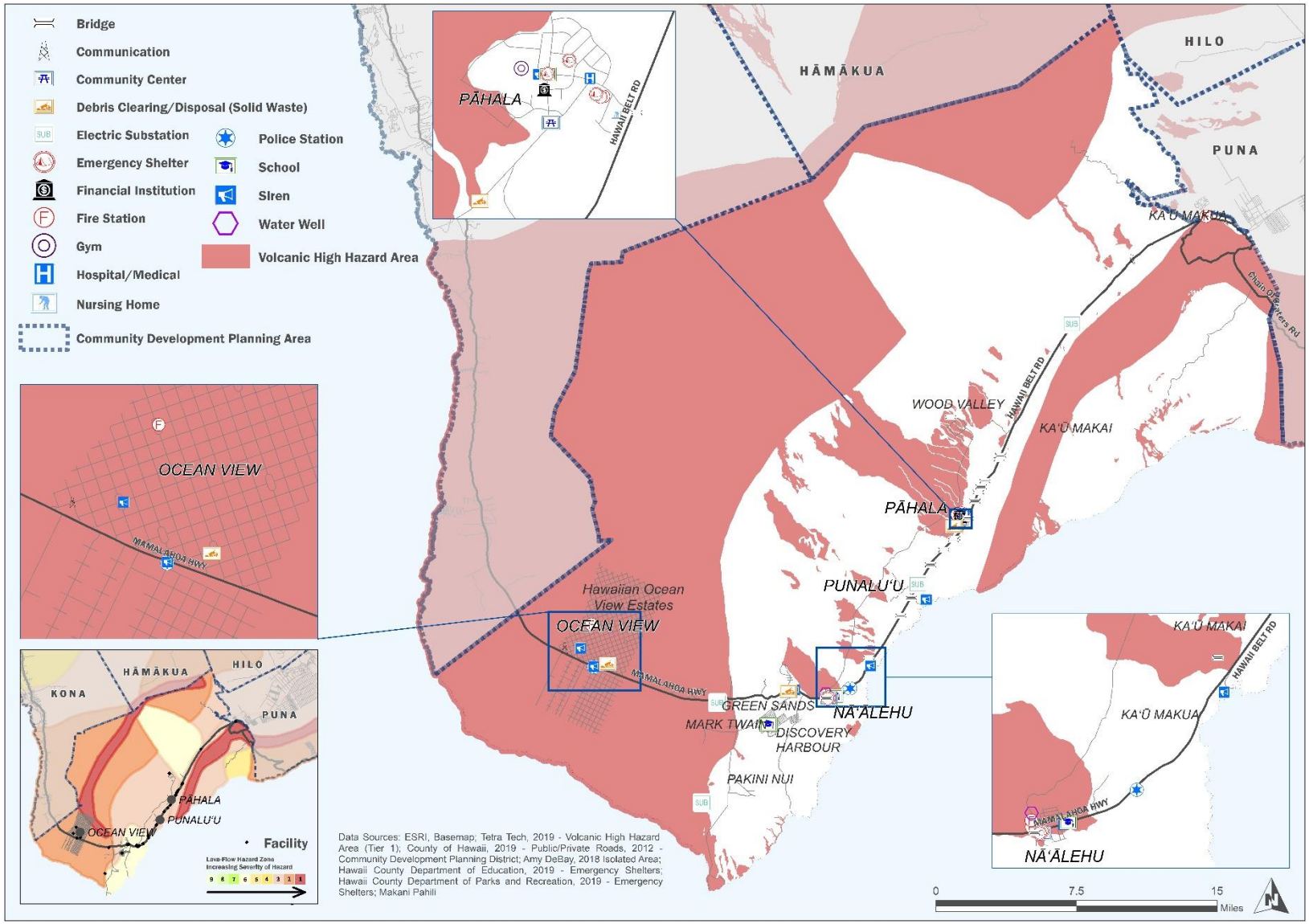
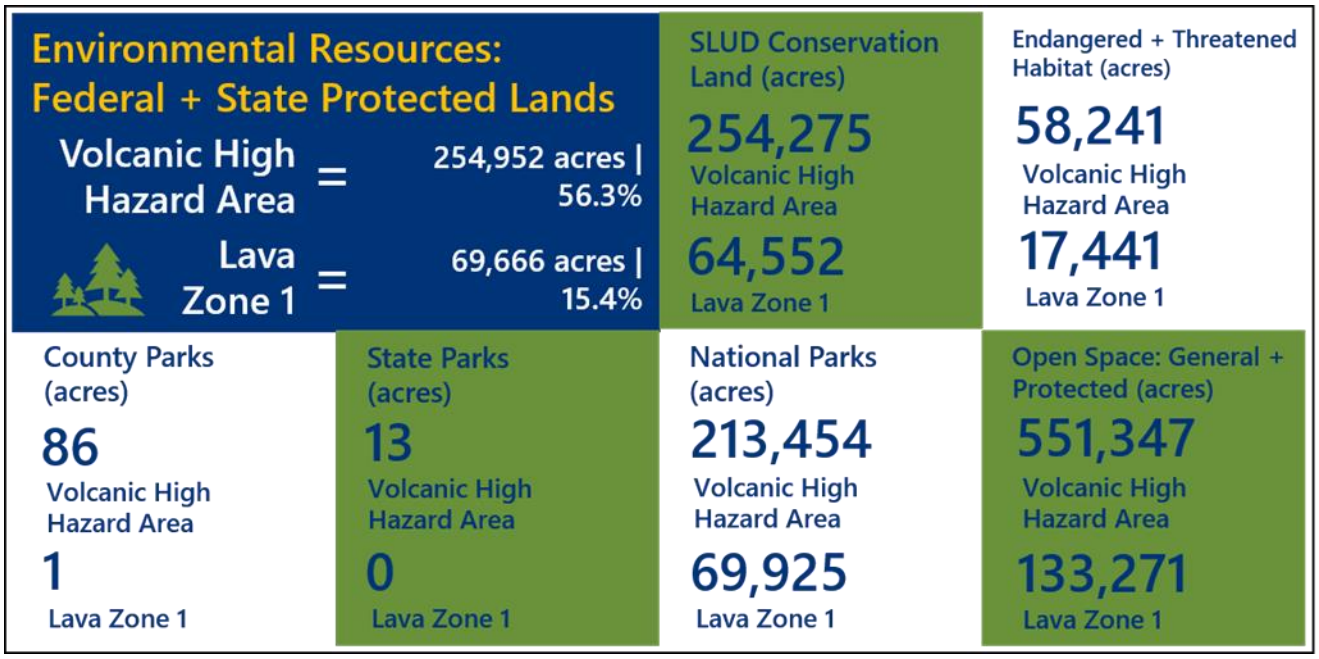


Figure 4-83. Ka'ū Critical Facilities Located in the Volcanic High Hazard Area and Lava Zones

4.4.6 ENVIRONMENT



Note: All percentages are relative to the Ka'ū CDP District

Figure 4-84. Ka'ū Environmental Resources Located in the Volcanic High Hazard Area and Lava Zone 1

A large portion of land (designated by parcel) in Ka'ū is developed land, meaning according to the County assessor at least one structure exists on the parcel. Despite the technical designation of "developed" Ka'ū maintains a distinct rural lifestyle and way of life that is intimately connected to place and Hawaiian cultural heritage (Ka'ū CDP 2017). Alongside a range of developed land, however, sits the Hawai'i Volcanoes National Park representing nearly 300,000 acres of Ka'ū's entire 653,292 total acres. Hawai'i Volcanoes National Park and other County (29) and State (1) parks account for 45.1% of Ka'ū land area and is also protected land under federal and state regulations (County of Hawai'i 2008). 64% of Ka'ū is in the State Conservation District with much of the overall land maintaining public management and ownership (Ka'ū CDP 2017). Agriculture in Ka'ū includes majority macadamia nuts, commercial forestry, coffee, and some tropical fruits (***see Figure 4-86 and Figure 4-86***).

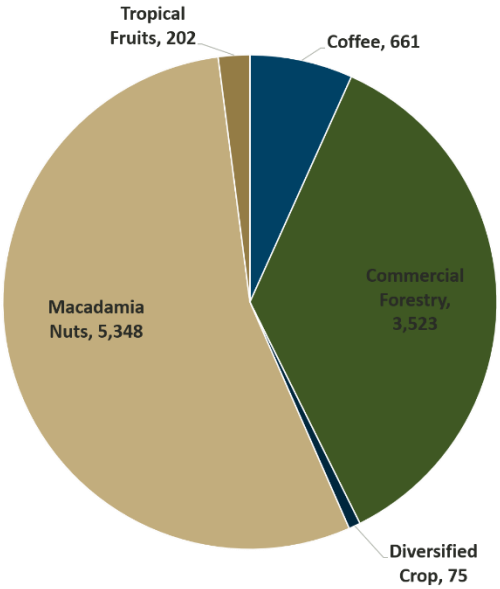


Figure 4-85. Ka'ū Crop Land (Acres)

Much of the land around the Kīlauea Volcano and Mauna Loa 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).

Environmental assets identified as part of the County of Hawai'i General Plan update (in progress) were used for this risk assessment (see ***Table 4-57***). ***Figure 4-84 and Figure 4-86*** illustrate the environmental resources relative to the Volcanic High Hazard Areas.

Table 4-57. Ka'ū Environmental Resources

Agricultural Land of Importance *(acres)*	Crop Land *(acres)*	Pasture Land *(acres)*	Hunting Areas *(acres)*	Wetlands *(acres)*
64,390	9,810	99,502	150,716	140

Federal Reserves *(acres)*	State Reserves *(acres)*	Exceptional Trees (*number*)	Anchialine Pools (*number*)	Reservoirs (*number*)	Endangered and Critical Habitats *(acres)*
315,553	133,836	2	85	16	141,607

Ka'ū has the County's second highest percentage of federal and/or state reserve land located in the Volcanic High Hazard Area (56.3%), second only to Puna with 57.3%. Ka'ū's remaining protected land, including Hawai'i Volcanoes National Park, is found in lava zones 3, 5, and 6 (***Table 4-58***).

Over 45% of Ka'ū's Agricultural Land of Importance is in a Volcanic High Hazard Area, totaling 29,513 acres (representing the greatest percentage in the County). The greatest percent of Ka'ū's reservoirs (also top percent in County) are in a Volcanic High Hazard Area (56.3%) and 90.6% of Ka'ū's anchialine pools are in a Volcanic High Hazard Area.

Ka'ū's environmental resource land is minimally exposed to lava zone 1. However, of that subset of land, Ka'ū's National Park land has the greatest exposure to lava zone 1 (23.8%).

Forty percent of Ka'ū's agricultural crop land is exposed to high volcanic hazards. More than half of the following crops are grown and harvested in a Volcanic High Hazard Area: tropical fruit, diversified crop, coffee, and commercial forestry. Macadamia nuts have a relatively low exposure to volcano risk in Ka'ū with over 70% of macadamia crop land located outside of the Volcanic High Hazard Area.

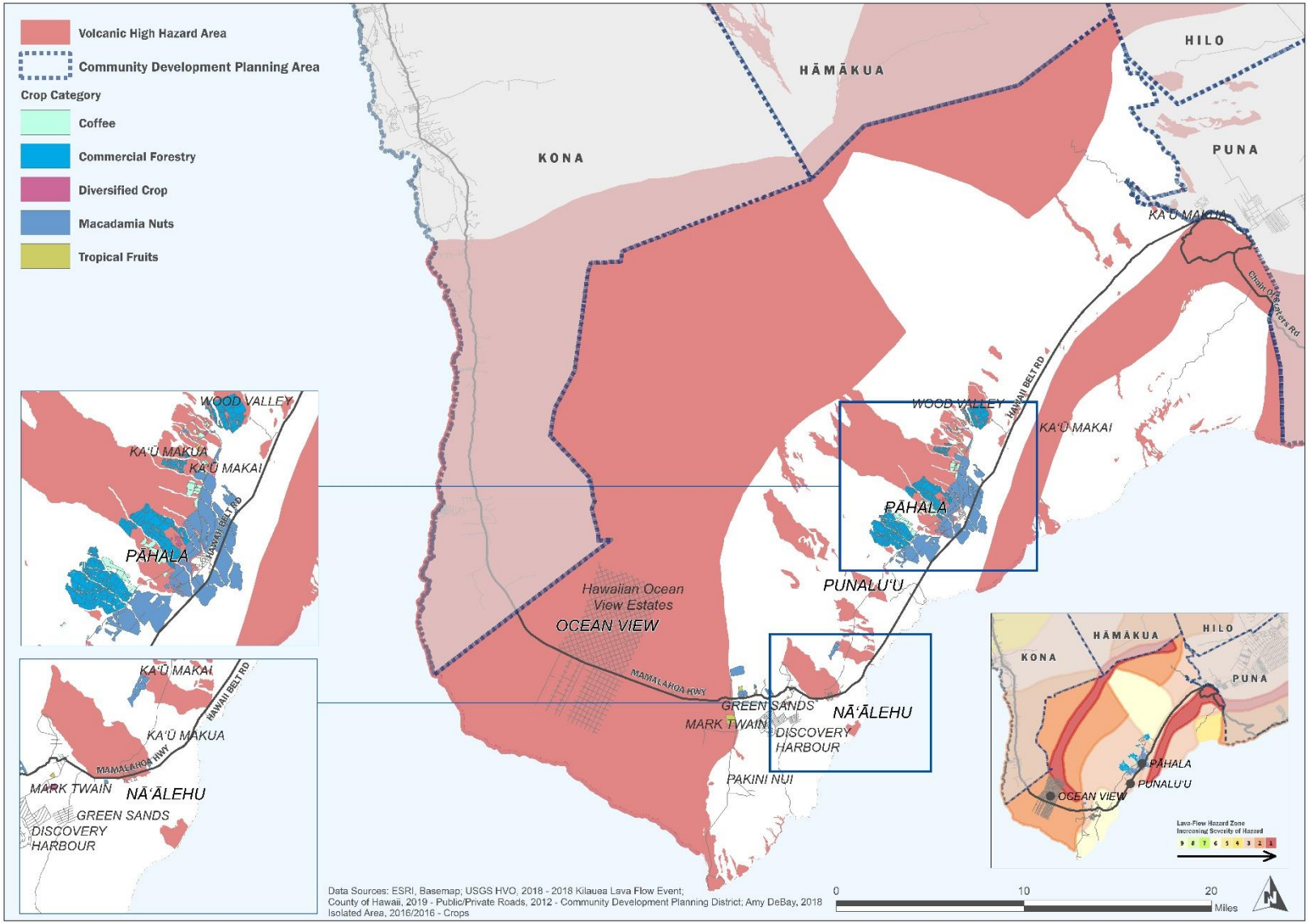


Figure 4-86. Ka'ū Important Agricultural Crops Located in Lava Zones and Volcanic High Hazard Areas

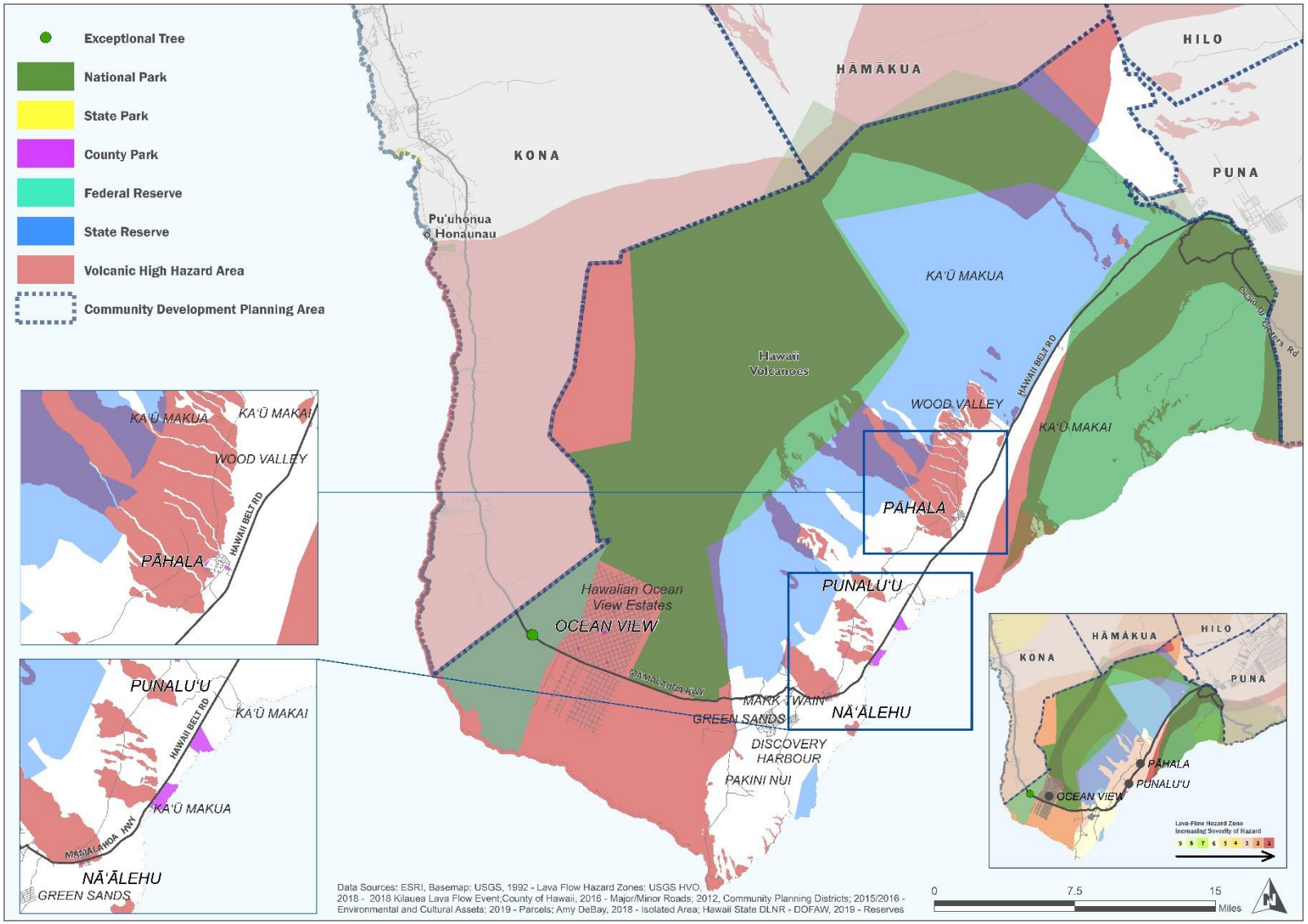


Figure 4-87. Protected Environmental Land in Ka'ū Located in Lava Zones and Volcanic High Hazard Areas

Table 4-58. Ka'ū 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	254,952 / 56.3%	254,275 / 60.6%	58,241 / 41.1%	0 / 100%	551,347 / 56.2%	29,513 / 45.8%
Lava	69,666 / 15.4%	64,552 / 15.4%	17,441 / 12.3%	0 / 0%	133,271 / 13.6%	1,928 / 3%
Lava	168,616 / 37.2%	172,457 / 41.1%	36,631 / 25.9%	0 / 100%	364,803 / 37.2%	10,643 / 16.5%

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	3,930 / 40.1%	23,356 / 23.5%	38,407 / 25.5%	86 / 14.3%	13 / 100%	213,454 / 72.6%
Lava Zone	0 / 0%	2,859 / 2.9%	83 / 0.1%	1 / 0.1%	0 / 0%	69,925 / 23.8%
Lava Zone	134 / 1.4%	9,367 / 9.4%	26,952 / 17.9%	76 / 12.6%	13 / 100%	2 / 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	49 / 35.2%	9 / 56.3%	77 / 90.6%
Lava Zone 1	10 / 7.2%	0 / 0%	0 / 0.0%
Lava Zone 2	21 / 15.3%	2 / 12.5%	76 / 89.4%

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. In 2010, Donald Thomas from the Center for the Study of Active Volcanoes, and Trisha Macomber from the University of Hawai'i's College of Tropical Agriculture produced a study on the effects of fluoride and sulfates on forage lands downwind of Kīlauea's Halema'uma'u Crater (Thomas and Macomber 2010). The study shows that forage samples contained fluoride and sulfate values higher than recommended by the World Health Organization. Additionally, the study indicates 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.

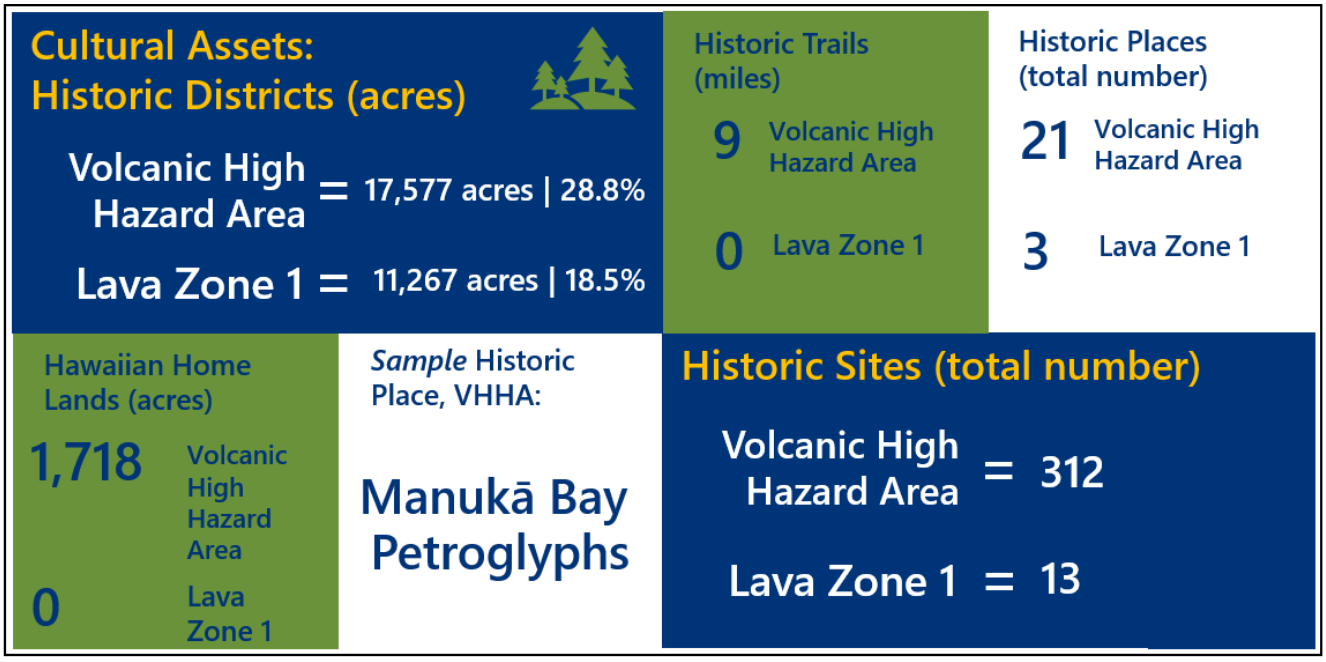
The general effects of sulfur dioxide exposure to plants varies between plant species, age, and the sulfur dioxide dosage. These effects may include:

- 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

Farmers growing food crops, foliage crops, and cut flowers downwind of Kīlauea have 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.

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

4.4.7 CULTURAL ASSETS



Note: All percentages are relative to the Ka'ū District

Figure 4-88. Ka'ū Cultural Assets Located in the Volcanic High Hazard Area and Lava Zone 1

Ka'ū 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 Ka'ū, 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. In Ka'ū, a total of 1,718 acres of Hawaiian Home Lands (14.8% of Ka'ū's total Hawaiian Home Lands), 21 historic places (70%), 312 historic sites (64.5%) and 9 miles (45%) of historic trail are in the Volcanic High Hazard Area (***see Table 4-59***).

It is important to note that many of the cultural assets are located along the coast and overlap with other hazard areas including tsunami, sea level rise, flood and coastal erosion (see ***Figure 4-89***).

Table 4-59. Ka'ū 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)	1,718 / 14.8%	17,577 / 28.8%	21 / 70%	312 / 64.5%	9 / 45.1%
VHHA with Additional Natural High Hazard Area	1,717 / 99.9%	1,945 / 11.1%	5 / 16.7%	65 / 20.8%	2 / 9%
Lava Zone 1	0 / 0%	11,267 / 18.5%	3 / 10%	13 / 2.7%	0 / 0%
Lava Zone 2	6 / 0.1%	3,185 / 5.2%	13 / 43.3%	269 / 55.6%	7 / 37.5%

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.

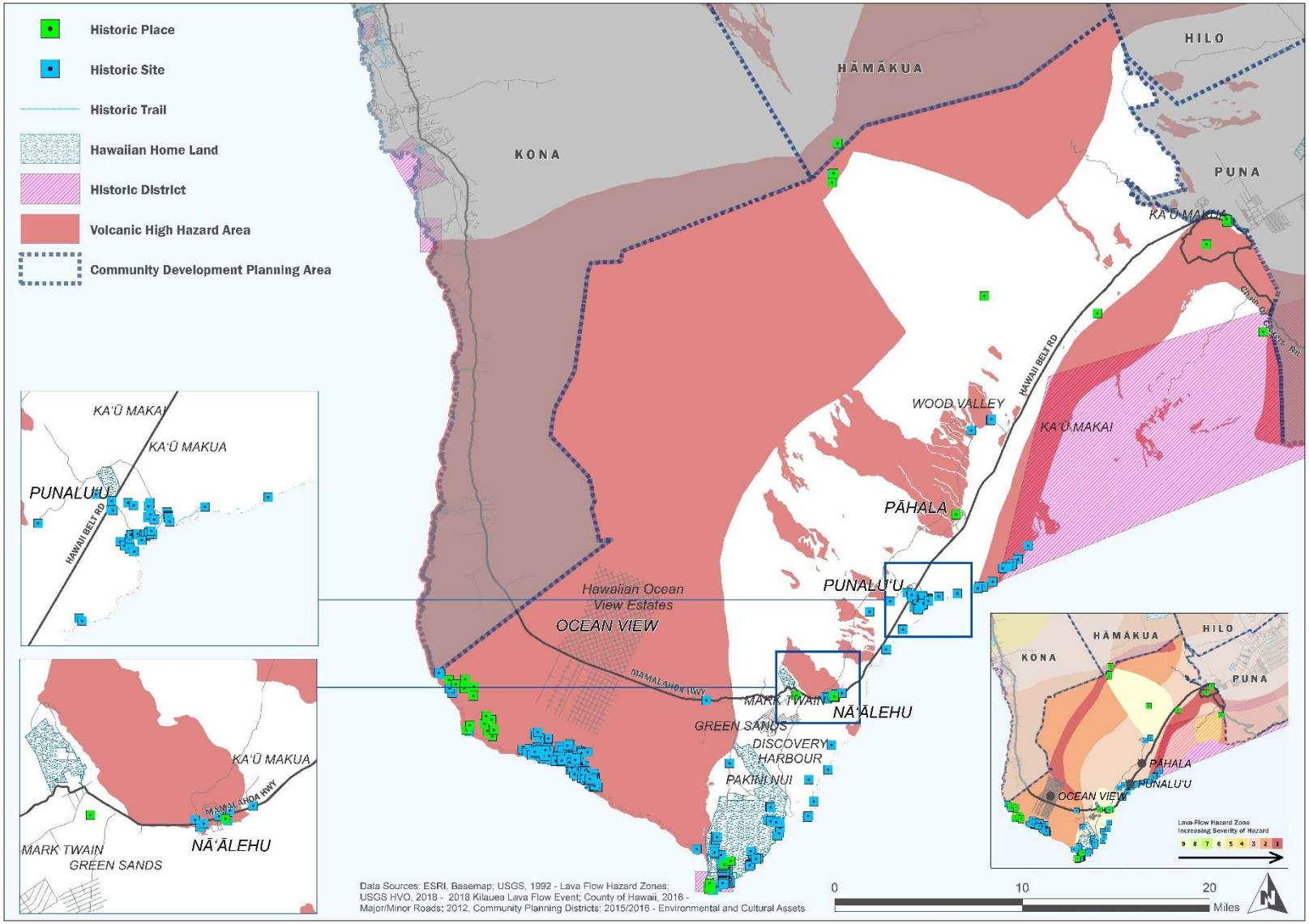


Figure 4-89. Cultural Assets in Ka'ū and Volcanic Hazards

4.4.8 FUTURE LAND USE AND DEVELOPMENT

Ka'ū is comprised of mixed land use classifications as categorized by the Land Use Pattern Allocation Guide (LUPAG) (***see Figure 4-90***). While LUPAG designations guide decisions related to future land use, County zoning determines a parcel's current permitted land use and development entitlements.

The vast majority of Ka'ū is designated conservation or extensive agriculture, representing a combined total of 583,628 acres or 90% of all Ka'ū land. Conservation land is defined as "forest and water reserves, natural and scientific preserves, areas in active management for conservation purposes, areas to be kept in a largely natural state, with minimal facilities consistent with open space uses, such as picnic pavilions and comfort stations, and lands within the State Land Use Conservation District" (Ka'ū CDP 2017). Following extensive agriculture designated land, important agricultural lands comes in third for largest footprint in the District. 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 10% of Ka'ū is classified as a mix of rural, open area, low-density urban, medium-density urban, and urban expansion with a very minor classification of industrial land.

Overall, the land in the Volcanic High Hazard Area is mainly classified as conservation land (68%) and extensive agriculture land (21.8%) (***see Table 4-60 and Figure 4-90***). There are 273 acres of land identified for urban expansion located in the Volcanic High Hazard Area and lava zone 2. For reference, lava zone 3 has the greatest acreage of low-density urban land. Land identified for urban expansion may also be susceptible to other natural hazards. For example, the Hawaiian Ocean View Estates subdivision, located in the Volcanic High Hazard Area, is also at high risk for landslides and wildfire and is Ka'ū's fastest growing population development center.

Table 4-60. Ka'ū 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	442,658	276,298	71,003	203,529
Extensive Agriculture	141,581	58,345	8,211	47,043
Important Agriculture Lands	46,830	17,539	277	2,854
Industrial	74	32	0	0
Low-Density Urban	870	240	0	0
Medium-Density Urban	412	43	0	0
Open area	4,590	2,651	195	1,544
Resort	29	0	0	0
Rural	13,101	11,961	1,609	11,105
Urban Expansion	598	273	0	273

LUPAG Land Use Pattern Allocation Guide

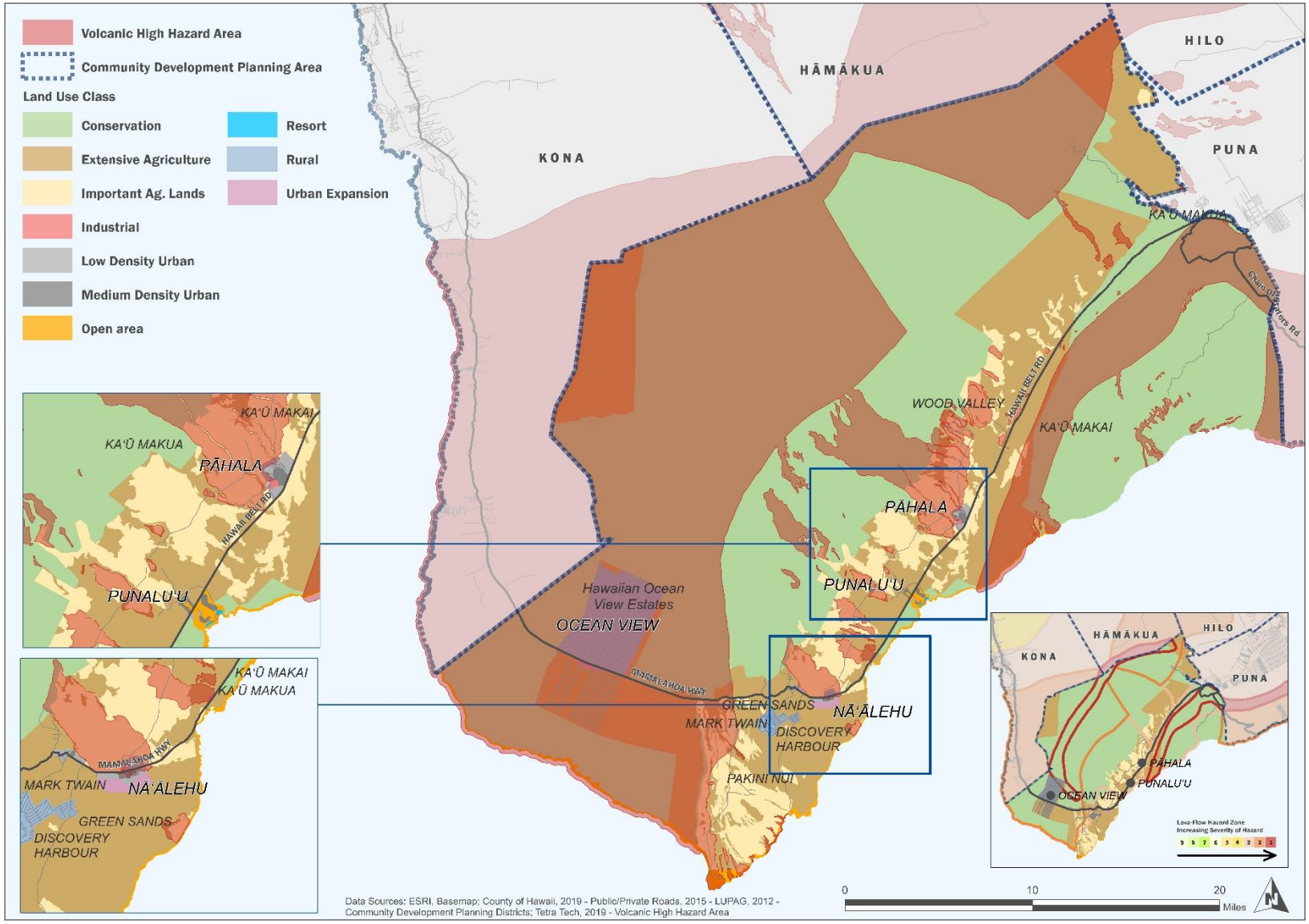


Figure 4-90. Ka'ū Land Use Pattern Allocation Guide (LUPAG) Classifications

In preparation for the in-progress County of Hawai'i General Plan update, a build-out analysis was conducted to determine residential and non-residential capacity. Ka'ū has the greatest number of acres of identified residential greenfield area in the County (164,711 acres) illustrating the high potential for 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.

In Ka'ū, there are 10,794 residential greenfield parcels identified for potential future development located in the Volcanic High Hazard Area; of these 1,398 are in lava zone 1, and 9,169 are in lava zone 2. In terms of non-residential development, there are only 4 non-residential parcels located in the Volcanic High Hazard Area and 16 parcels identified for potential non-residential redevelopment. One hundred percent of all non-residential parcels identified for greenfield development or redevelopment are outside of lava zone 1.

The exposure to other natural hazards should also be considered when making future development decisions. One hundred percent of parcels identified for residential redevelopment located in the Volcanic High Hazard Area also have the presence of another natural high hazard. Refer to ***Table 4-61*** for additional statistics regarding parcels identified for future development and their location relative to the volcanic hazard areas and other natural high hazards.

Table 4-61. Ka'ū 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)	10,794 / 85.2%	274 / 44.8%	4 / 44.4%	16 / 53.3%
VHHA with Additional Natural High Hazard Area	10,791 / 100%	274 / 100%	4 / 100%	16 / 100%
Lava Zone 1	1,398 / 11%	5 / 0.8%	0 / 0%	0 / 0%
Lava Zone 1 with Additional Natural High Hazard Area	1,398 / 100%	5 / 100%	0 / 0%	0 / 0%
Lava Zone 2	9,169 / 72.4%	117 / 19.1%	2 / 22.2%	0 / 0%
Lava Zone 2 with Additional Natural High Hazard Area	9,166 / 100%	117 / 100%	2 / 100%	0 / 0%

**The percentage of parcels relative to the total number in the Ka'ū 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.

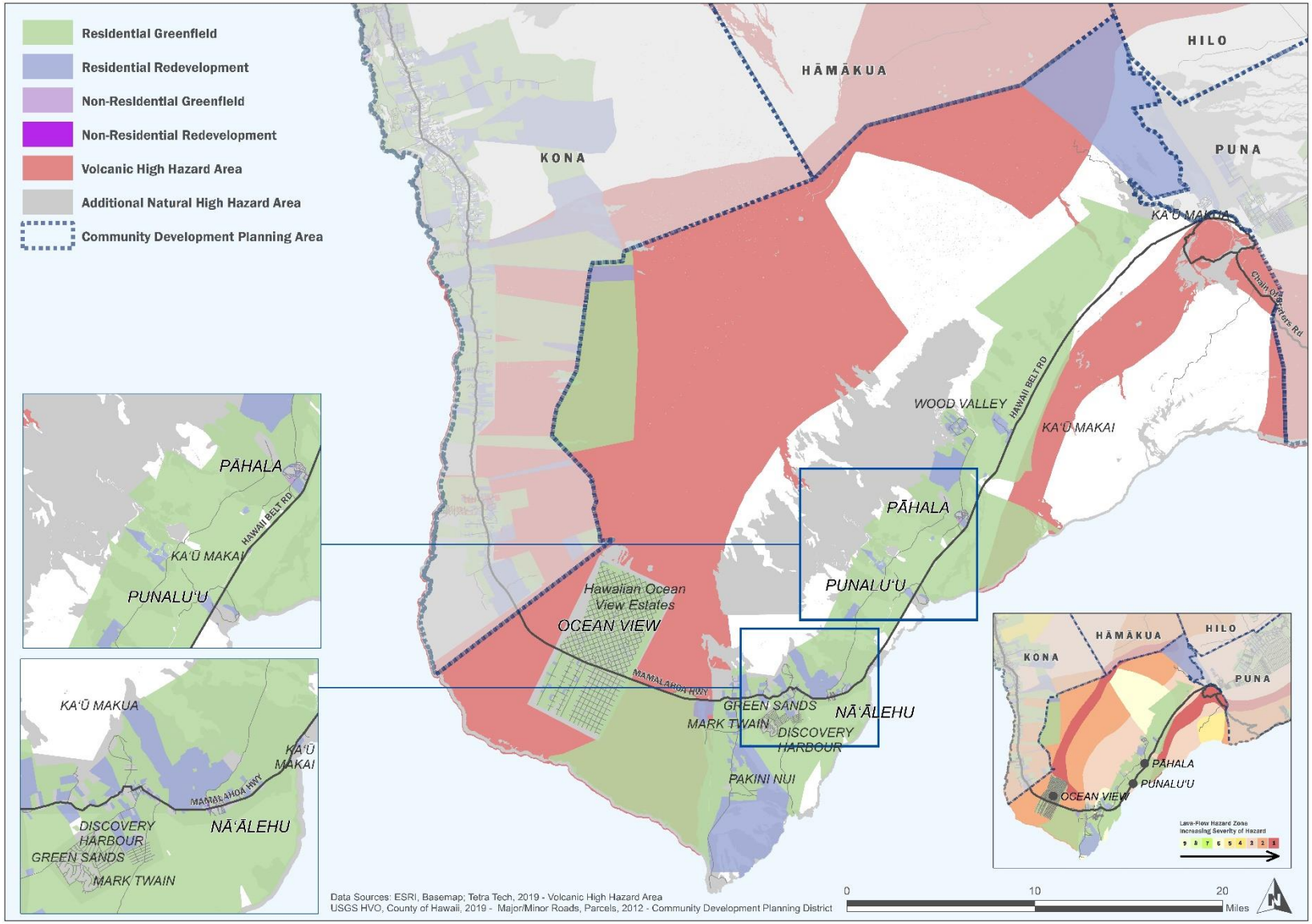


Figure 4-91. Ka'ū Greenfield and Redevelopment Areas, and Volcanic Hazard Areas

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).

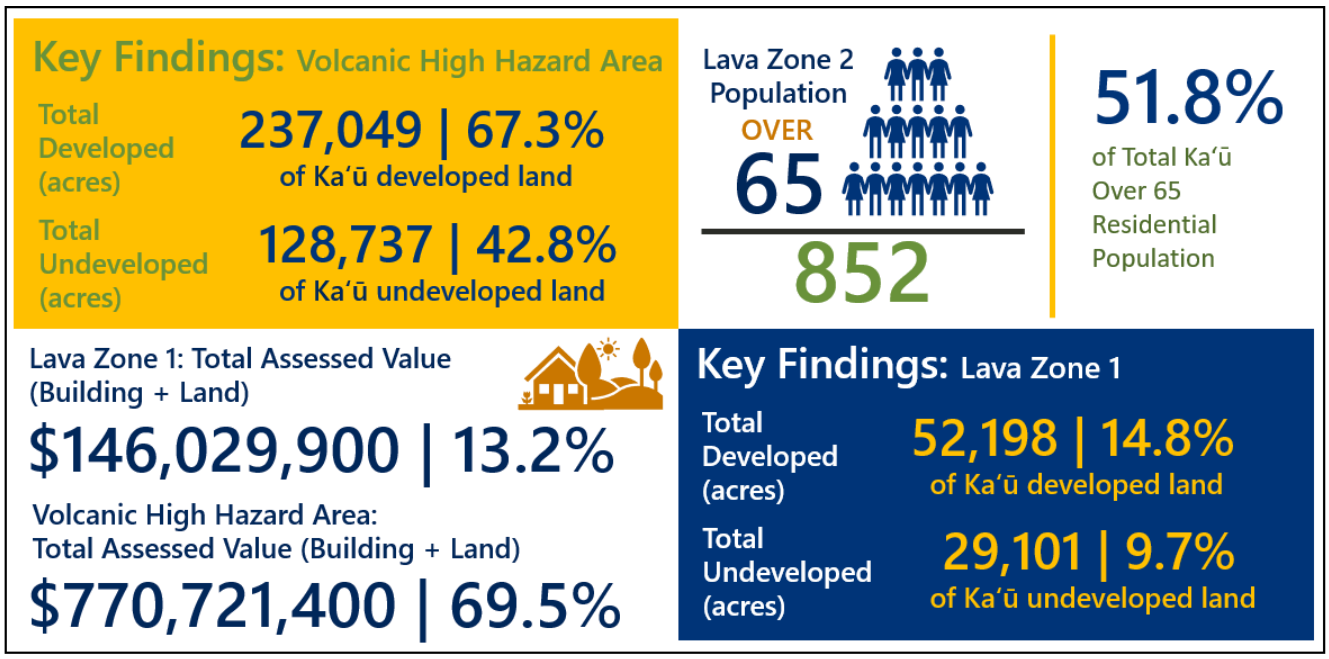
High hazard risk combined with limited or high cost insurance, when available, is a considerable factor when planning for the continued growth of Ka'ū. Critical questions that need to be addressed prior to moving forward with future plans for development/re-development and decisions about future population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

- Who will be able to afford to live in an area that is vulnerable to lava flow and other volcano-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 less vulnerable districts, or perhaps other highly vulnerable areas due to availability and affordability?
- 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 centers in Ka'ū. Development or redevelopment is not always the preferred option. In fact, Hilo 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.

Additionally, the prevalence of informal houses or settlements within Ka'ū should be considered. These settlements represent people that are often left out of traditional population surveys, like the U.S. Census, and whom reside in homes that are not officially documented/permitted. This makes evacuation and emergency messaging difficult. In high hazard areas, similar to those within Ka'ū, it's important to determine ways to account for populations and un-permitted structures that are not well documented.

4.4.9 KEY FINDINGS



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

Figure 4-92. Ka'ū Key Findings

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

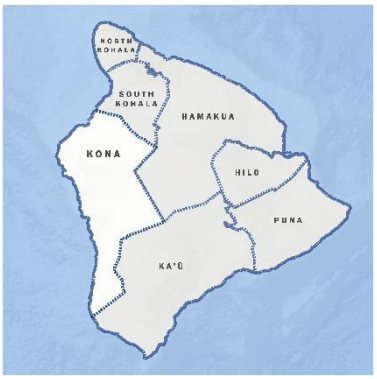
- Ka'ū has the greatest percentage of parcels located in the Volcanic High Hazard Area (80.4%) in the County
- Ka'ū has the greatest percentage of land assessed value located in the Volcanic High Hazard Area (75.5%) in the County
- Utilizing current data, 3,345 parcels (20.4%), 216 households (6%), and 559 residents (6.2%) are located in historic lava flow areas (1790-1996)
- Ka'ū has 1,471 acres in lava zone 1 and 10,975 acres in lava zone 2
- Over 60% of Ka'ū's population lives in a Volcanic High Hazard Area (64.2%)

Ka'ū is confronted with significant future decisions pertaining to life safety, development, redevelopment, and general land use. Perhaps most significant is population, sacred places and agricultural land located within lava zones 1 and 2. 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 Ka'ū, should be carefully considered. There are existing populated locations within Ka'ū with significantly less exposure and volcano risk, such as the subdivisions located near the Nā'ālehu southeast portion of Ka'ū, should be assessed for future growth and redevelopment targets, providing an option for keeping up with the demand of living safely in Ka'ū. Exploration should be balanced with the future expansion of Ocean View, which exists solely in the Volcanic High Hazard Zone. Furthermore, considerations for Ka'ū's most vulnerable populations need to 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 and prioritize safe evacuations when needed.

4.5 Kona

4.5.1 OVERVIEW

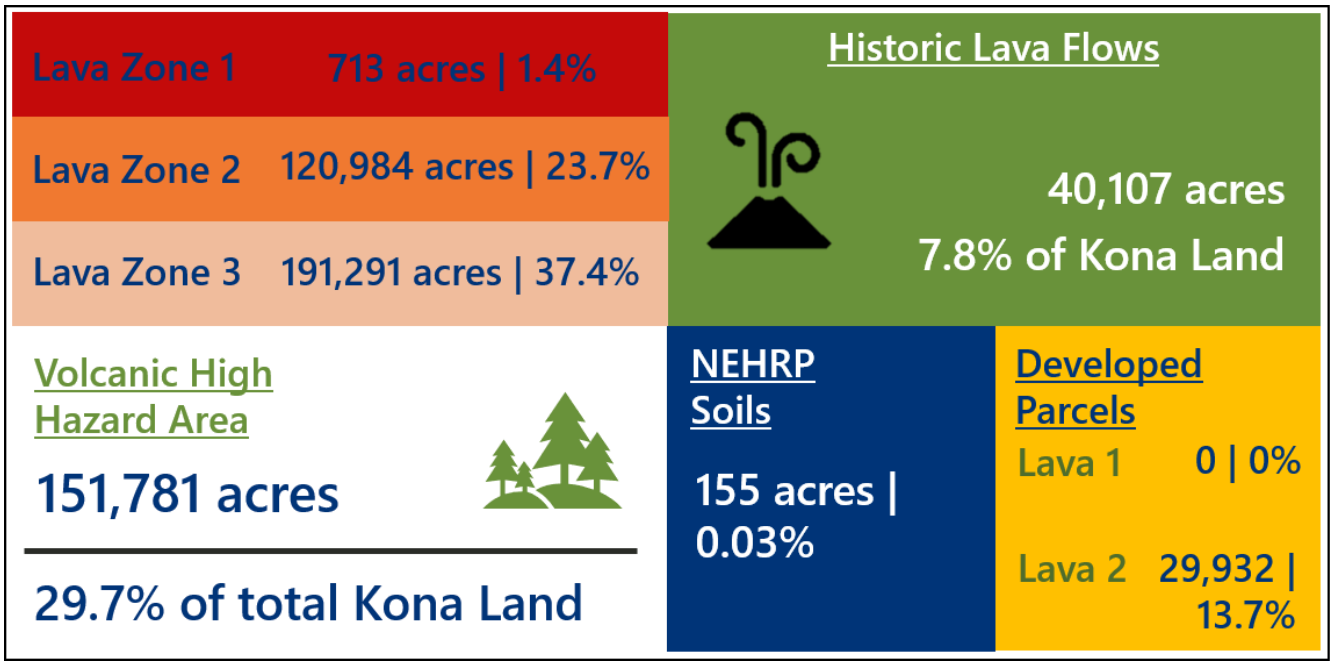


The Kona Community Development Plan district (CDP), herein referred to as Kona, is located on the west coast of the Island of Hawai'i. It is a large CDP (accounting for 20% of the County's land area) bordered by the South Kohala CDP district to the north, the Ka'ū CDP district to the south and defined by the Pacific Ocean to the west. Within Kona there are numerous named communities and subdivisions with the following town centers: Keāhole, Kailua, Keauhou, and Kealakekua, all centered in the northern portion of the CDP district. Kona's landscape is diverse and is often described by three categories from west to east: coastal, central lava fields, and agricultural uplands.

Kona's tourism economy is a strong local presence due in part to a long coastline that stretches nearly two-thirds of the entire west side of the Island. This natural feature has attracted a significant number of resorts, second homes, and new residents in the last 35 years, doubling Kona's population since 1980. Mauna Loa, located to the southeast in Ka'ū, shields Kona from strong winds leading to surprisingly calm and clear ocean water.

Today, Kona's character and developmental patterns are largely mixed with a balance between beaches, tourists, coffee farms, and historic Hawaiian historic sites. Kona is known internationally for its Kona coffee, grown on the slopes of Mauna Loa. Kona, particularly North Kona, has been one of the County's major population centers both in contemporary time and in ancient Hawai'i. Current future population projections and trends, however, demonstrate an island-wide diversifying shift which include a rapid expansion of population near Puna's northern border shared with Hilo (CHPD Hawai'i 2019).

4.5.2 VOLCANIC HAZARDS



Note: All percentages are relative to the Kona District

Figure 4-93. Kona Volcanic Hazard Exposure Overview

Kona is home to the Hualālai shield volcano. Hualālai is the third youngest and third-most historically active volcano on the Island. Its six different vents erupted lava over the course of several years ranging from the late 1700s to 1801. Today, the Keāhole Airport is built atop the largest historic flow. Hualālai is not nearly as active during contemporary times, like Kīlauea and Mauna Loa, but geologic mapping of the volcano shows that 80% of the volcano has been covered in lava flows over the past 5,000 years. Recent contemporary development throughout Kona, including resorts, homes, and commercial structures, is important to understand in its relationship to historic lava flows (U.S. Geological Survey [USGS] 2017b). Although the earthquake activity under the volcano has been low in the last couple hundred years, nearly 30% of Kona land is located in the Volcanic High Hazard Area; and nearly 8% of Kona land is located in areas with historic lava flows.

Although far from the immediate impacts (i.e. lava flow) of the 2018 Kīlauea eruption, Kona experienced an estimated 30% loss in the following tourist season, including a significant decrease in tourists and cruise lines (Raymond 2018).

Kona is located within USGS-delineated lava-flow hazard zones 1, 2, 3, 4, and 8 (***Figure 4-94***). Lava zone 1 just slightly crosses into Kona and is reflective of the nearby Mauna Loa volcano. Lava zone 2 is found in the more rural, lower density portion of the southern half of the district. Lava zone 3 has limited oceanfront exposure and is primarily located inland buffering between the most populous part of Kona (lava zone 4) and the Hāmākua CDP district.

Nearly 25% of Kona 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). On the other hand, Kona's population center is primarily located in lava zone 4. Keāhole, Kailua, and Keauhou are all located in lava zone 4's 197,925 acres. Lava zone 4 represents 38.7% of Kona land. Of the 42.9% of land in Kona that is developed (or parcel with a building assessment value according to County assessor records), 13.7% (or 29,932 acres)

is located within high-risk lava-flow hazard zones 1 and 2 ***(Table 4-62***). For the purposes of this assessment, developed and undeveloped land has been calculated at the parcel level (regardless of private or public ownership).

Table 4-62. Kona 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)*
Kona District	**510,992**	**713**	**120,984**	**191,291**	**197,925**	**0**	**0**	**0**	**51**	**0**
Developed	219,168	0	29,932	90,653	98,567	0	0	0	0	0
Undeveloped	291,824	713	91,052	100,638	99,358	0	0	0	51	0

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

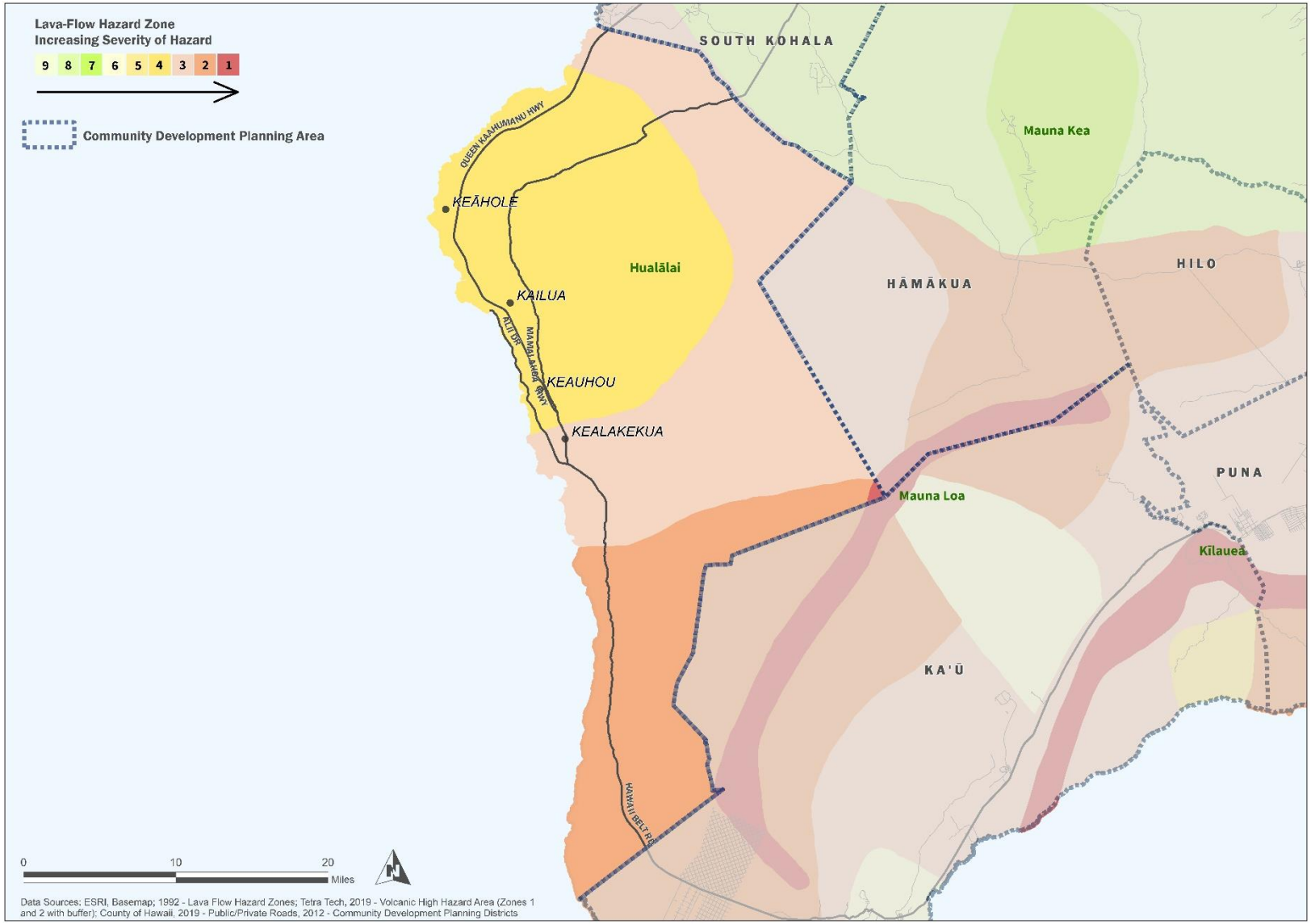


Figure 4-94. Lava Zones in Kona

Kona 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 Kona coast. Once wind reaches the Kona 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 National Earthquake Hazards Reduction Program (NEHRP) D and E soils. This risk assessment focuses on Kona's exposure to the Volcanic High Hazard Area and lava-flow hazard zones 1 and 2. Overall, nearly one quarter of Kona is located within the Volcanic High Hazard Area (23.8%) with the remainder located in lava zones 3, 4, and a small amount in lava zone 8 (51 acres). Refer to ***Table 4-63*** and ***Figure 4-95*** for a summary of Kona's land area in each volcanic hazard area.

Table 4-63. Kona Land by Volcanic High Hazard Area and Lava Zones

Hazard Area	Total Land Area *(acres)*	Developed Parcel Area *(acres)*	Undeveloped Parcel Area *(acres)*
Volcanic High Hazard Area	151,781	40,716	111,064
Lava Zone 1	713	0	713
Lava Zone 2	120,984	29,932	91,052
Lava Zone 3	191,291	90,653	100,638
Lava Zone 4	197,925	98,567	99,358
Lava Zone 8	51	0	51

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.

Kona is also prone to additional natural hazards. Kona's coast has communities identified as at risk to wildfire and the coastline has large sections located in a tsunami evacuation zone. Additional hazards include: floods, storm surge, sea level rise, and dam failure inundation zones. In addition to examining the assets exposed to the volcanic hazard areas, it is important to determine if those assets are located in additional natural high hazard zones to inform the identification of recovery and mitigation strategy development. ***Figure 4-96*** illustrates the additional natural high hazard areas located in Kona and ***Figure 4-97*** illustrates the additional natural high hazard areas relative to the lava zones and the Volcanic High Hazard Area.

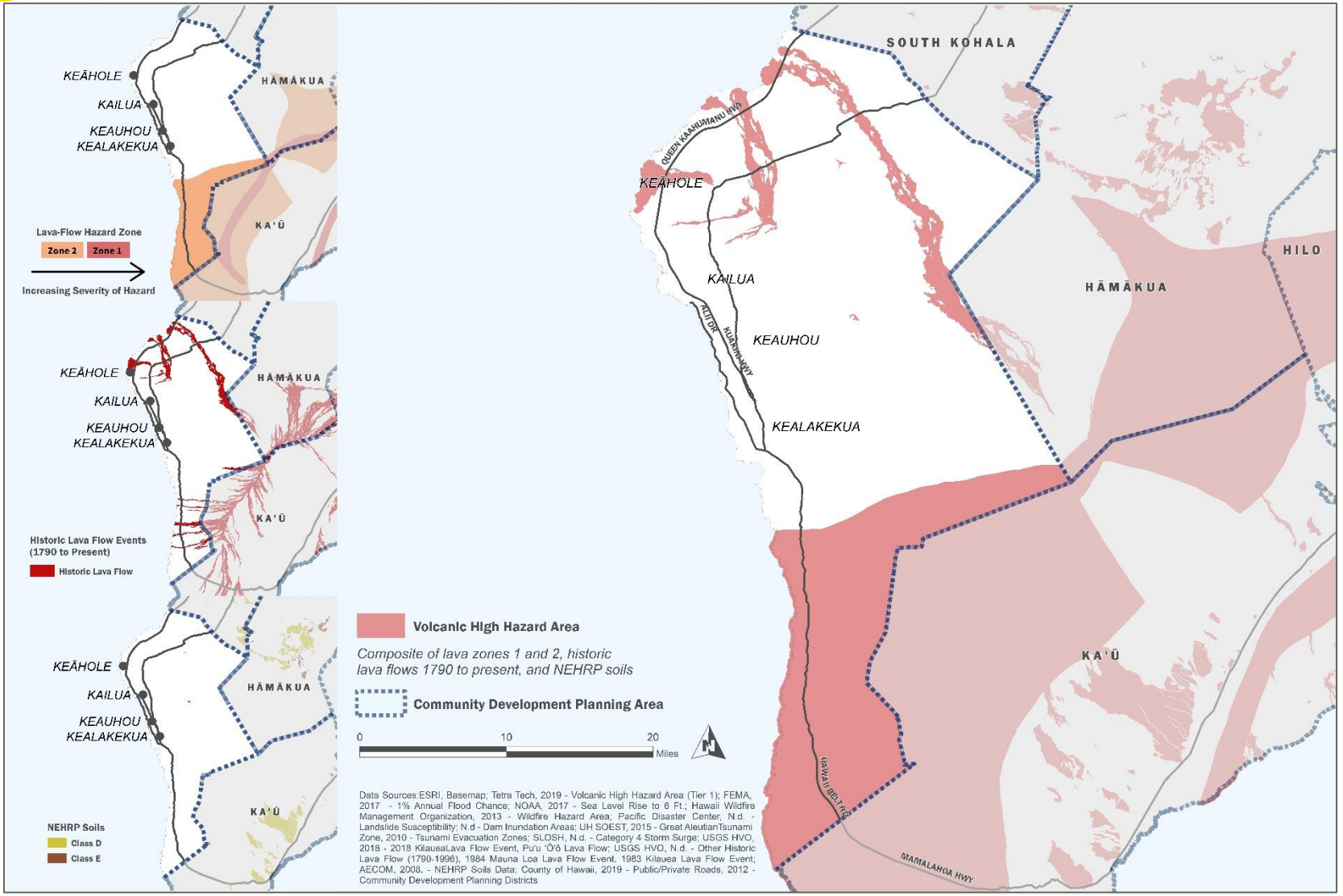


Figure 4-95. Volcanic High Hazard Areas in Kona

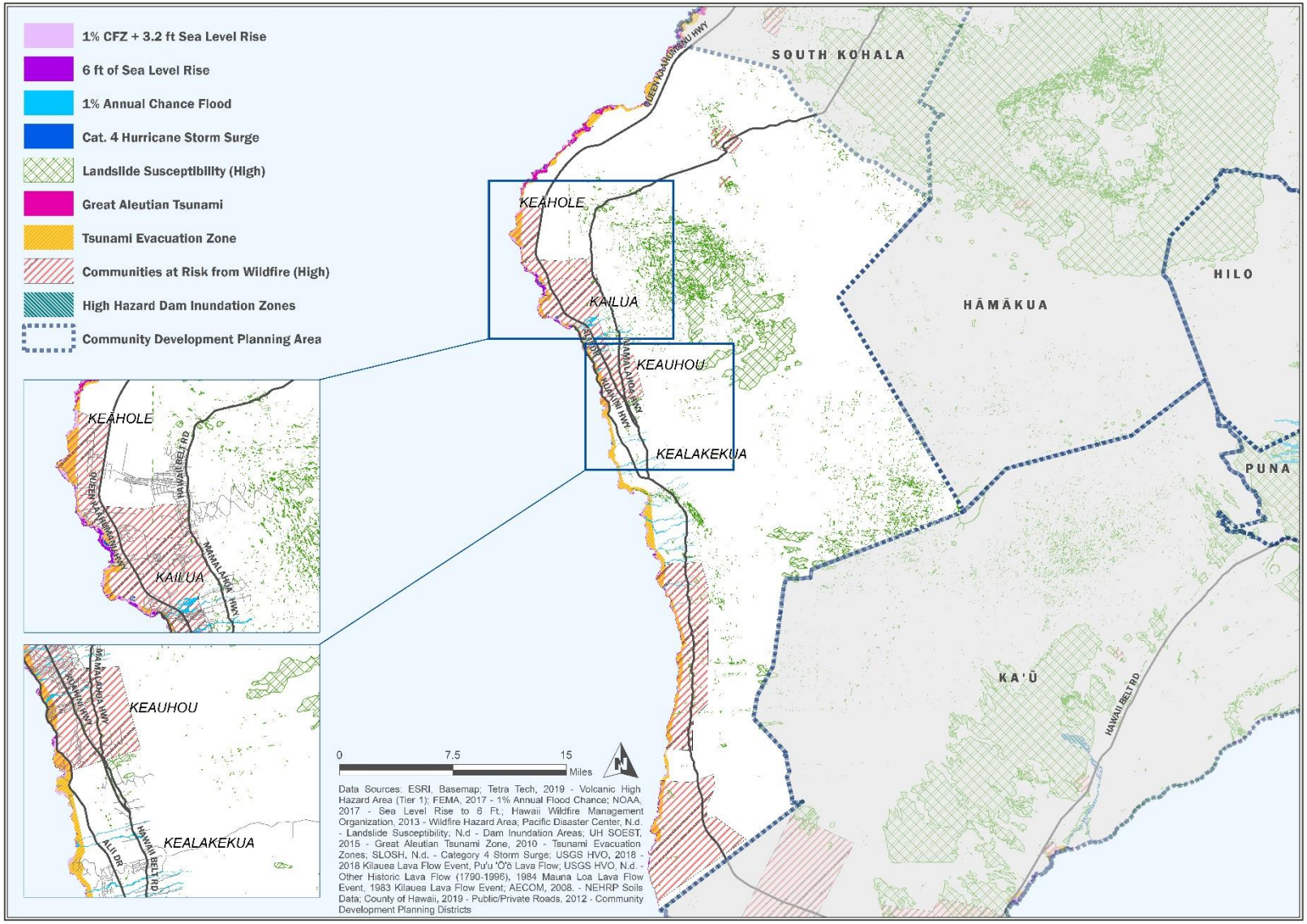


Figure 4-96. Additional Natural High Hazard Areas in Kona

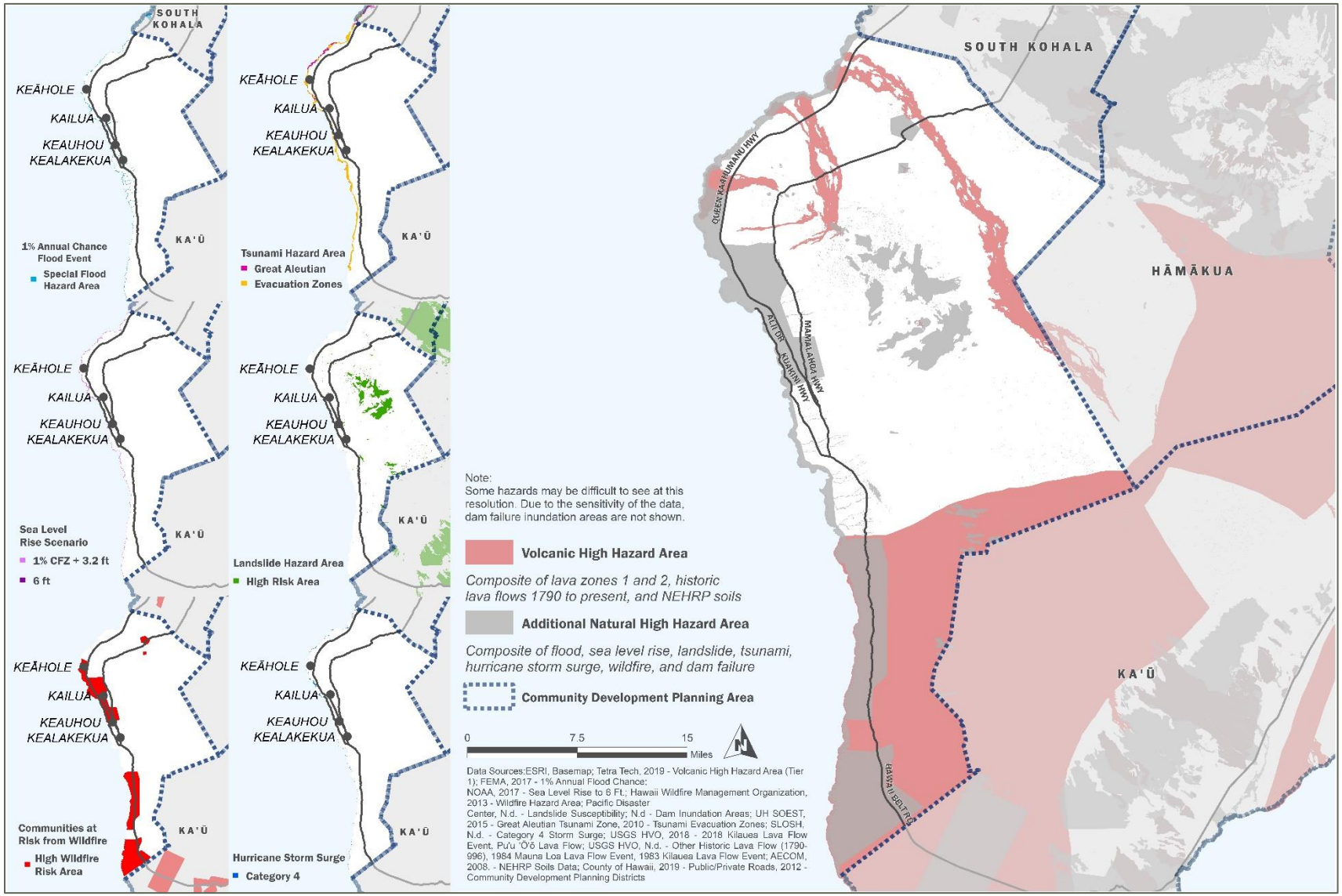
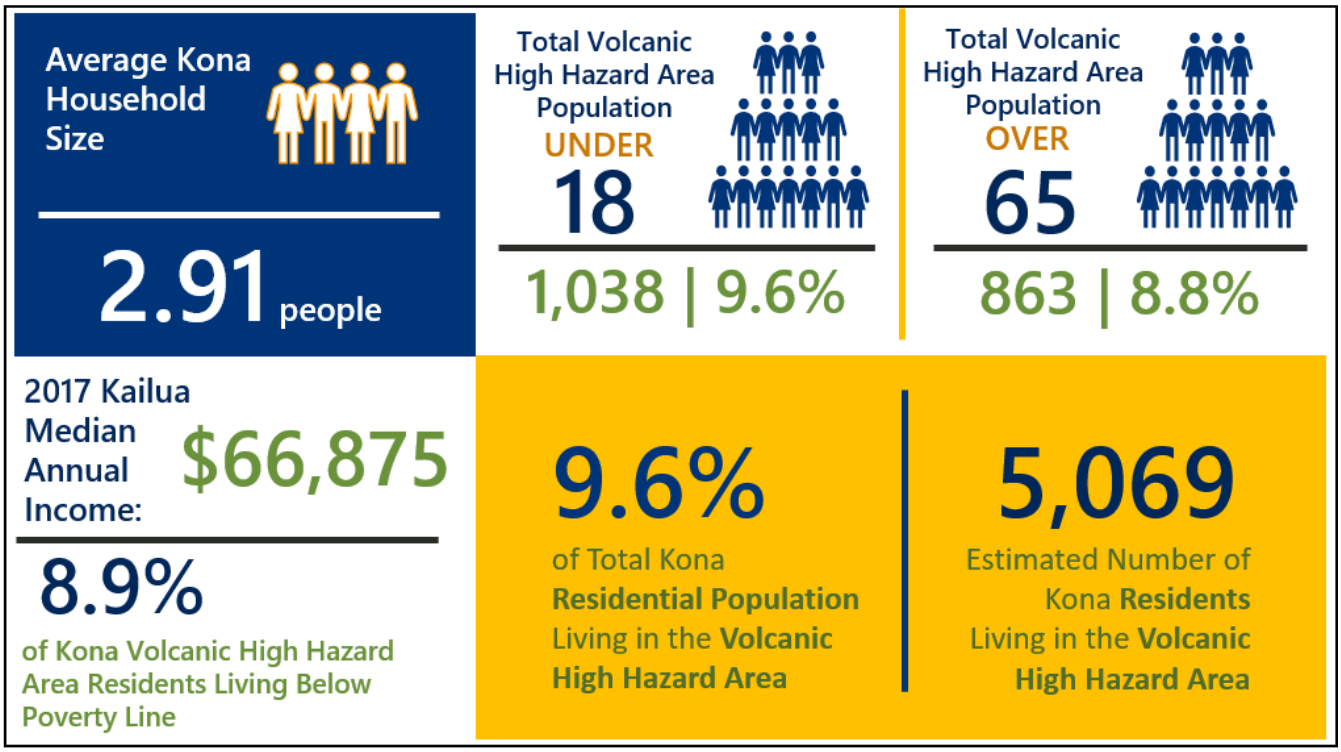


Figure 4-97. Volcanic High Hazard and Additional Natural High Hazard Areas Located in Kona

4.5.3 POPULATION



Note: All percentages are relative to the Kona District

Figure 4-98. Kona Population Exposure to the Volcanic High Hazard Areas

As of 2017, Kona's total population was 52,565, which represents 26.8% of the County's total population (U.S. Census 2017). Kona is the most populated CDP district in the County. According to the 2019 draft County of Hawai'i General Plan, Kona has historically been one of the most significant centers of population in the County (alongside Hilo), containing 25% of all County housing on the Island. Population growth is continued to be shared between Puna and Kona, with parts of Puna expected to grow most quickly, therefore moving away from spikes in concentrated growth and population in Kona. As the Kona CDP district population steadily continues to increase, so too will the numbers of residents at risk to the volcanic hazard (including those unfamiliar with volcanic risk).

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 Kona CDP district is located within a lava zone (1, 2, 3, 4, and 8); therefore, all residents in Kona are exposed to some level of lava flow hazard. There is no calculated probability associated with each lava-flow hazard zone. The 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. Therefore, land classified as lava zone 1 is the most hazardous (USGS 2019a).

Figure 4.5-3 summarizes the number of Kona residents living in lava zones 2, 3, and 4. Lava zones 1 and 8 are present in Kona, however there is no population located in these zones. As shown, the greatest number of residents live in lava zone 4 (78.8%). However, more than 3,400 residents live in lava zone 2.

Figure 4-100 illustrates the population density across Kona relative to the Volcanic High Hazard Area. The greatest population density is in the Kailua, Keauhou, and Kealakekua areas. These resident totals do not reflect the number of undocumented residents, tourists and visitors residing in the Kona CDP district.

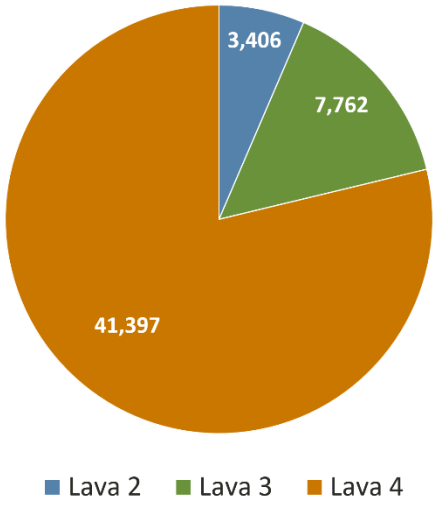


Figure 4-99. Kona Residents by Lava Zone

In summary:

- 82% of Kona's households are located in lava zone 4 (17,816), which is the Hualālai area
- There are no households located in lava zone 1 and lava zones 5-9
- Over 50% of households located in a Volcanic High Hazard Area are also located in another high hazard area (i.e. wildfire, tsunami evacuation zone, etc.)

At the individual resident level:

- Over 5,000 people in Kona live in the Volcanic High Hazard Area (nearly 10% of total Kona population)
- Of the Kona residents living in lava zone 2, over 50% are also exposed to another natural high hazard (representing 77.5% of Kona's overall lava zone 2 population, second highest in the County)

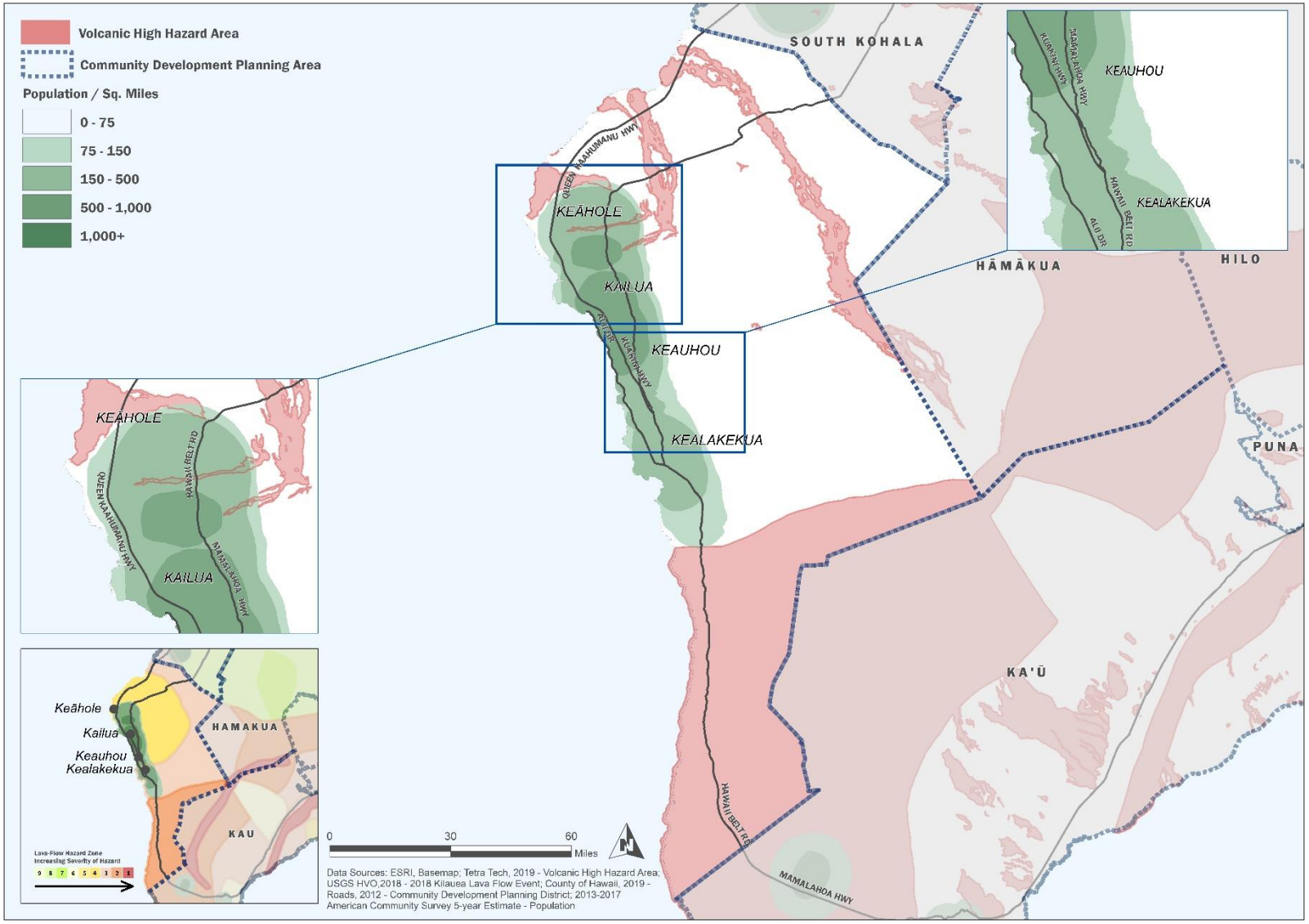


Figure 4-100. Kona Population Density Relative to the Volcanic Hazards

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 4-64. Kona Vulnerable Population

Estimated Vulnerable Populations	
Under 18	10,758
Over 65	9,854
No Internet	8,671
Single Parent	7,941
SNAP	6,593
Disability	6,136
Below Poverty Line	5,957
No Health Insurance	3,479
Non-English Speaking	3,301
No Diploma	3,114
No Vehicle	2,178
Unemployed	1,380
No Phone	767

Table 4-65 summarizes the vulnerable population statistics in Kona by number of residents. There are nearly 6,000 residents in the District living below the poverty line (5,957 or 11.3% of the District's population). The 2017 median annual income of residents in Kailua, for example, was $66,875 (one of the highest incomes on the island) and Keauhou's 2017 median annual income was $81,144 (U.S. Census 2017). These numbers are significantly greater when compared to the median average income on the eastern side of the County, in Puna's Pāhoa community: $31,176. At the same time, countywide, Kona has some of the largest share of affordable housing stock (22.5%) (County of Hawai'i 2019).

In terms of total number of residents, those residents under 18, over 65, and no internet access at home represent the top three vulnerable population categories within the Kona CDP district. 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 40% of Kona residents living in the Volcanic High Hazard Area are either under 18 years of age or over 65 years of age (37.5%). Nearly 12% 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. Countywide, this is a relatively small percentage when compared to with the Ka'ū, Puna, and Hāmākua CDP districts. The following summarizes the residents living in the Volcanic High Hazard Area and considered the most vulnerable to the volcanic hazard in Kona (estimates generated using U.S. Census American Community Survey 2017 data):

- 1,038 people under 18 years of age
- 863 people over 65 years of age
- 863 single parents
- 660 people living with a disability
- 988 people with no internet access
- 127 people with no vehicle access

- 90 people with no phone access
- 127 people who are unemployed
- 622 people utilizing SNAP (Supplemental Nutrition Assistance Program)
- 531 people living below the poverty line—representing 8.9% of total Kona population

Table 4-65 through Table 4-68 summarize the exposure of vulnerable residents in Kona by socioeconomic factor to the volcanic hazard, as well as where the volcanic hazard area overlaps with another high hazard zone.

Table 4-65. Kona 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)	5,069 / 9.6%	1,038 / 9.6%	863 / 8.8%	863 / 10.9%	660 / 10.8%
VHHA with Additional Natural High Hazard Area	2,697 / 53.2%	581 / 56%	479 / 55.5%	483 / 56%	416 / 63%
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	3,406 / 6.5%	736 / 6.8%	607 / 6.2%	612 / 7.7%	530 / 8.6%
Lava Zone 2 with Additional Natural High Hazard Area	2,639 / 77.5%	571 / 77.5%	470 / 77.5%	474 / 77.5%	411 / 77.5%

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 4-66. Kona 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)	127 / 5.8%	405 / 11.6%
VHHA with Additional Natural High Hazard Area	76 / 60.4%	261 / 64.5%
Lava Zone 1	0 / 0%	0 / 0%
Lava Zone 1 with Additional Natural High Hazard Area	0 / 0%	0 / 0%
Lava Zone 2	97 / 4.5%	334 / 9.6%
Lava Zone 2 with Additional Natural High Hazard Area	75 / 77.5%	259 / 77.5%

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 4-67. Kona 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)	227 / 7.3%	325 / 9.8%	988 / 11.4%	90 / 11.8%
VHHA with Additional Natural High Hazard Area	144 / 63.4%	205 / 63.1%	623 / 63.1%	53 / 59.1%
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	184 / 5.9%	262 / 7.9%	796 / 9.2%	68 / 8.9%
Lava Zone 2 with Additional Natural High Hazard Area	143 / 77.5%	203 / 77.5%	616 / 77.5%	53 / 77.5%

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.

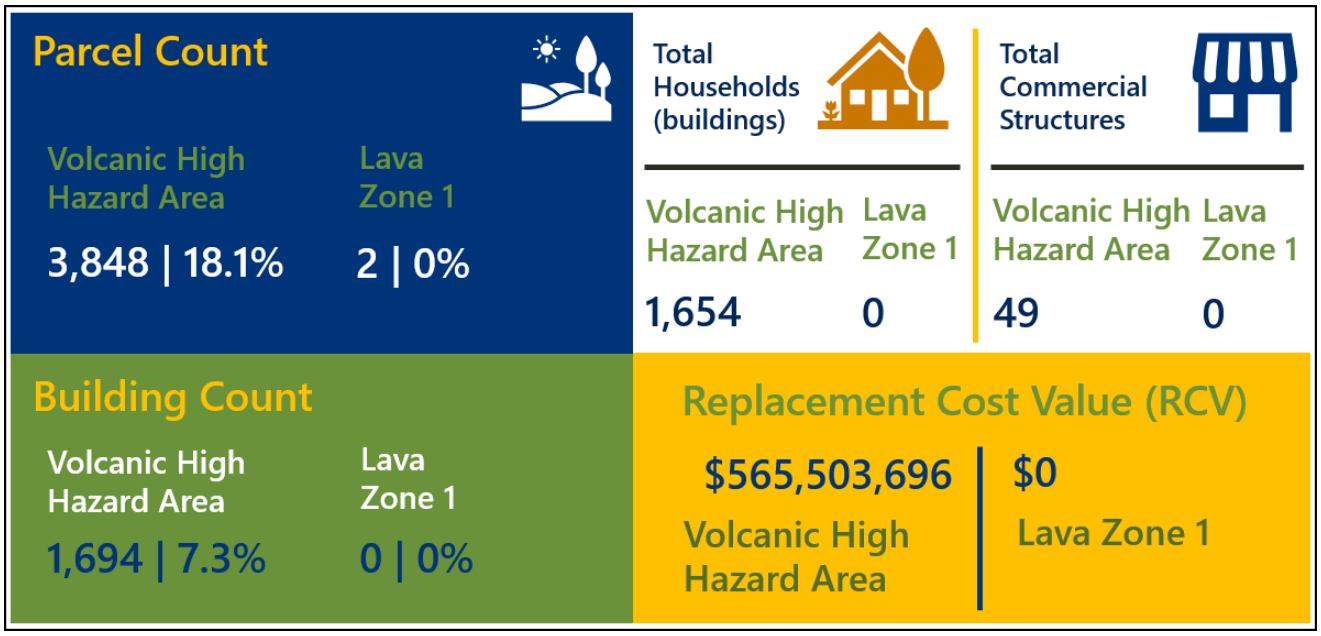
Table 4-68. Kona Resident Socioeconomic Status, by Volcano Hazard Area - A measure of the population that is less likely to have the necessary economic resources to adequately prepare for or recover from a natural disaster.

Hazard Area	Unemployed *(number / %)*	Receiving SNAP *(number / %)*	Below Poverty Line *(number / %)*
Volcanic High Hazard Area (VHHA)	127 / 9.2%	622 / 9.4%	531 / 8.9%
VHHA with Additional Natural High Hazard Area	70 / 55.4%	339 / 54.6%	291 / 54.7%
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	89 / 6.4%	429 / 6.5%	368 / 6.2%
Lava Zone 2 with Additional Natural High Hazard Area	69 / 77.5%	333 / 77.5%	285 / 77.5%

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 Kona Community Development Plan, an interconnected street network is a prioritized goal and objective for the District, which simultaneously supports easier evacuation emergency evacuation (when needed) (CHPD 2008). Kona's urbanized and developed areas are denser and more strategically built around the road system when compared to some of the other, more rural, southern districts of the County. In addition to the density of the road system supporting potential volcanic evacuations, Kona has tsunami evacuation zones and wildfire risk zones that may also warrant quick evacuation and utilize the interconnected road system in times of emergency evacuation.

4.5.4 PARCELS AND BUILDINGS



Note: All percentages are relative to the Kona District

Figure 4-101.Kona Parcels and Buildings Located in a Volcanic High Hazard Area (VHHA)

Kona's pattern of development and growth is the result of its leeward side climate, concentrated resort development, and attraction of new residents, particularly those with second homes. Between 1980 and 2005, Kona's population more than doubled. As such, traffic congestion and affordable housing are two concerns of existing residents and an overall priority of the District (CHPD 2008). According to the 2008 Kona CDP, many of the newer subdivisions and residential developments were built with little to no connectivity to the existing highway system. This means, local Kona residents who live off of the highway, in areas accessed by local roads, have a difficult time freely moving around from home to work, to shopping, to recreation, etc.

A total of 3,848 acres of parcels (18.1%) and 1,694 buildings (7.3%) in Kona 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 and lava zone 2. While Kona has land located in lava zone 1, according to the parcel record they are not developed. Lava zone 2 has 29,932 acres of developed parcels with 1,104 buildings. ***Figure 4-102*** illustrates the developed parcel area by lava-flow hazard zone.

Lava may burn structures and can 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 $1.5 billion which is the highest of any CDP District in the County. This value represents nearly 10% of Kona's total parcel assessed values. In terms of the replacement cost value of buildings (estimated structure and contents), an estimated $565 million is located in the Volcanic High Hazard Area (***Table 4-69***).

Table 4-69. Number of Kona 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)	3,848 / 18.1%	$1,528,884,100	1,694 / 7.3%	$565,503,696	1,654 / 7.7%	49 / 3.1%
VHHA with Additional Natural High Hazard Area	2,438 / 63.4%	$664,258,600	910 / 53.7%	$294,011,174	872 / 52.7%	47 / 95.9%
Lava Zone 1	2 / 0%	$4,366,200	0 / 0%	$0	0 / 0%	0 / 0%
Lava Zone 1 with Additional Natural High Hazard Area	2 / 100%	$2,183,100	0 / 0%	$0	0 / 0%	0 / 0%
Lava Zone 2	2,931 / 13.8%	$524,139,900	1,104 / 4.8%	$312,304,219	1,092 / 5.1%	12 / 0.8%
Lava Zone 2 with Additional Natural High Hazard Area	2,264 / 77.2%	$449,078,200	864 / 78.3%	$249,065,029	853 / 78.1%	11 / 91.7%

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. All structures built prior to 1985 are therefore, for the purposes of this analysis, considered to be unreinforced and susceptible to earthquake and hurricane wind damage due to the lack of uplift ties and a complete load path of connections (Hawai'i Martin and Chock, Inc. 2013). The frequency and location of the structures built prior to 1985 (both residential and commercial) is illustrated on ***Figure 4-103*** with many clustered very close or even overlapping with Volcanic High Hazard Areas in the northern and southern part of Kona.

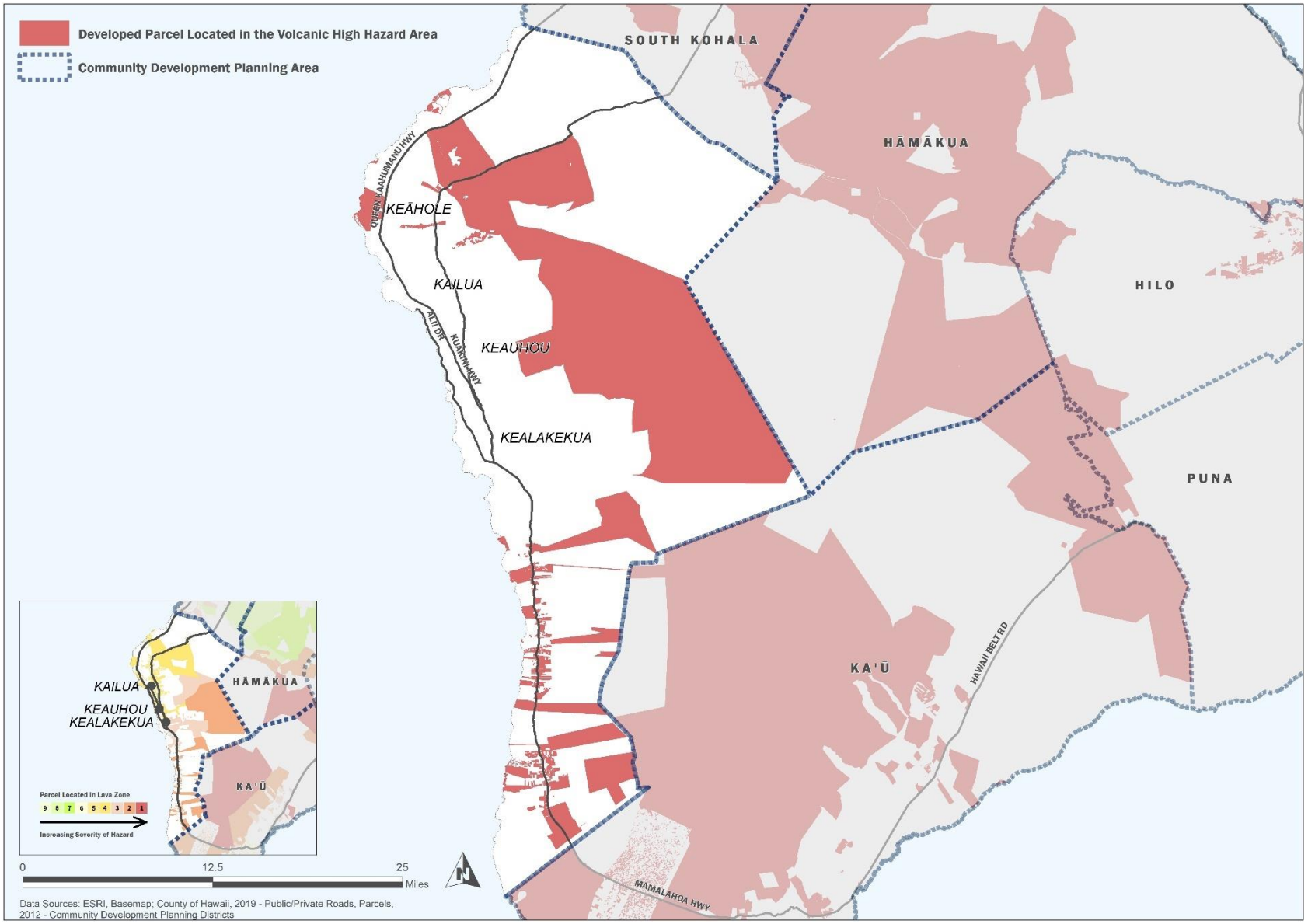


Figure 4-102. Developed Parcels in Kona by Lava Zone and the Volcanic High Hazard Area

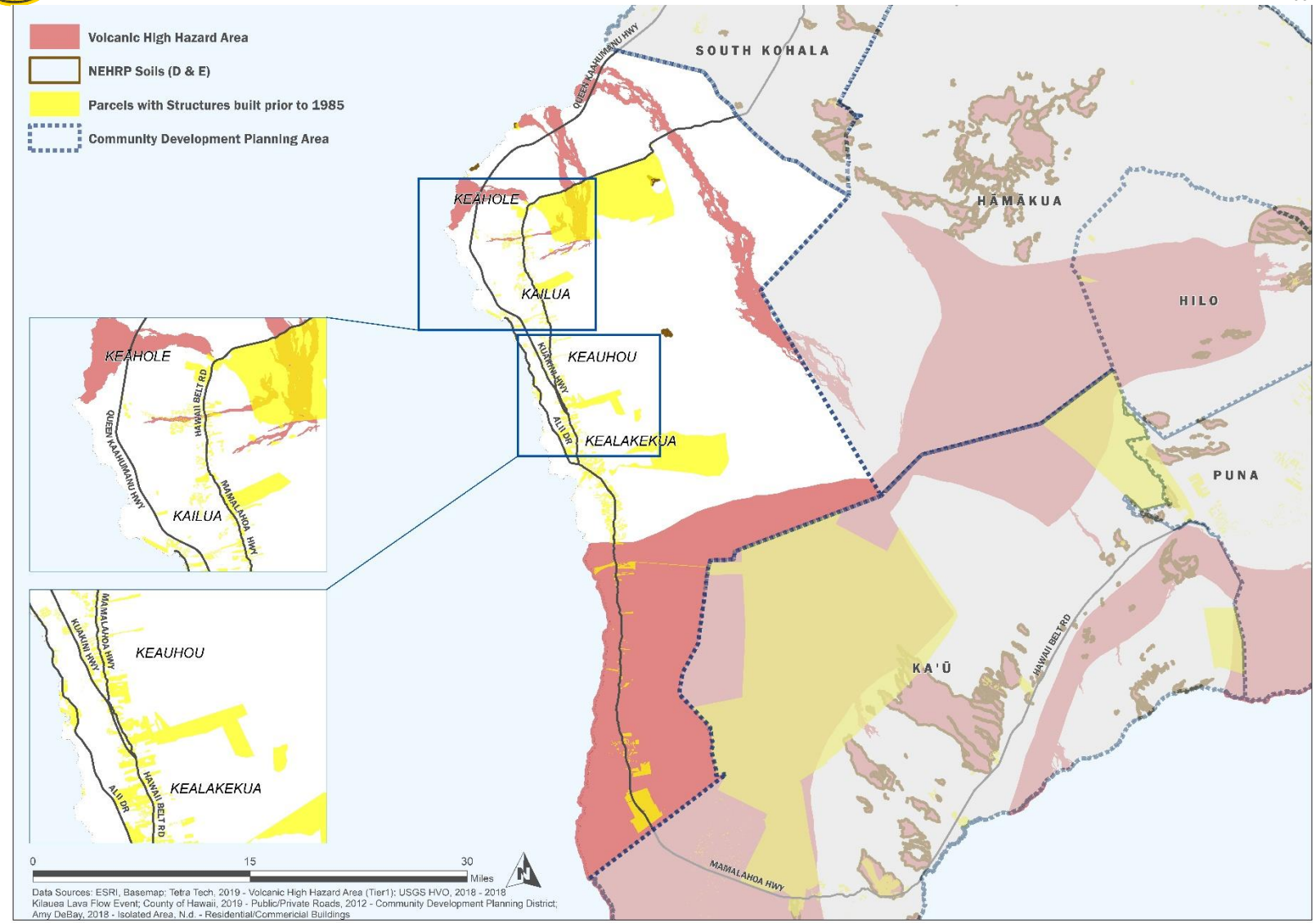
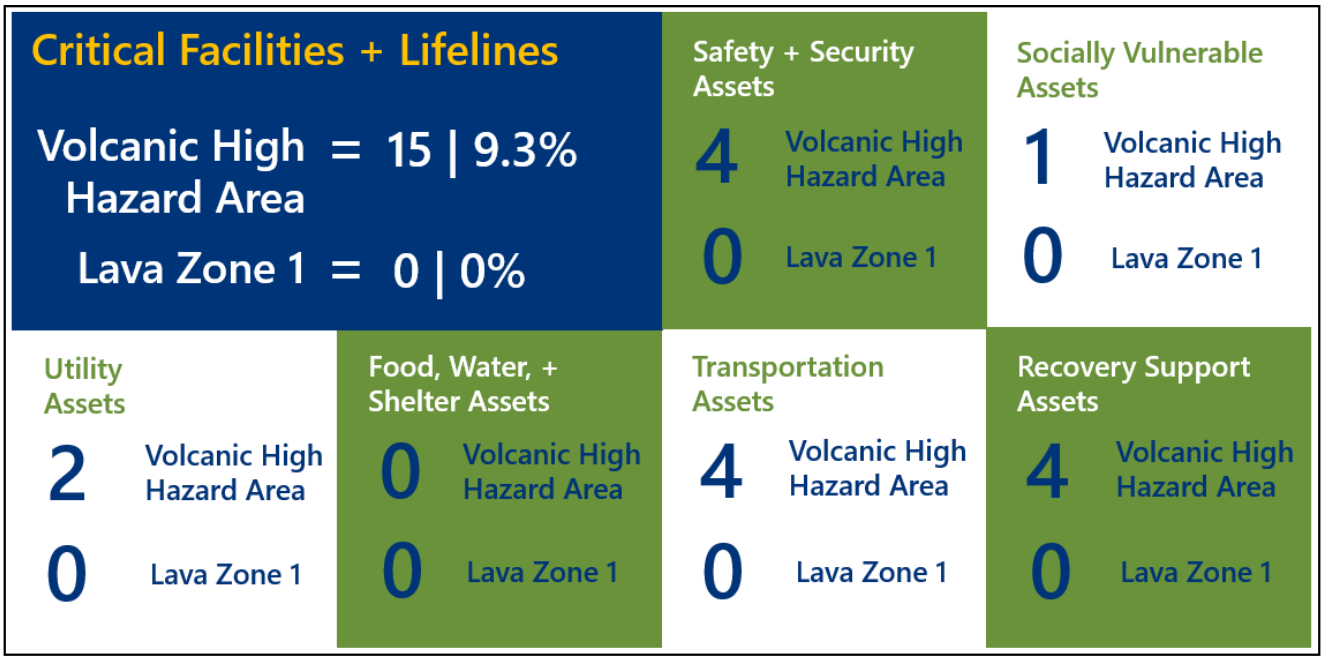


Figure 4-103. Kona Parcels with Structures Constructed Pre-1985 in the Volcanic High Hazard Area

4.5.5 CRITICAL FACILITIES AND LIFELINES



Note: All percentages are relative to the Kona District

Figure 4-104. Kona Critical Facilities and Lifelines Located in the Volcanic High Hazard Area and Lava Zone 1

Through the development of the volcanic risk assessment, 161 critical facilities and lifelines were identified in Kona. The critical facility and lifeline categories align with the 2015 County Hazard Mitigation Plan asset categories.

Table 4-70 summarizes the exposure of the critical facilities to the volcanic hazards. The vast majority of Kona's critical facilities are clustered around the major population centers in the District, of which the majority lava zone is 4 (see ***Figure 4-105***). Of the 15 critical assets located in the Volcanic High Hazard Area, 7 are located in lava zone 2 and 8 are located in an area impacted by historic lava flow (1790-1996). Relative to the County, Kona has the second highest percentage of critical facilities and lifelines located in historic lava flow areas (5%), behind Puna's 12.2%.

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. Kona has 87.7 miles of roadway (State, County and privately owned) located in the Volcanic High Hazard Area. Of which, 68.8 miles are located in lava zone 2.

Similar to the discussion on structures constructed pre-1985, there are a number of critical facilities in Kona constructed prior to 1985 and therefore more vulnerable to earthquake damage (during a volcanic eruption or occurring separately). Based on year-built data, over half of Kona's critical facilities and lifelines were constructed prior to 1985 (56.2%). 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. At the same time, only 5.5% of Kona's pre-1985 critical facilities are located in a Volcanic High Hazard Area.

Table 4-70. Kona 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)	15 / 9.3%	4 / 5.5%	4 / 11.1%	0 / 0%	4 / 26.7%	1 / 5.3%	2 / 4.4%
VHHA with Additional Natural High Hazard Area	8 / 53.3%	0 / 0%	3 / 75%	0 / 0%	2 / 50%	1 / 100%	2 / 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	7 / 4.3%	0 / 0%	3 / 8.3%	0 / 0%	2 / 13.3%	1 / 5.3%	1 / 2.2%
Lava Zone 2 with Additional Natural High Hazard Area	7 / 100%	0 / 0%	3 / 100%	0 / 0%	2 / 100%	1 / 100%	1 / 100%

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.

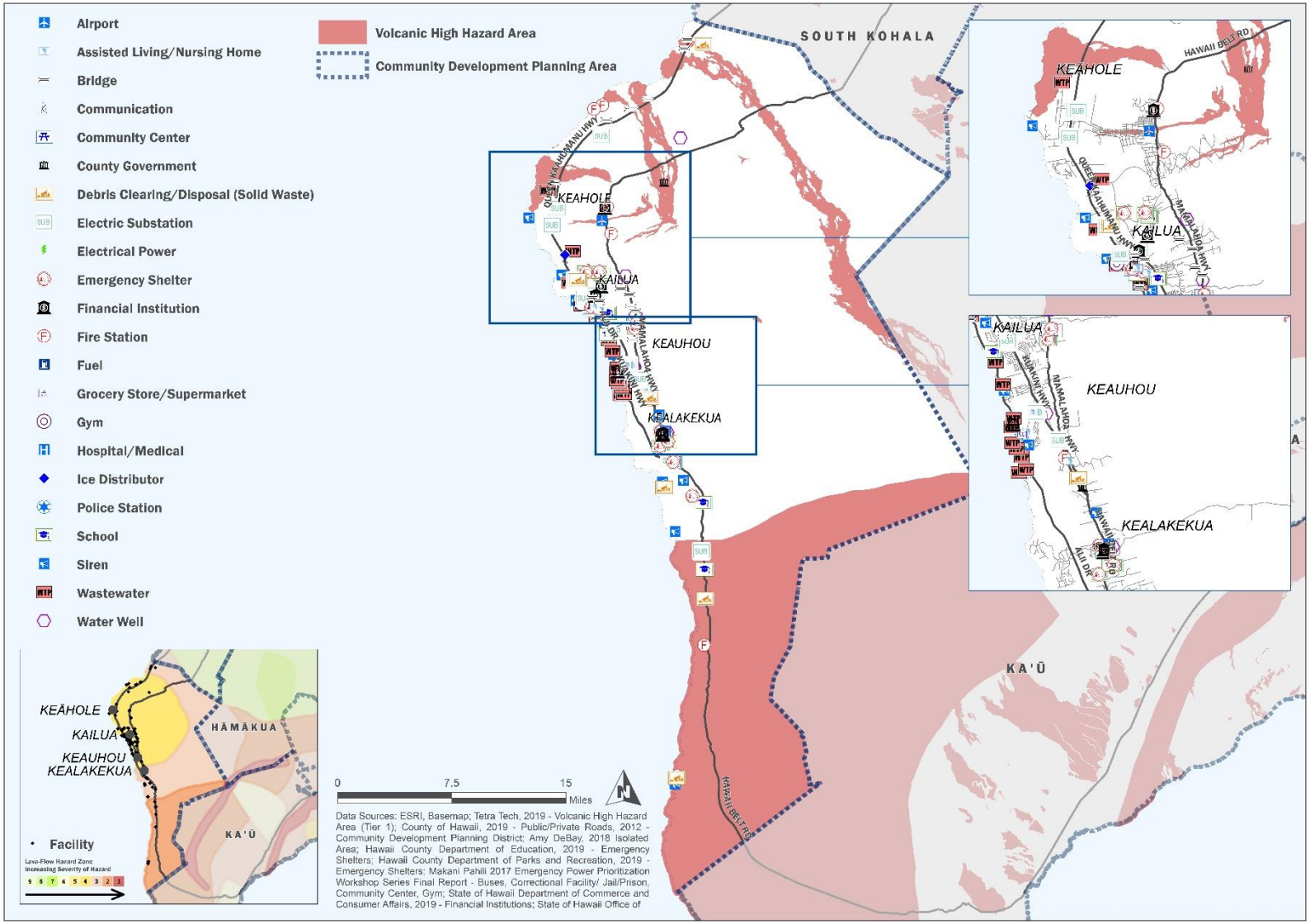
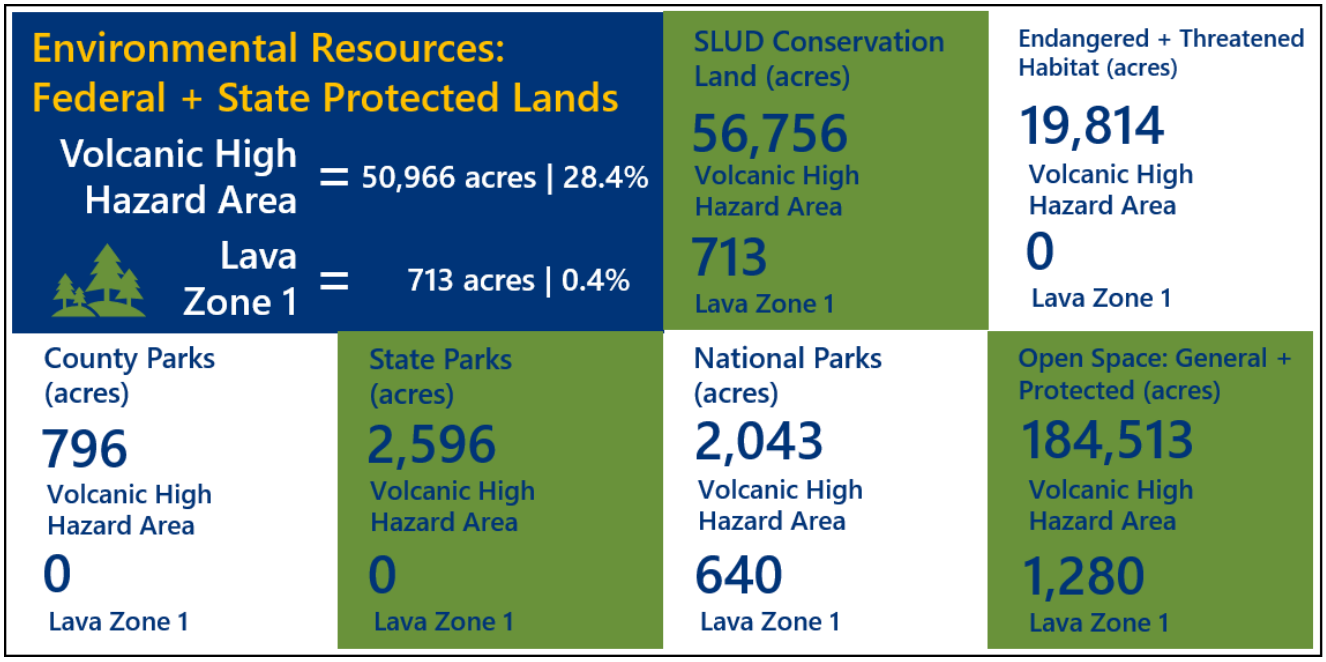


Figure 4-105. Kona Critical Facilities Located in Volcanic High Hazard Areas

4.5.6 ENVIRONMENT



Note: All percentages are relative to the Kona District

Figure 4-106. Kona Environmental Resources Located in the Volcanic High Hazard Area and Lava Zone 1

More than half (57.1%) of Kona land is undeveloped with 179,411 acres of intact natural area that is protected under federal and state regulations. Agriculture in the region includes macadamia nuts, coffee, and a mix of agriculture, tropical fruits, and flowers (***Figure 4-108*** and ***Figure 4-107***). Kona's beaches, famous coffee farms, and national historic parks attract locals and tourists alike (Hawai'i Tourism Authority 2019).

A large portion of land around the Hualālai Volcano is undeveloped and protected by Pu'u Wa'awa'a State Wildlife Sanctuary, Pu'u Wa'awa'a Forest Bird Sanctuary, Pu'u Wa'awa'a Cinder Cone State Park, and the Honua'ula Forest Reserve. In total, the majority of protected land in Kona is state-owned/managed (77.8%). Of the state-owned/managed land, 18.7% of it is located in the Volcanic High Hazard Area.

Environmental assets identified as part of the County of Hawai'i General Plan update (in progress) were used for this risk assessment (see ***Table 4-71***). ***Figure 4-106*** and ***Figure 4-109*** illustrate the environmental resources relative to the Volcanic High Hazard Area in Kona.

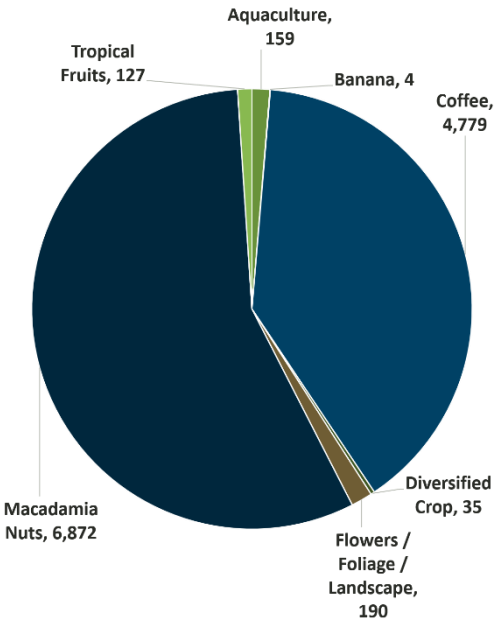


Figure 4-107. Kona Crop Land (Acres)

Table 4-71. Kona Environmental Resources

Agricultural Land of Importance *(acres)*	Crop Land *(acres)*	Pasture Land *(acres)*	Hunting Areas *(acres)*	Wetlands *(acres)*
100,035	12,167	128,410	132,965	214

Federal Reserves *(acres)*	State Reserves *(acres)*	Exceptional Trees	Anchialine Pools	Reservoirs	Endangered and Critical Habitats *(acres)*
17,228	139,525	6	251	83	59,850

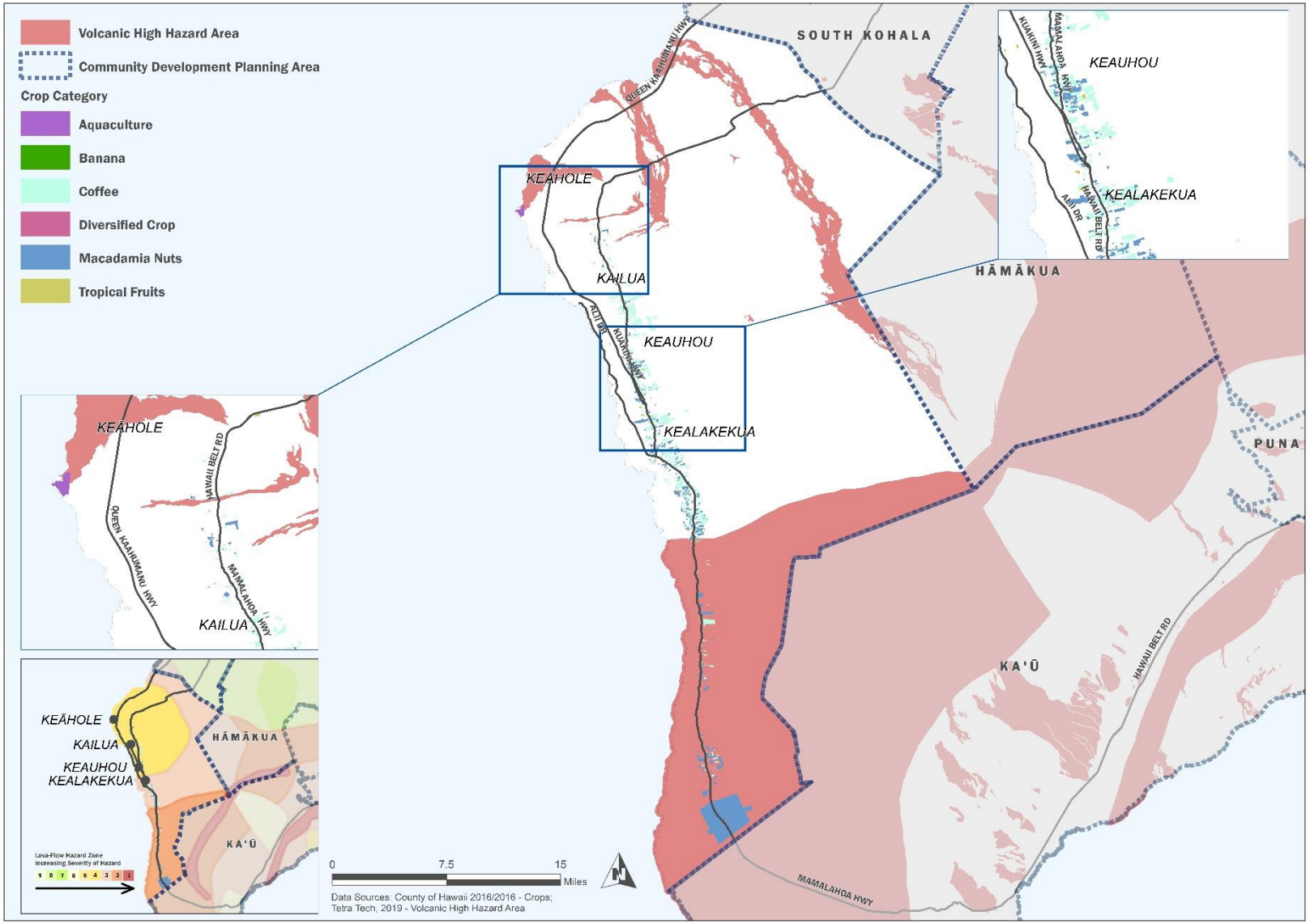


Figure 4-108. Kona Important Agricultural Crops Located in Lava Zones and Volcanic High Hazard Areas

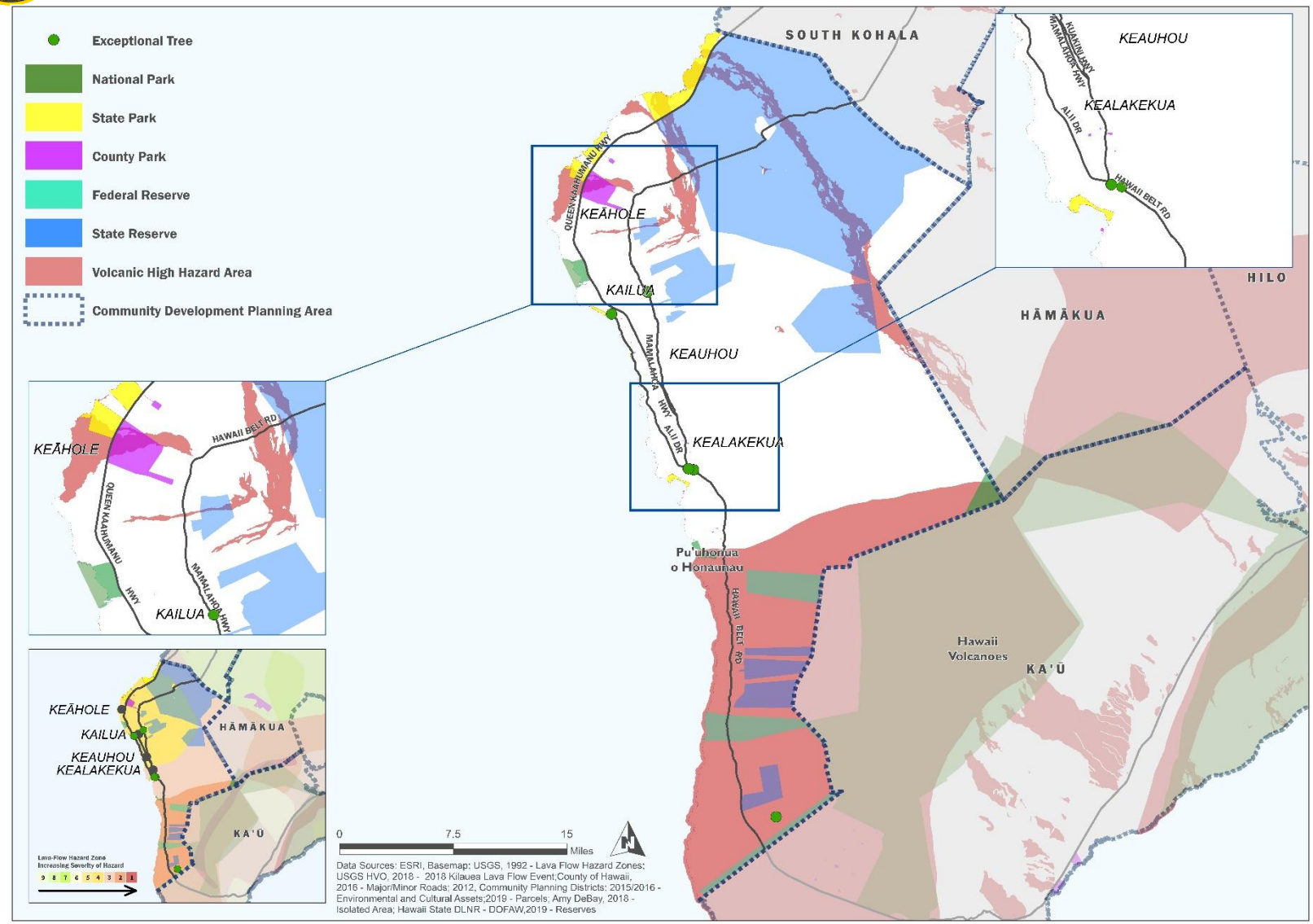


Figure 4-109. Protected Environmental Land in Kona Located in Lava Zones and Volcanic High Hazard Areas

Kona has the County's highest percentage of non-governmental organizational (99.7%) and federal (94.1%) reserve land located in a Volcanic High Hazard Area. Kona's remaining protected land, owned by the military, is nearly exclusively found outside of a Volcanic High Hazard Area.

Over 38% of Kona's Agricultural Land of Importance is located in the Volcanic High Hazard Area, totaling 38,659 acres. Kona has the greatest percent of pasture land, in the County, located in a Volcanic High Hazard Area (33.4% or 42,834 acres). Kona also has the greatest number of reefs that are considered exposed to the Volcanic High Hazard Areas in the entire County (10). This was determined because the reefs are located within 1,000-feet offshore and adjacent to the Volcanic High Hazard area. Future lava may flow to the ocean and generate more land and impact these reefs (see ***Table 4-72***).

Thousands of acres of Kona's environmental resource land are located in a Volcanic High Hazard Area. Over 50,000 acres (25.4%) of State Land Use Districts (SLUD) conservation land and over 50,000 acres of protected land (28.4%) is in a Volcanic High Hazard Area. Only 1,426 acres are located directly in lava zone 1. Nearly 20,000 acres (33.1%) of Puna's critical habitat land is in a Volcanic High Hazard Area.

Well over a majority of Kona's macadamia nuts (72.1%) are located in a Volcanic High Hazard Area, which is also Kona's largest crop in acres (6,872). Another large crop, coffee, is much less exposed to Volcanic High Hazard Areas (9%). Over 25% of Kona's aquaculture and diversified crops are also located in a Volcanic High Hazard Area. Kona's remaining crops, tropical fruits and flowers, are found in lava zones 2 and 4.

Table 4-72. Kona 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	50,966 / 28.4%	56,756 / 25.4%	19,814 / 33.1%	1 / 16.7%	184,513/ 28%	38,659 / 38.6%
Lava Zone	713 / 0.4%	713 / 0.3%	0 / 0%	0 / 0%	1,280 / 0.2%	28 / 0%
Lava Zone	34,552 / 19.3%	35,458 / 15.9%	16,841 / 28.1%	1 / 16.7%	138,096 / 20.9%	38,086 / 38.1%

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	5,458 / 44.9%	42,834 / 33.4%	30,583 / 23%	796 / 32.9%	2,596 / 40.3%	2,043 / 67.3%
Lava Zone 1	0 / 0%	0 / 0%	73 / 0.1%	0 / 0%	0 / 0%	640 / 21.1%
Lava Zone 2	5,411 / 44.5%	40,324 / 31.4%	16,967 / 12.8%	5 / 0.2%	0 / 0%	1,403 / 46.2%

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	53 / 24.6%	4 / 4.8%	17 / 6.8%
Lava Zone 1	0 / 0%	0 / 0%	0 / 0%
Lava Zone 2	39 / 18.2%	1 / 1.2%	5 / 2.0%

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.

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. While Kona is located a good distance away from Kīlauea, the County's most active volcano, vog travels throughout the entire island during significant eruptions. 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 4-72***, nearly 25% of Kona's hunting land and 33% of pasture land is in the Volcanic High Hazard Area.

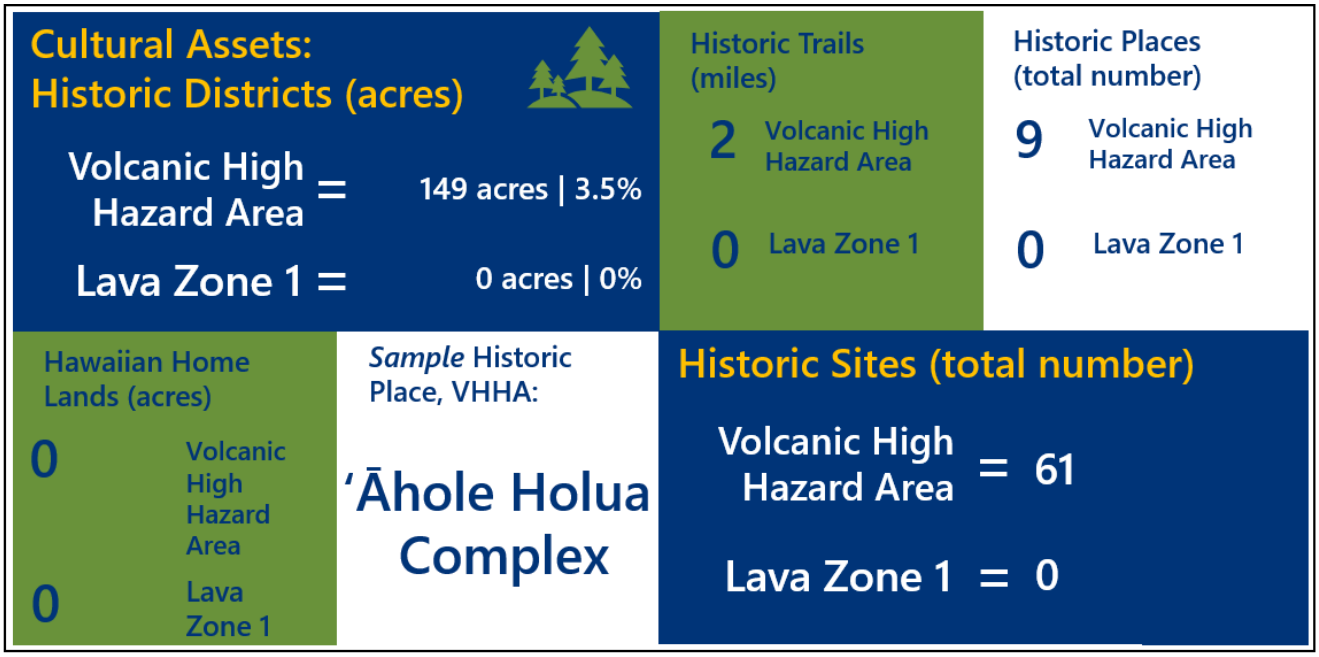
Also, of great concern to wildlife and livestock is the deposition of fluoride salts carried by vog onto forage crops. The scientific literature has documented a number of events where there have been significant losses of sheep, cattle, and horses because of acute exposure as well as chronic exposure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

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

The impacts resulting from gas discharge 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.

4.5.7 CULTURAL ASSETS



Note: All percentages are relative to the Kona District

Figure 4-110.Kona Cultural Assets Located in the Volcanic High Hazard Area and Lava Zone 1

Kona is home to many formally designated and recognized cultural assets, historic places and sites that are important because they help to shape the identity of the place and the people of Kona, 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 9 historic places, 61 historic sites and 2 miles of historic trail are in the Volcanic High Hazard Area (Kona has no acres of Hawaiian Home Lands in the Volcanic High Hazard Area). All 1,294 acres of Kona's Hawaiian Home Lands are in lava zones 3 and 4 (***see Table 4.5-12***).

It is important to note that many of the cultural assets are located along the coast and overlap with other hazard areas including tsunami, sea level rise, flood storm surge, and wildfire risk (see ***Figure 4-111***).

Table 4-73. Kona 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%	149 / 3.5%	9 / 20.5%	61 / 2.2%	2 / 2.2%
VHHA with Additional Natural High Hazard Area	0 / 0%	142 / 95.5%	7 / 15.9%	40 / 65.6%	2 / 1.9%
Lava Zone 1	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%
Lava Zone 2	0 / 0%	149 / 3.5%	5 / 11.4%	44 / 1.6%	2 / 1.8%

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.

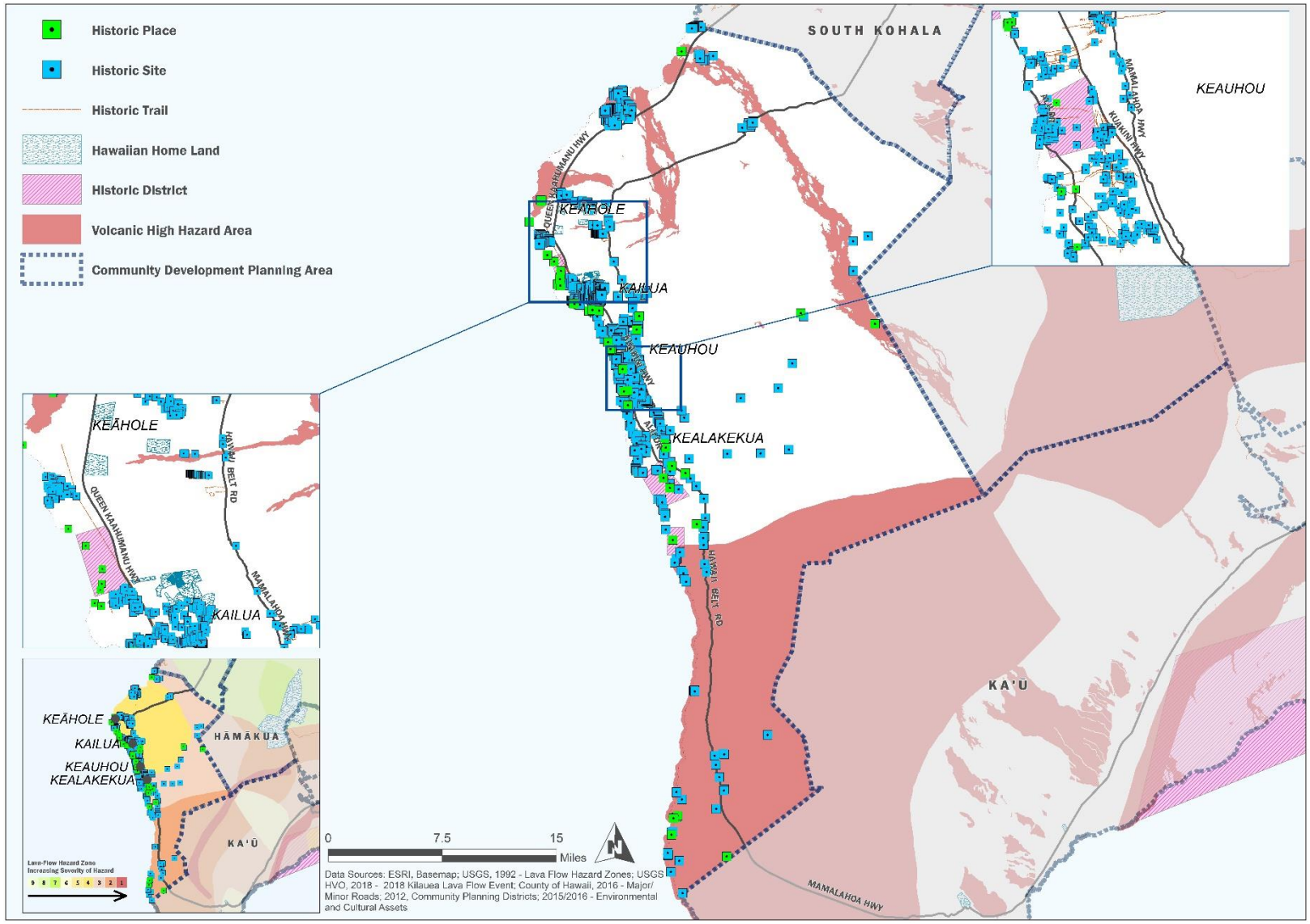


Figure 4-111.Cultural Assets in Kona and Volcanic Hazards

4.5.8 FUTURE LAND USE AND DEVELOPMENT

Kona is comprised of mix of land use classifications as categorized by the Land Use Pattern Allocation Guide (LUPAG) (***Figure 4-112***). 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 eastern and southern halves of Kona is conservation land, representing 47.5% of all District land, and extensive agriculture, representing 33.7% of all District land. Combined, Kona's conservation and extensive agriculture land represents over 80% of all District land (81.2%). A substantial portion of the remaining land in Kona is classified as important agricultural land (11.1%), open area (1.6%), and low-density urban (1.5%). 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. 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 Hawai'i 2005).

Keāhole and Kailua are classified as a mix of urban expansion, along with additional areas classified as industrial, medium and low density urban. These two population centers hold the vast majority of Kona's land targeted for urban expansion (lava zone 4). Further south, Keauhou and Kealakekua are less urban and more low-density development adjacent to conservation and agricultural land. See ***Figure 4-112*** for additional details about the classifications of Kona's land relative to the volcanic hazard areas and land classifications.

Kona has 713 acres of conservation land located in lava zone 1. In terms of developable land, Kona has 465 acres identified as resort node, 1,657 acres of industrial and 2010 acres of low-density urban land located in the Volcanic High Hazard Area. In addition, 15 acres are identified as urban expansion are located in the Volcanic High Hazard Area (see ***Table 4-74***). Land that has been identified for future urban expansion may be susceptible to other hazards (i.e. wildfire) or underestimating future/potential volcanic risk from Hualālai. As mentioned previously, scientists expect Hualālai to experience another eruption at some point in the next 100 years.

Table 4-74. Kona 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)*
Conservation	243,395	64,047	713	45,058
Extensive Agriculture	173,058	61,800	0	54,047
High-Density Urban	459	0	0	0
Important Agricultural Lands	57,177	19,433	0	19,051
Industrial	3,896	1,657	0	0
Low-Density Urban	7,515	210	0	0
Medium-Density Urban	1,752	0	0	0
Open area	8,549	2,653	0	1,536
Orchards	874	0	0	0
Resort	25	0	0	0

LUPAG Classification	Total Area *(acres)*	Volcanic High Hazard Area *(acres)*	Lava Zone 1 *(acres)*	Lava Zone 2 *(acres)*
Resort Node	2,432	465	0	0
Rural	1,119	31	0	31
University Use	462	0	0	0
Urban Expansion	12,092	15	0	0

LUPAG *Land Use Pattern Allocation Guide*

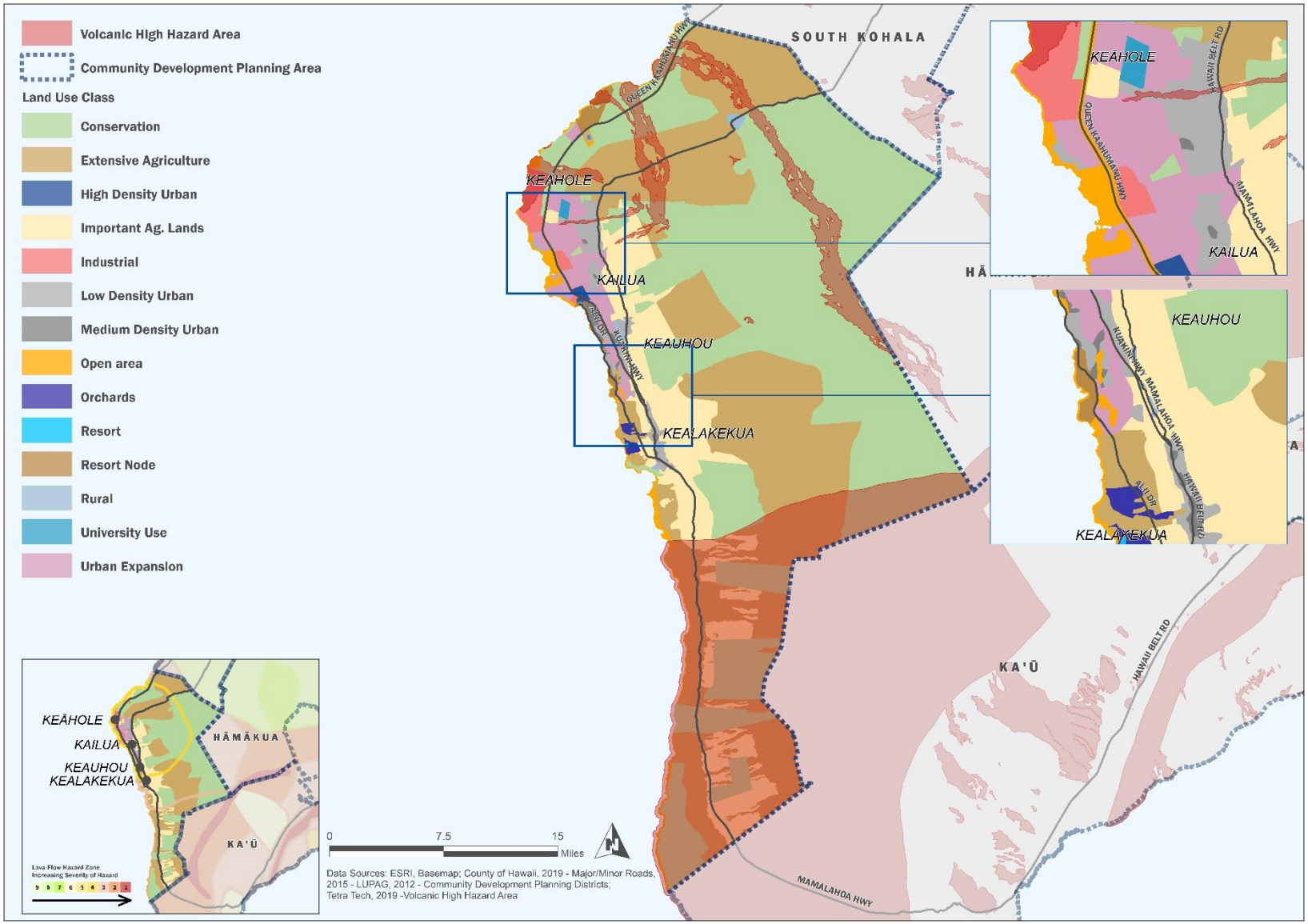


Figure 4-112. Kona Land Use Pattern Allocation Guide (LUPAG) Classifications and the Volcanic High Hazard Areas

In preparation for the County General Plan update (currently in progress), a build-out analysis was conducted to determine residential and non-residential capacity. Kona has nearly 5,000 identified residential greenfield parcels, which illustrates the potential scale of future development. Of the 5,000 parcels, nearly 2,000 are located in the Volcanic High Hazard Area (see ***Table 4-75***). Future land use decisions and future policy may consider the location of the volcanic and additional high hazards prior as part of future development decisions.

In Kona, non-residential greenfield development or potential redevelopment is nearly non-existent. Nearly half of the Volcanic High Hazard Area parcels identified for potential residential redevelopment are also at-risk to another high hazard.

The exposure to other natural hazards should also be taken into consideration when considering future development decisions. Over 70% of parcels identified for residential greenfield development located in a Volcanic High Hazard Area intersect with another natural high hazard area (i.e. tsunami evacuation zone, landslide, etc.). Refer to ***Table 4-75*** for additional statistics regarding parcels identified for future development and their location relative to the volcanic hazard areas and other high hazards.

Table 4-75. Kona 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)	1,814 / 37.3%	480 / 9.6%	1 / 0.5%	2 / 0.9%
VHHA with Additional Natural High Hazard Area	1,298 / 71.6%	231 / 48.1%	0 / 0%	2 / 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	1,658 / 34.1%	261 / 5.2%	0 / 0%	0 / 0%
Lava Zone 2 with Additional Natural High Hazard Area	1,216 / 73.3%	217 / 83.1%	0 / 0%	0 / 0%

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

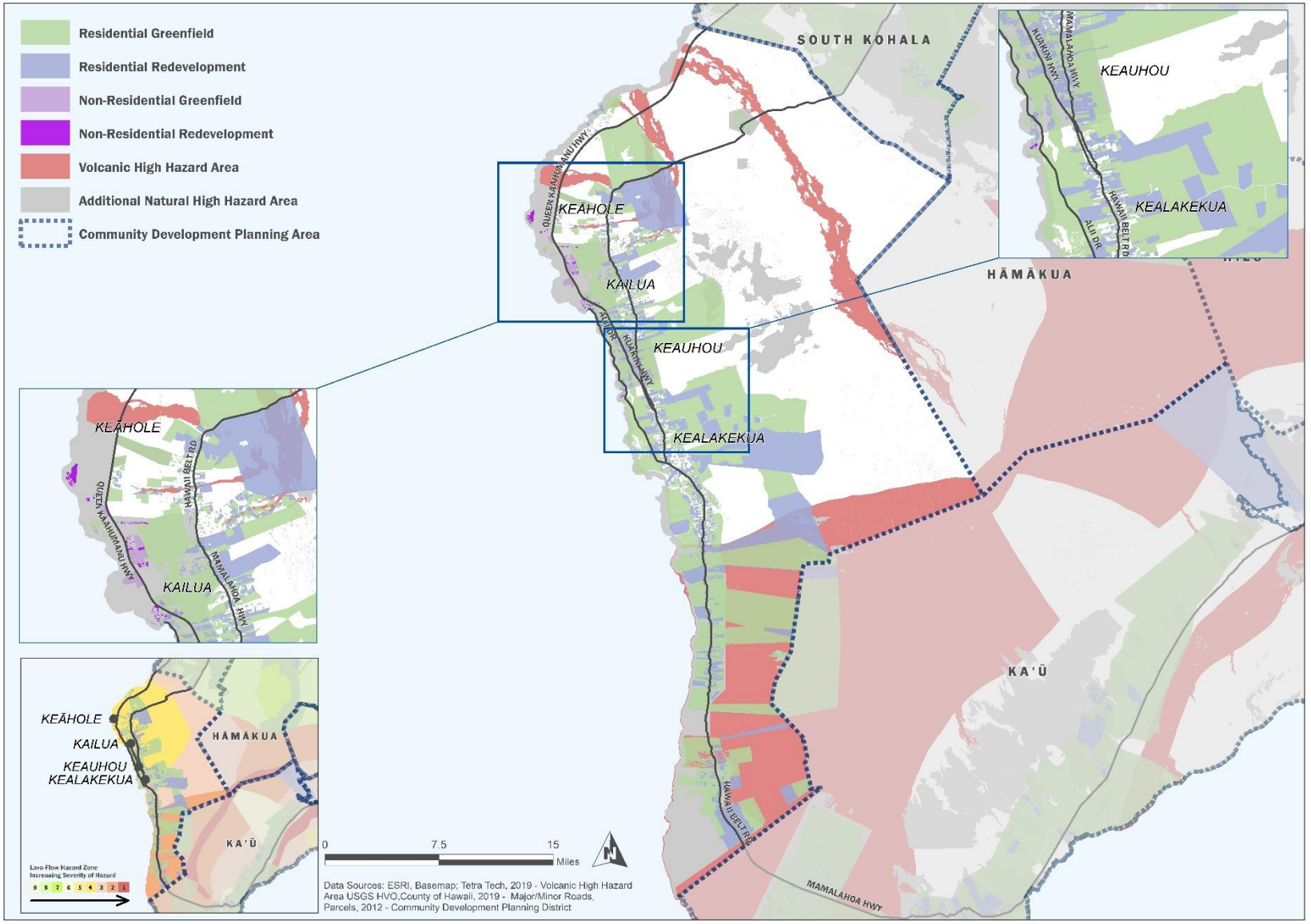


Figure 4-113. Kona Greenfield and Redevelopment Areas, and Volcanic Hazard Areas

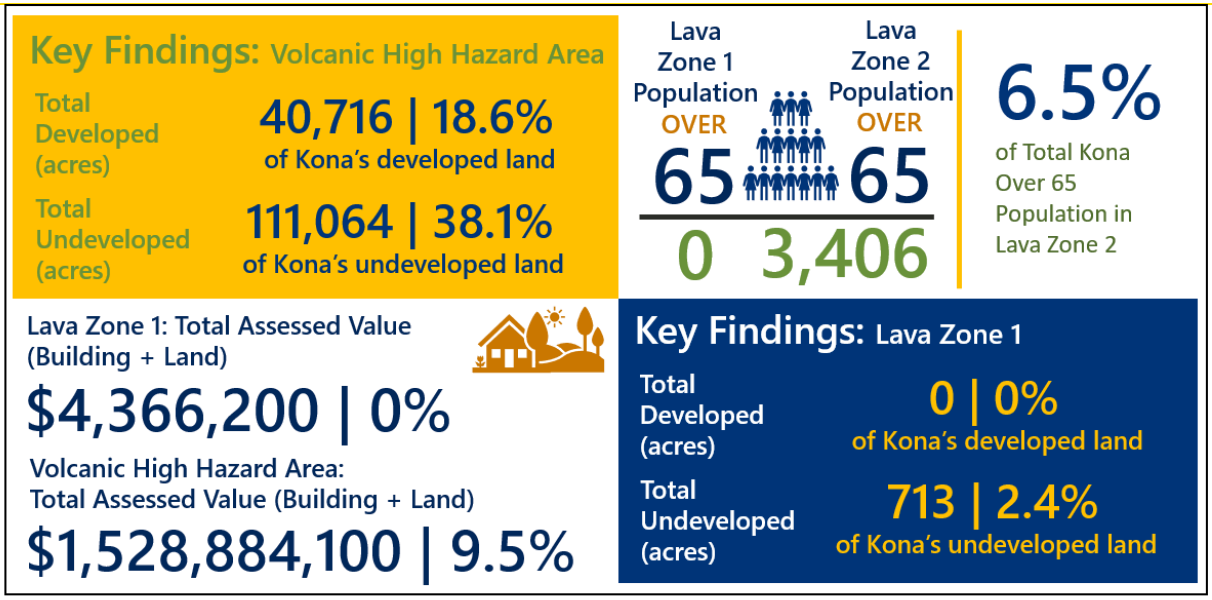
There is a significant lack of hazard insurance for many structures, across the County. In 1991, State of Hawai'i lawmakers created a nonprofit collection of insurance companies called the Hawai'i Property Insurance Association to address this gap. The State assembled the nonprofit to provide basic property 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 high hazard risk combined with limited or high cost insurance, when available, is a considerable factor when planning for the continued growth of Kona. 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 Kona 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 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 the shape of population centers in Kona. Development or redevelopment is not always the preferred option. In fact, Hilo 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.

4.5.9 KEY FINDINGS



Note: All percentages are relative to the Kona District

Figure 4-114. Kona Key Findings

Understanding what is at risk from natural hazards and future changes that impact vulnerability 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 Kona District:

- Kona is the only District in the County with parcels located in lava zone 4 (14,698 parcels), which represents 69.3% of Kona's overall parcel count
- Kona has the greatest parcel assessed value located in the Volcanic High Hazard Area ($1,528,884,100) in the County
- 1,123 parcels (5.3%), 593 households (2.8%), and 1,764 residents (3.4%) have been inundated and impacted by historic lava flows (1790-1996)
- Kona has 713 acres in lava zone 1, representing less than 1% of Kona land
- Kona has 119,301 acres in lava zone 2, representing 23.3% of Kona land
- Kona has over 40,000 acres (7.8%) impacted by historic lava flows (1790 – present)

Kona is confronted with future decisions about life safety, development, volcano and other natural high-hazard risks, and general land use. Although Kona has not experienced a volcanic eruption since 1790-1801, scientists anticipate Hualālai will erupt again at some point during the next 100 years (USGS 2017a). 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 Kona with exposure to the volcanic risk and other natural high hazards.

Alternatively, there are locations within Kona that are located outside of the Volcanic High Hazard Area. These areas are located in the northern portion of Kona and should be assessed for future growth and redevelopment. Kona's population centers, Keāhole, Kailua, Keauhou, and Kealakekua have been and will continue to be important places and determinants of the future growth. All urban expansion land classifications exist in one of these four communities. Despite low volcanic risk, Keauhou, Keāhole, and Kailua are identified as communities at high risk to and are located in additional natural hazard areas that should be weighed as future development decisions are made. Furthermore, considerations for Kona's most vulnerable populations need to 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.

4.6 North Kohala

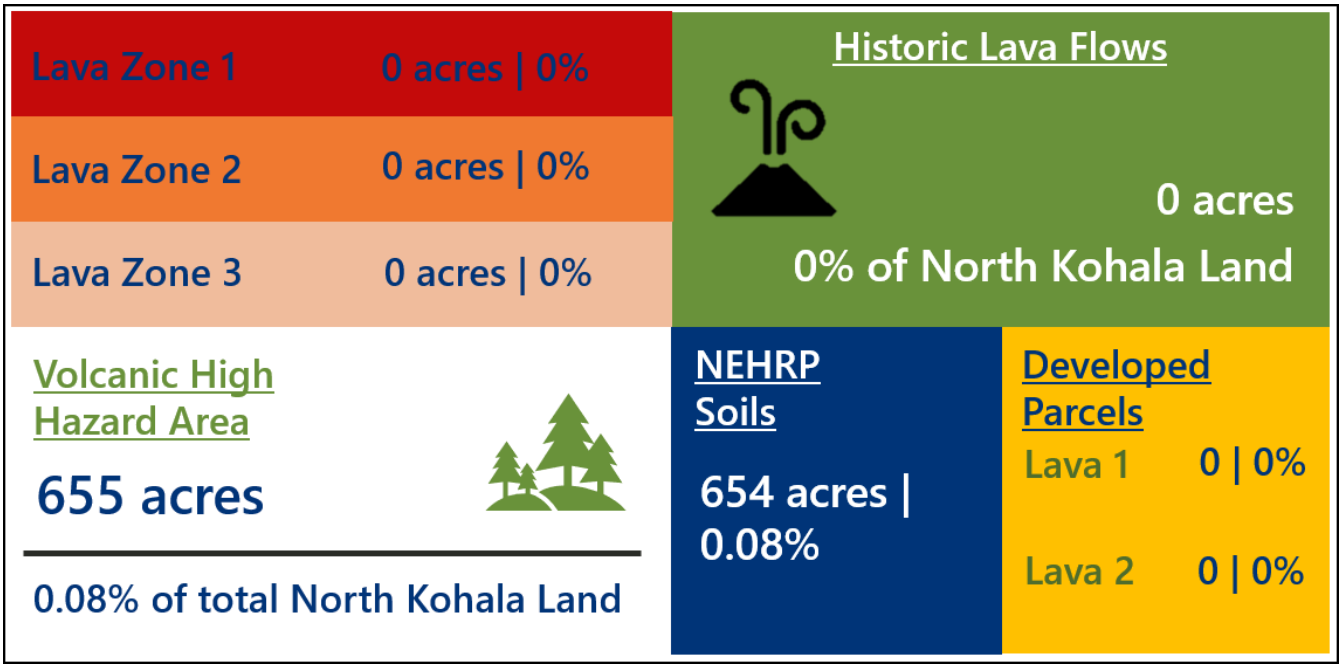
4.6.1 OVERVIEW

The North Kohala Community Development Plan district (CDP), herein referred to as North Kohala, is located at the northwestern tip of the Island of Hawai'i. The district is bordered by the South Kohala District to the south and the Hāmākua District to the east. The ocean defines the region's north and west borders. North Kohala is the smallest CDP in the County, comprising only 3% of the County's total land area. North Kohala has a long history of change, starting with early subsistence farming practiced by Native Hawaiians, to sugar plantations, to the post-plantation era. This evolution, at times, has been reluctantly accepted by residents. Today, the North Kohala CDP plan identifies "Keep Kohala, Kohala" as its primary guiding goal (CHPD 2008). North Kohala does not have a volcano contained within its boundaries but is closest to the Kohala Volcano located in South Kohala. The Kohala Volcano is the oldest of five volcanoes that form the County of Hawai'i. As such, North Kohala has the lowest volcanic risk in the County. One hundred percent of its population lives in lava zone 9; the lowest U.S. Geological Survey (USGS) lava-flow hazard risk zone.

North Kohala's landscape has been formed largely by its history of sugar plantations and ranching. The early North Kohala lifestyle was oriented around a system of sharing and exchange. Neighbors looked out for one another and shared resources during harvest time. Much of development was structured around a camp or village framework with most residents being more concerned about the community as a whole, rather than their personal needs. This culture and ethic is something the residents of North Kohala today would like to see maintained and preserved into the future. While North Kohala is not the epicenter of the County's tourism industry, its natural beauty often attracts many Island visitors, for example: the Pololū Valley and Pololū Valley Lookout, Kohala Forest Reserve, the Lapakahi State Historical Park, and the historic town of Hāwī. Most visitors and tourists reach North Kohala by the Ellison Onizuka Kona International Airport in Kona.

North Kohala's small land area (just under 80,000 acres) is largely undeveloped land, complete with many significant areas of natural beauty and working land. There are several towns throughout the District that contain the most significant population clusters, such as Hāwī and Kapa'au. Unique to other County CDP areas, North Kohala maintains a majority of land categorized as Important Agricultural Lands and Extensive Agriculture (78.8%). Only 4% of North Kohala land is categorized as urban or urban expansion, with the remainder designated as conservation, open area, or rural (CHPD 2008). North Kohala's modest population in 2000 was 6,038 people. Between 1980 and 2000, however, the population more than doubled. According to the 2005 County General Plan, North Kohala is expected to continue to grow. The anticipated growth rate between 2005 and the year 2020 was set to increase to a population of 11,273. However, according to the 2017 American Community Survey (ACS), North Kohala's population is currently 5,845 residents (U.S. Census 2017).

4.6.2 VOLCANIC HAZARDS



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

Figure 4-115. North Kohala Volcanic Hazard Exposure Overview

Although one of the County's five volcanoes is not within the boundaries of North Kohala, the County's oldest volcano (Kohala) is located just south of the shared border between North Kohala and South Kohala. The Kohala volcano has not erupted in the last 60,000 years (Seach No Date). The entire District is located in lava zone 9 (***Figure 4-116***). North Kohala is located entirely in lava zone 9 which is based on Kohala volcano's long-standing dormancy.

Ground shaking is the primary cause of earthquake damage to buildings and infrastructure. Softer soils amplify ground shaking. There is a small amount of land (654 acres or 301 parcels) located on National Earthquake Hazard Reduction Program (NEHRP) soil classes D and E (less than 1 percent of North Kohaa land) that are characterized by soft soils.

Only 30% of North Kohala's land is considered "developed" (or parcels with a building assessment value according to County assessor records), and 100% of developed land is located within lava zone 9 (***Table 4-76***). For the purposes of this assessment, developed and undeveloped land has been calculated at the parcel level, regardless of private or public ownership.

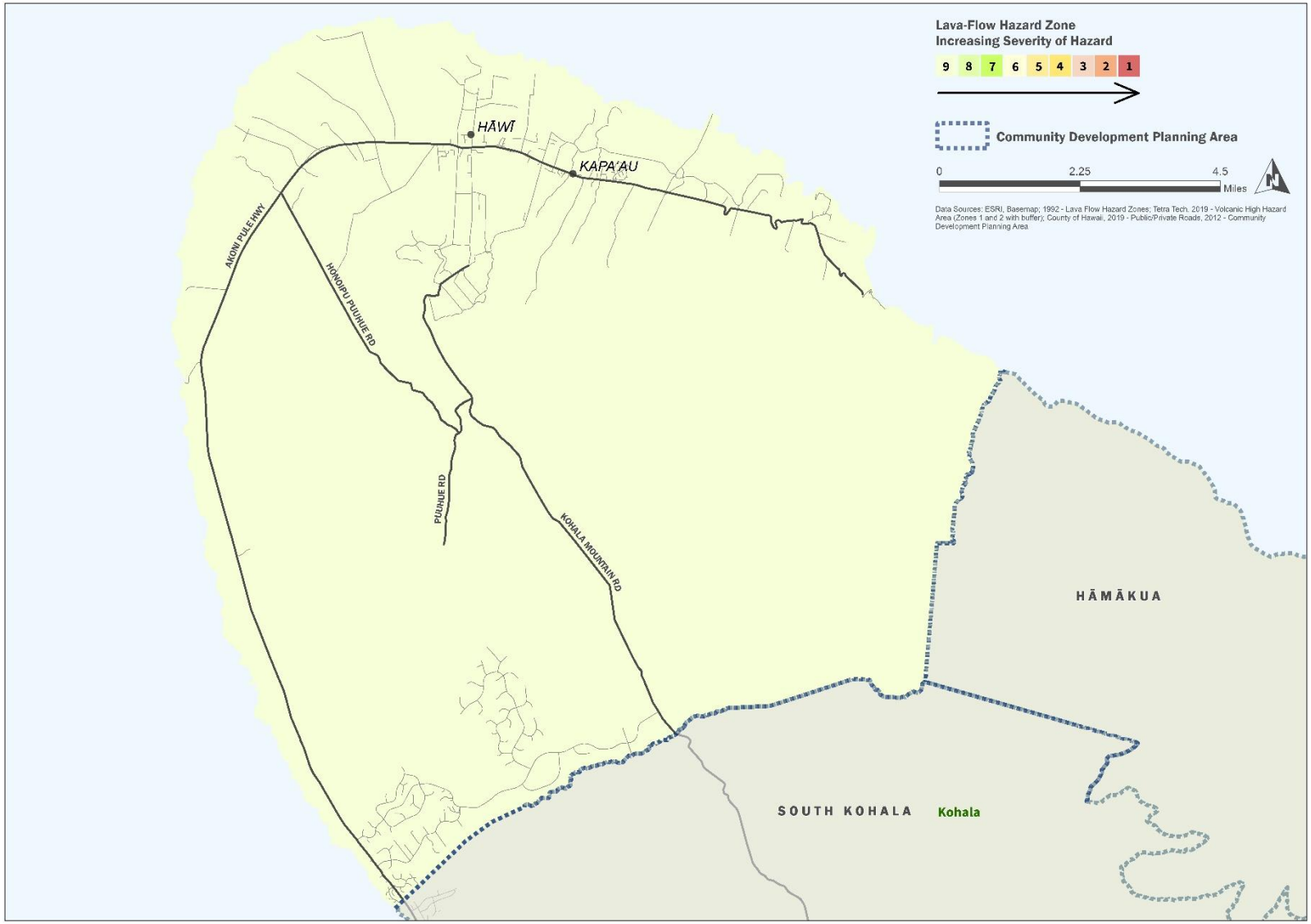


Figure 4-116. Lava Zones in North Kohala

Table 4-76. North 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)
North Kohala District	**79,193**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**79,183**
Developed	24,006	0	0	0	0	0	0	0	0	24,005
Undeveloped	55,187	0	0	0	0	0	0	0	0	55,179

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

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 North Kohala's exposure to the Volcanic High Hazard Area and lava-flow hazard zones 1 and 2. As previously mentioned, North Kohala is located entirely in lava zone 9. The only Volcanic High Hazard Area that exists in North Kohala is related to the NEHRP D&E soils (less than 1 percent of the land in North Kohala). Refer to ***Table 4-77*** and ***Figure 4-117*** for a summary of North Kohala's land area in each volcanic hazard area, including the Volcanic High Hazard Area.

Table 4-77. North Kohala Land by Volcanic High Hazard Area and Lava Zones 1 and 2

Hazard Area	Total Land Area (acres)	Developed Parcel Area (acres)	Undeveloped Parcel Area (acres)
Volcanic High Hazard Area (VHHA)	655 (0.08%)	65 (0.02%)	590 (0.11%)
Lava Zone 1	0 (0%)	0 (0%)	0 (0%)
Lava Zone 2	0 (0%)	0 (0%)	0 (0%)
Lava Zone 3	0 (0%)	0 (0%)	0 (0%)
Lava Zone 4	0 (0%)	0 (0%)	0 (0%)
Lava Zone 5	0 (0%)	0 (0%)	0 (0%)
Lava Zone 6	0 (0%)	0 (0%)	0 (0%)
Lava Zone 7	0 (0%)	0 (0%)	0 (0%)
Lava Zone 8	0 (0%)	0 (0%)	0 (0%)
Lava Zone 9	79,183 (99.9%)	24,005 (99.9%)	55,179 (99.9%)

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.

Although North Kohala's lava-flow hazard risk is relatively low compared to other CDPs, it is susceptible to other natural hazards and their associated potential future impacts. These hazards include, but are not limited to, tsunami, sea level rise, landslide susceptibility, and flooding. ***Figure 4-118*** illustrates the location of additional natural high hazard areas located in North Kohala and ***Figure 4-119*** illustrates the additional high hazard areas relative to the lava zones and Volcanic High Hazard Area.

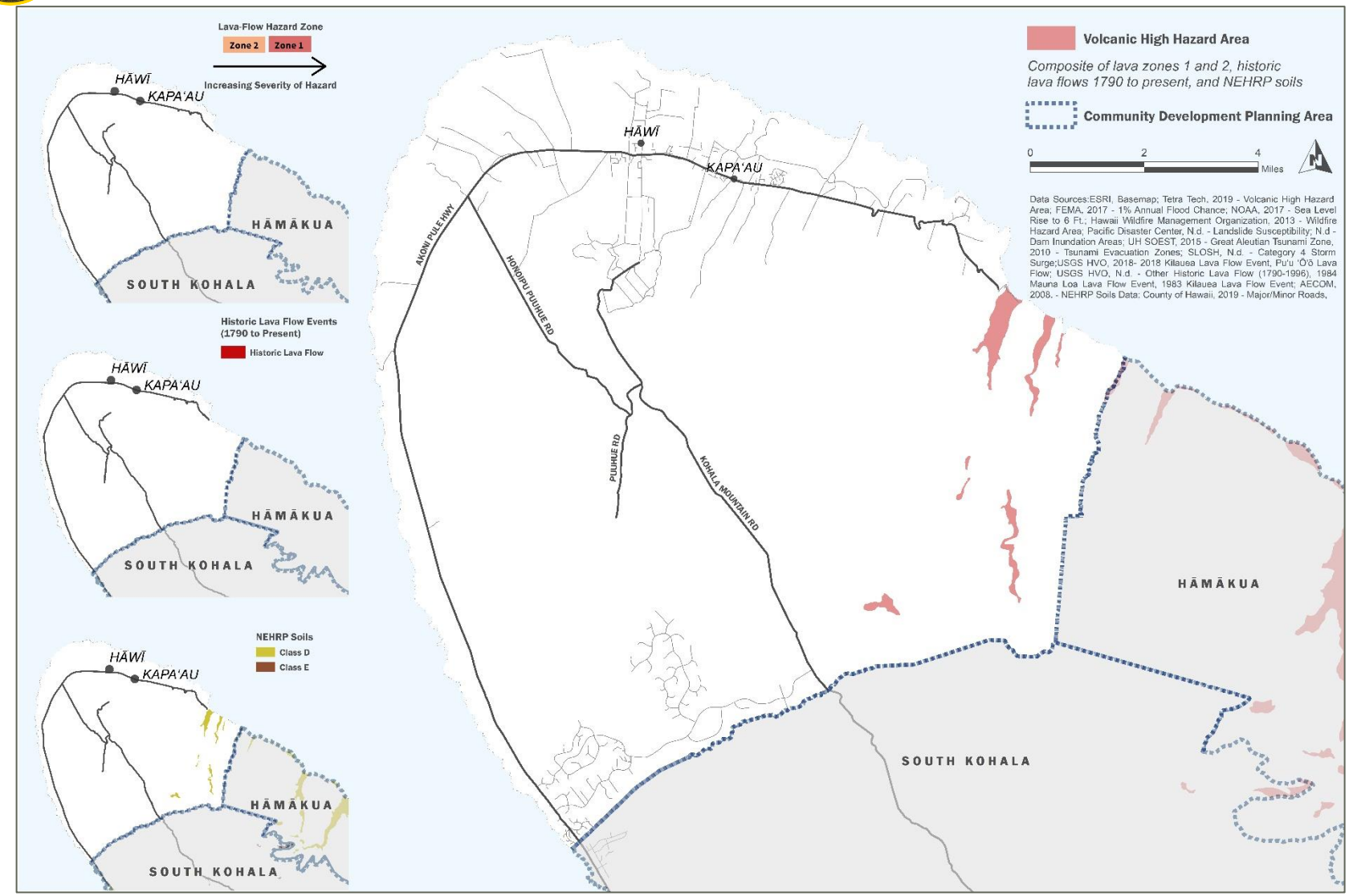


Figure 4-117. Volcanic High Hazard Area in North Kohala

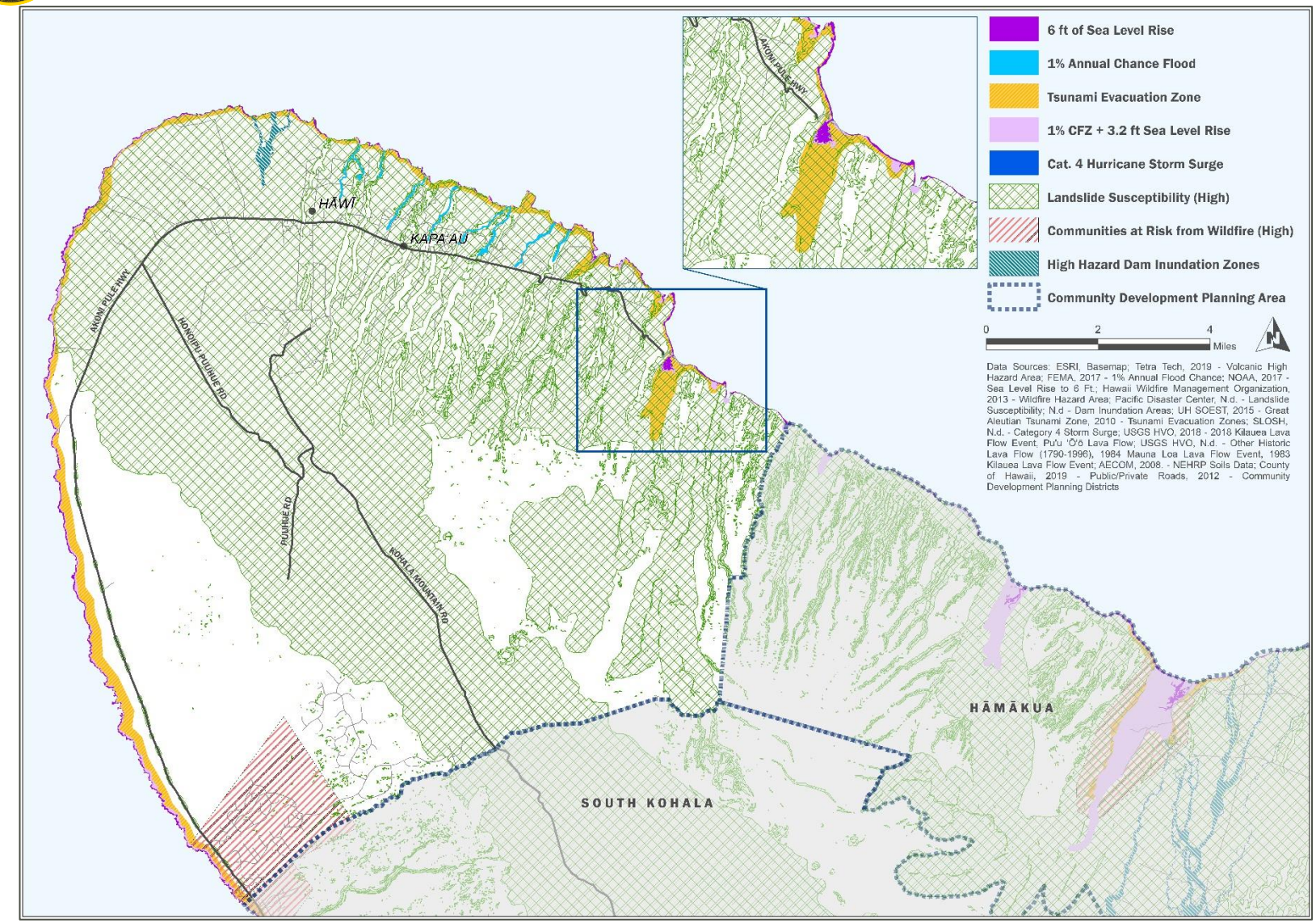


Figure 4-118. Additional Natural High Hazard Areas in North Kohala

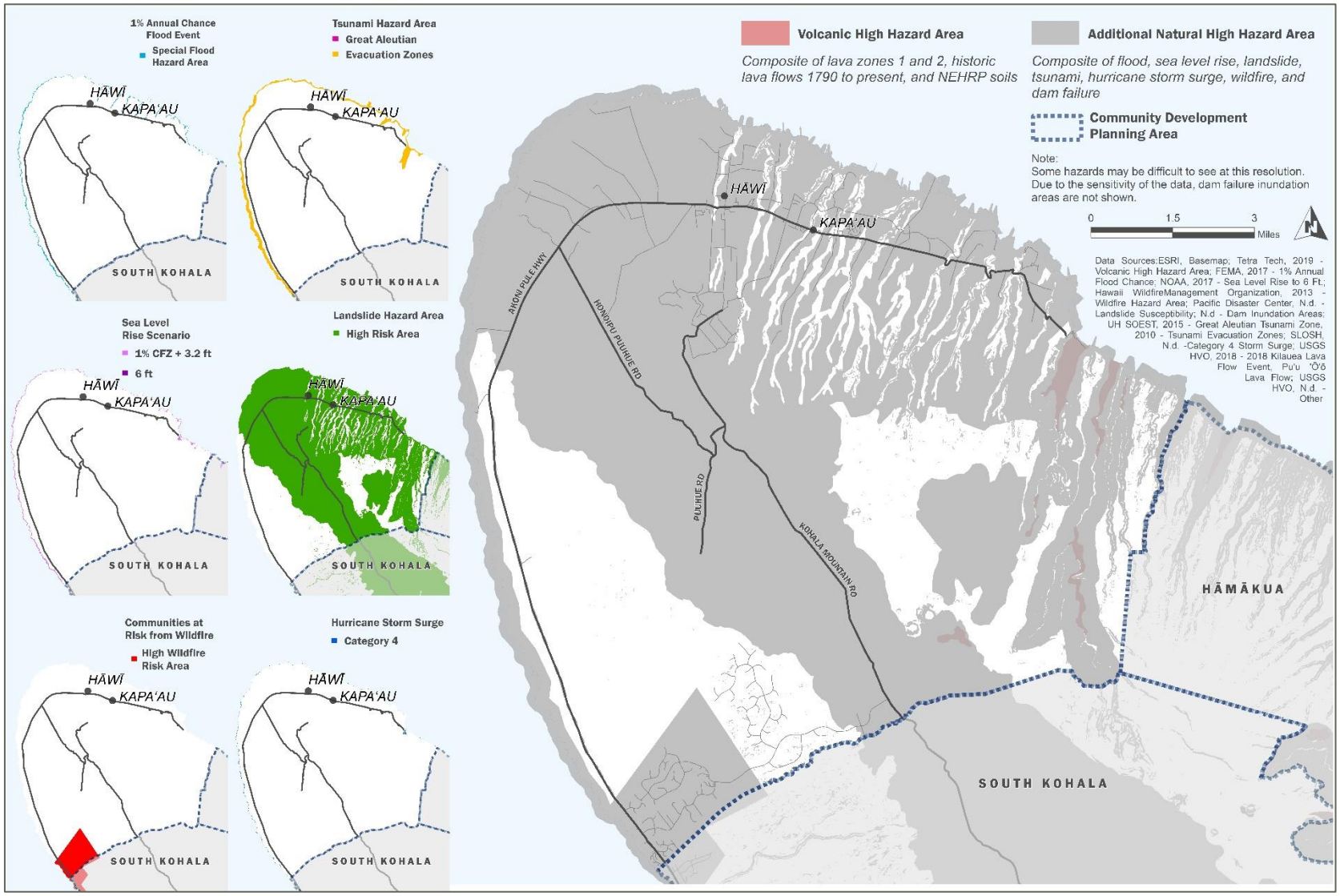
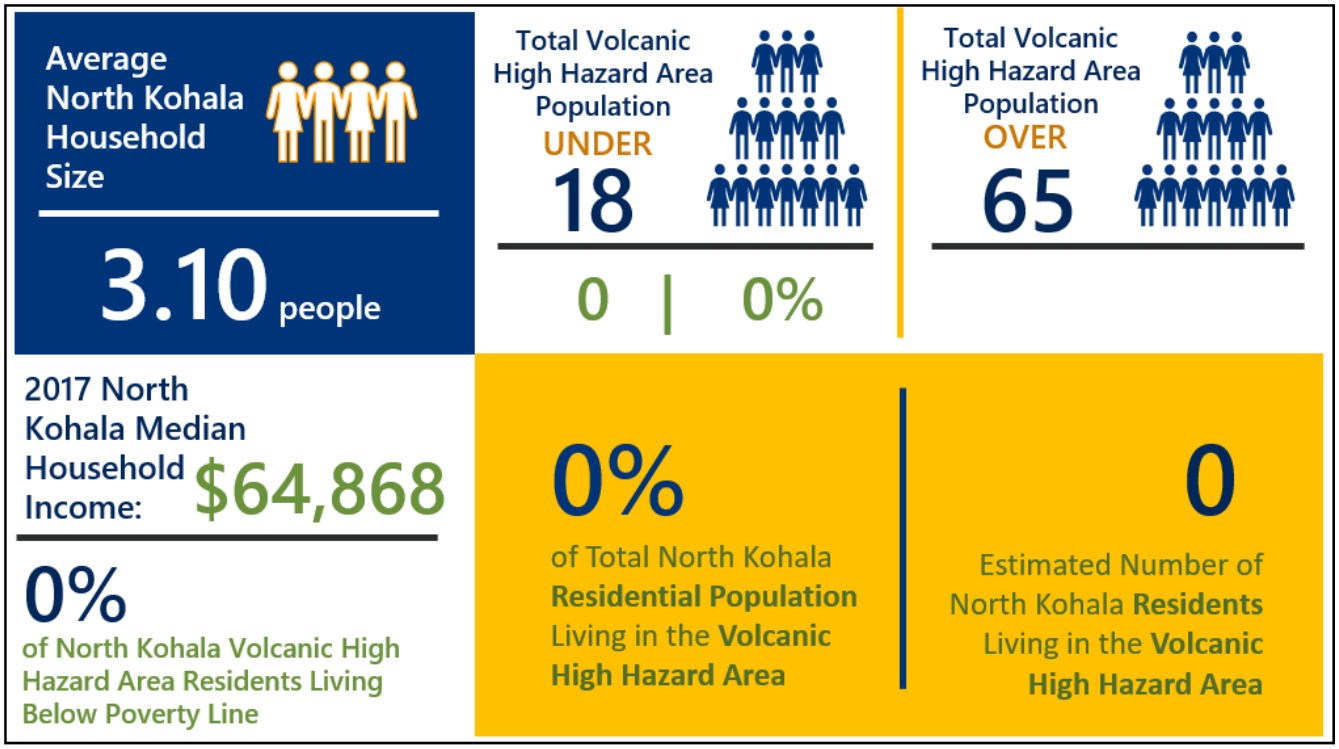


Figure 4-119. Volcanic High Hazard and Additional Natural High Hazard Areas in North Kohala

4.6.3 POPULATION



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

Figure 4-120. North Kohala Population Exposure to the Volcanic High Hazard Areas

As of 2017, North Kohala's total population was 5,845, which represents 3% of the County's total population (ACS 2017). While North Kohala experienced a doubling in population from 1980 to 2000, it appears that the growth increase trajectory has slowed in recent years, remaining close to 6,000 people for the last 10 to 20 years. According to the County of Hawai'i General Plan (update in progress), while North Kohala is sparsely populated it was identified as one of the top Districts in the County for percent of affordable housing. This is most likely due to the prevalence of rural communities. Future North Kohala growth will be influenced by either the agricultural or tourism industry (CHPD 2008).

Related to population growth and North Kohala's economic outlook, the majority of residents work either for the agricultural or tourism sector. This is not surprising, considering North Kohala's significant area of land dedicated to agriculture combined with the District's natural beauty, attracting tourists and visitors.

North Kohala's population is primarily centered around two communities: Hāwī and Kapa'au (see ***Figure 4-120***). There are several luxury resorts located along the northern coast including the Mauna Kea Beach Hotel and Fairmont Orchid. The remaining land contains ranches and agricultural farms.

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.

One hundred percent of North Kohala District residents live in lava zone 9 and therefore, have low exposure to the lava-flow hazard. There is no calculated probability associated with each lava-flow hazard zone. The 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. Therefore, land classified as lava zone 1 is the most hazardous and lava zone 9 is the least hazardous (USGS 2019).

Figure 4-121 summarizes the number of North Kohala residents living in lava zone 9 (the only lava zone that exists in North Kohala).

Figure 4-122 illustrates the population density across North Kohala relative to the Volcanic High Hazard Area. The greatest population densities are centered around Hāwī and Kapa'au. The rest of North Kohala's population is spread throughout the District at a rate of 0 to 75 people per square mile. Note, these resident totals do not reflect the number of undocumented residents, tourists and visitors residing in the District either permanently or temporarily.

There are no residents identified living in the Volcanic High Hazard Area; however, nearly 90% of North Kohala's residents are exposed to another high hazard area (i.e. tsunami, landslide, etc.).

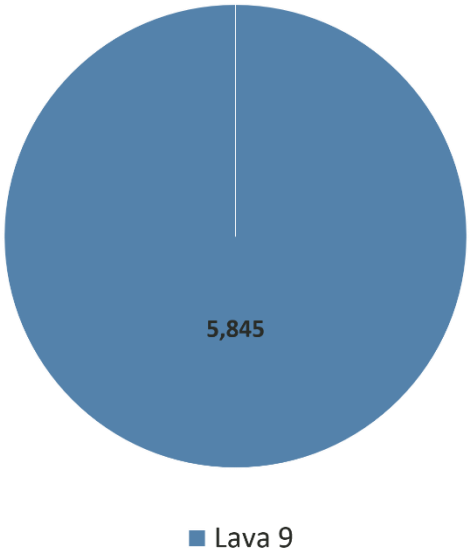


Figure 4-121. Number of Residents in North Kohala's Lava Zone (100%)

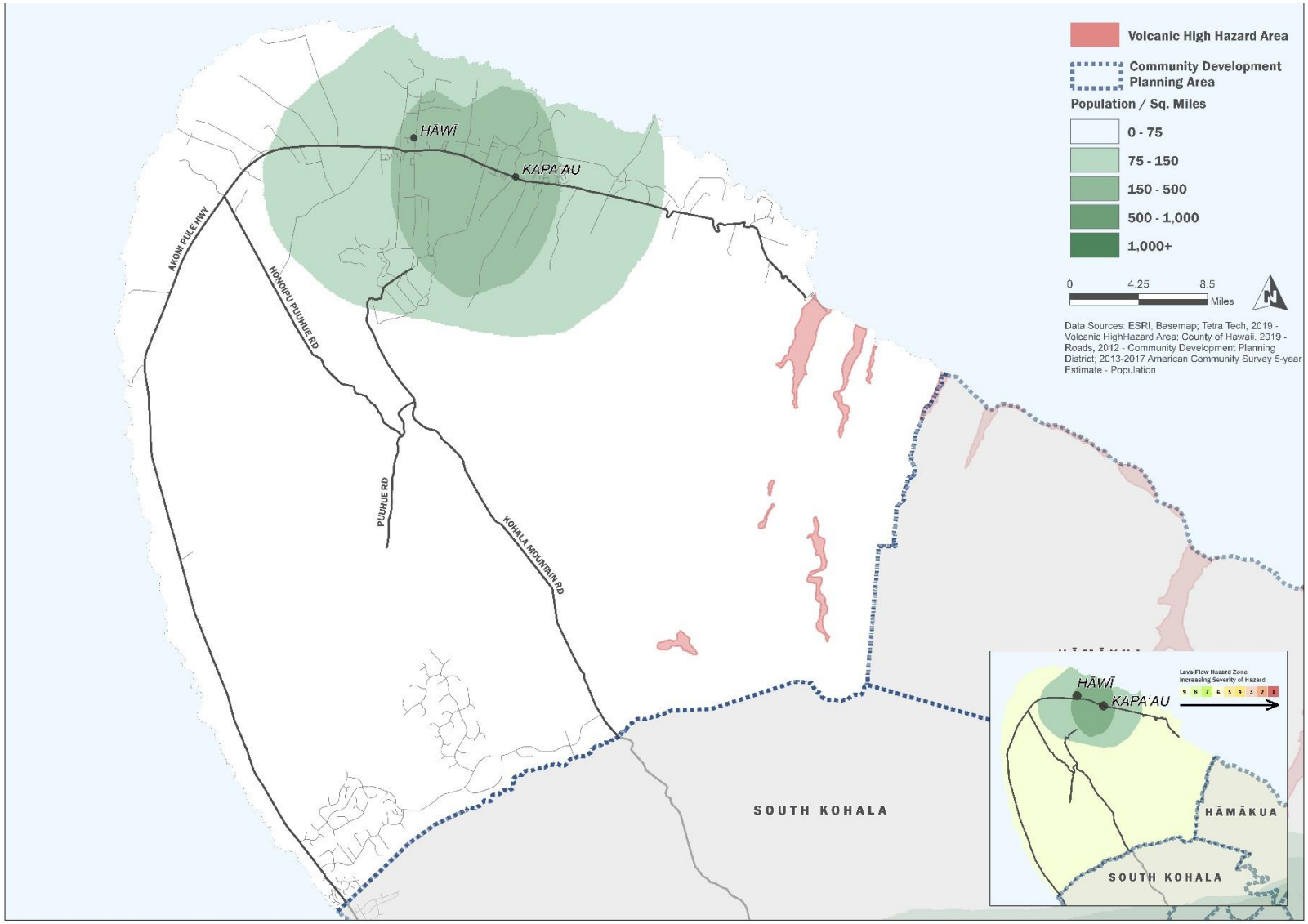


Figure 4-122. North Kohala Population Density Relative to the Volcanic High Hazard Area

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 4-78 summarizes the vulnerable population statistics in North Kohala by number of residents. Over 14.3% of the District's residents live below the poverty line. Two North Kohala villages had higher 2017 median annual income than the County's median annual income ($56,395): $64,868 in Hāwī and $74,200 in Kapa'au (U.S. Census 2017). At the same time, due to North Kohala's rural context, the District has some of the highest percentages of affordable housing stock in the County (CHPD 2019).

Table 4-78. North Kohala Vulnerable Population

North Kohala District: Vulnerable Populations [total residents]	
No Internet	1,439
Under 18	1,296
Over 65	1,271
Disability	1,094
Single Parent	899
Below Poverty Line	836
SNAP	686
Non-English Speaking	346
No Health Insurance	312
No Diploma	290
Unemployed	214
No Vehicle	207
No Phone	75

In terms of total number of residents, those residents with no internet, under 18, and over 65 represent the top three vulnerable population categories within the North Kohala District. The County should 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.

In summary, none (0%) of North Kohala residents live in the Volcanic High Hazard Area:

- 0 people under 18 years of age
- 0 people over 65 years of age
- 0 single parents
- 0 people living with a disability
- 0 people with no internet access
- 0 people with no vehicle access
- 0 people with no phone access
- 0 people who are unemployed
- 0 people utilizing SNAP (Supplemental Nutrition Assistance Program)
- 0 people living below the poverty line

Table 4-79 through ***Table 4-82*** summarize the exposure of vulnerable residents in North Kohala by socioeconomic factor to the volcanic hazard, as well as where the volcanic hazard area overlaps with another natural high hazard area.

Table 4-79. North 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)	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%
VHHA with Additional Natural High Hazard Area	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%
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 4-80. North 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)	0 / 0%	0 / 0%
VHHA with Additional Natural High Hazard Area	0 / 0%	0 / 0%
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 4-81. North 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)	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%

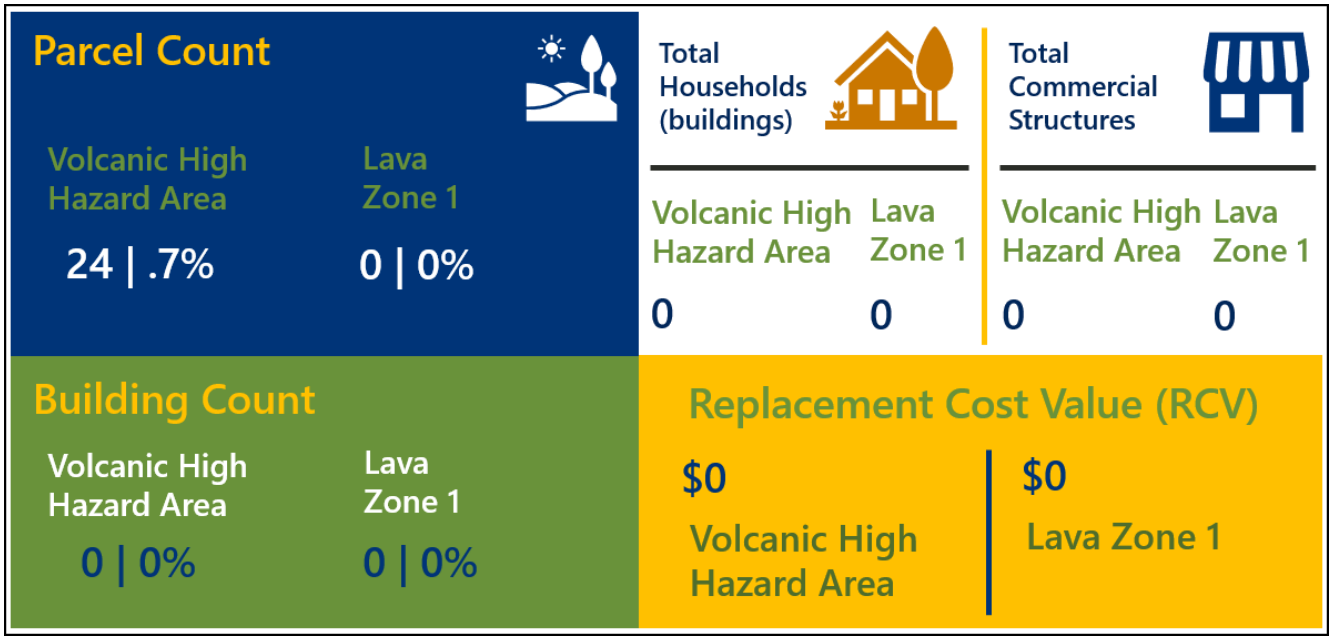
Note: Total residents in each hazard area were calculated separately as distinct and separate; therefore, individual hazard area totals do not equate to the VHHA total.

Table 4-82. North 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)	0 / 0%	0 / 0%	0 / 0%
VHHA with Additional Natural High Hazard Area	0 / 0%	0 / 0%	0 / 0%
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.

4.6.4 PARCELS AND BUILDINGS



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

Figure 4-123. North Kohala Parcels and Buildings Located in a Volcanic High Hazard Area (VHHA)

here are no identified buildings in North Kohala located in the Volcanic High Hazard Area. A total of 24 undeveloped parcels are in the Volcanic High Hazard Area exclusively located on NEHRP D and E soils. ***Figure 4-124*** illustrates the parcel areas located in the Volcanic High Hazard area.

For the purposes of this analysis, the total assessed value (land and building) located in the Volcanic High Hazard Area 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 $2,546,100 which represents 0.2% of the North Kohala District's total assessed values (land and structure) (see ***Table 4-83***).

Table 4-83. North 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)	24 / 0.7%	$2,546,100	0 / 0%	$0	0 / 0%	0 / 0%
VHHA with Additional Natural High Hazard Area	24 / 100%	$2,546,100	0 / 0%	$0	0 / 0%	0 / 0%
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%

Notes: 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 didn't 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 North Kohala's structures built prior to 1985 (both residential and commercial) is illustrated on Figure 4-125. All structures constructed prior to 1985 are located outside of the NEHRP D and E soils area.

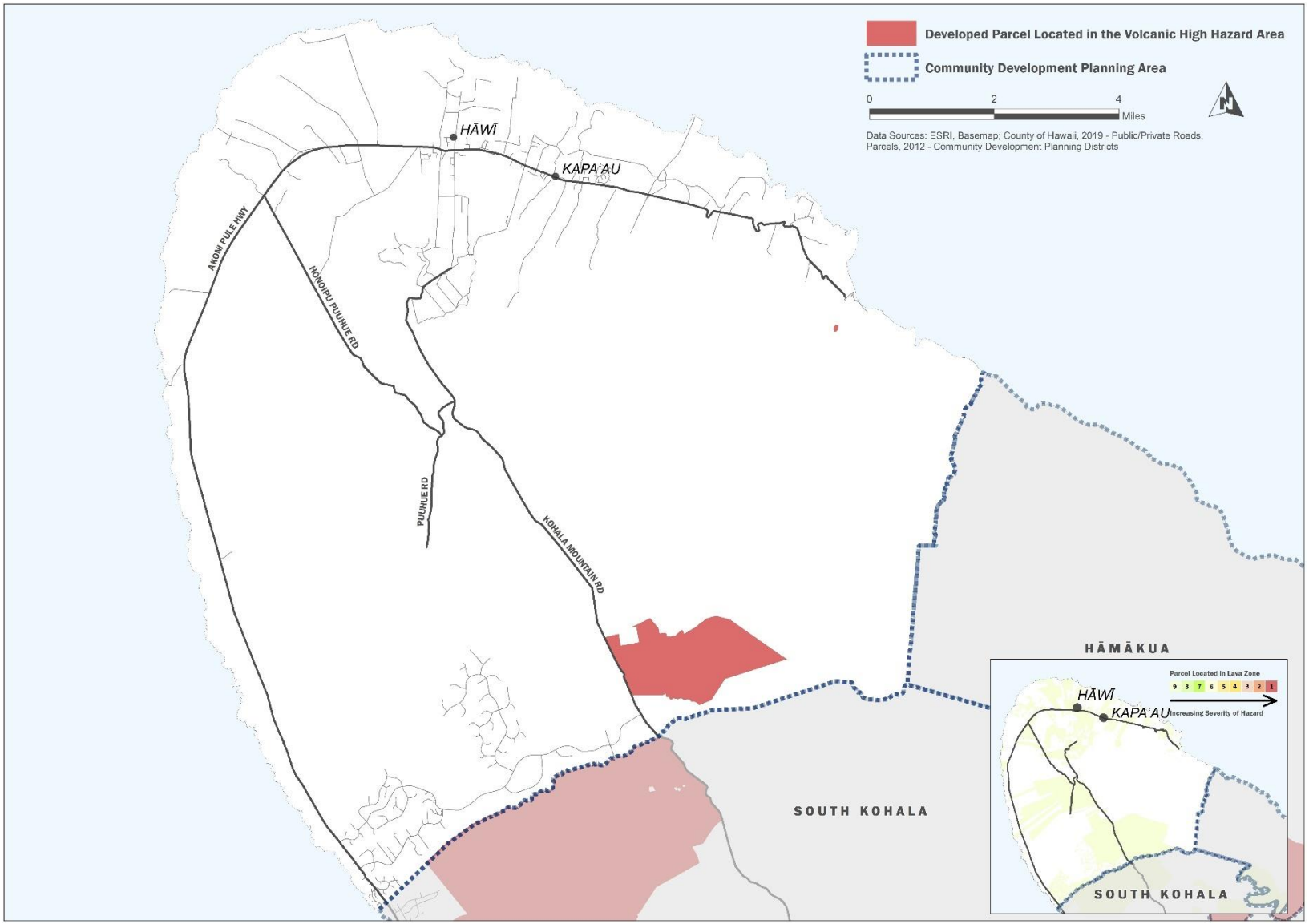


Figure 4-124. Developed Parcels in North Kohala by Volcanic High Hazard Area and Lava Zone

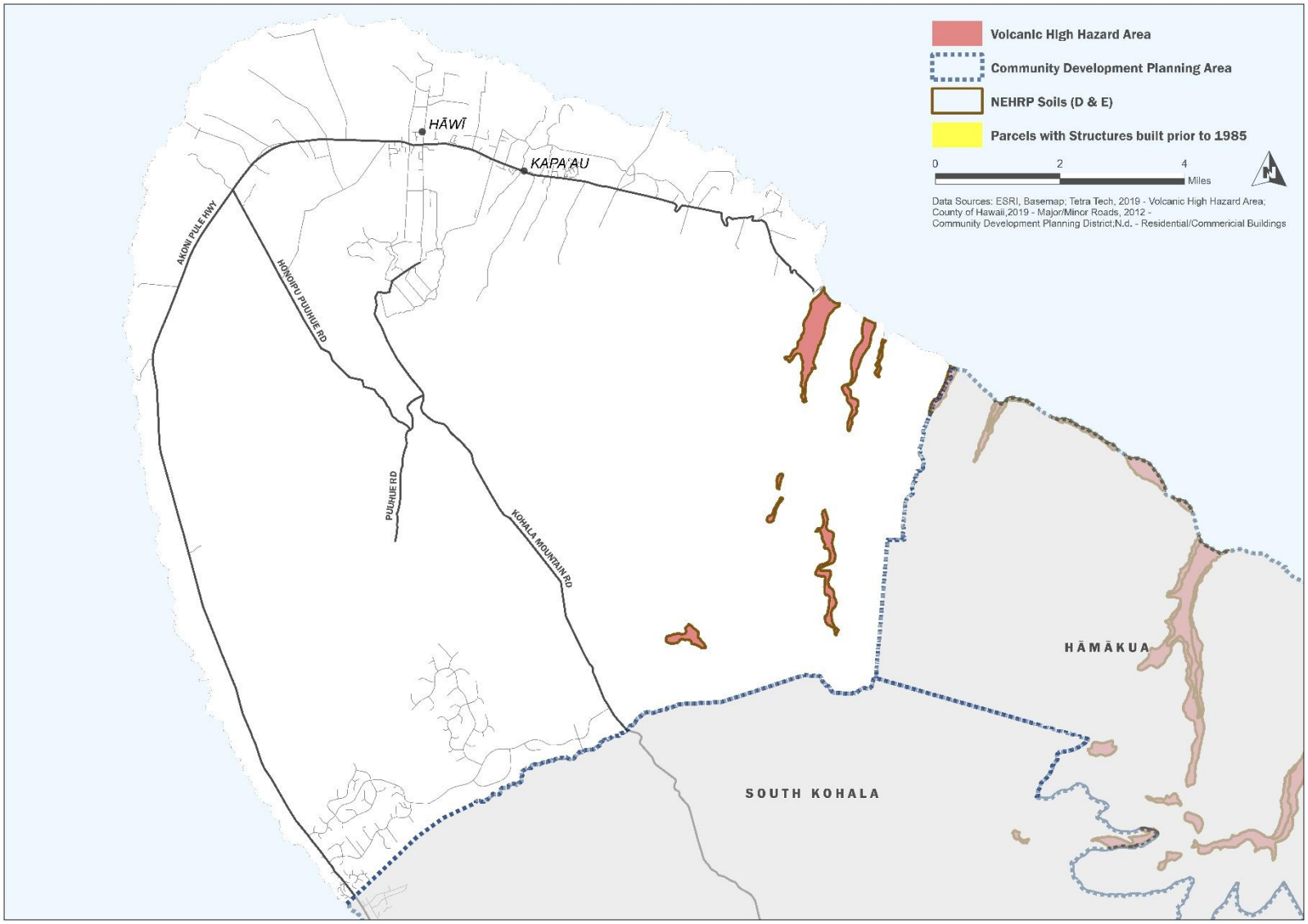
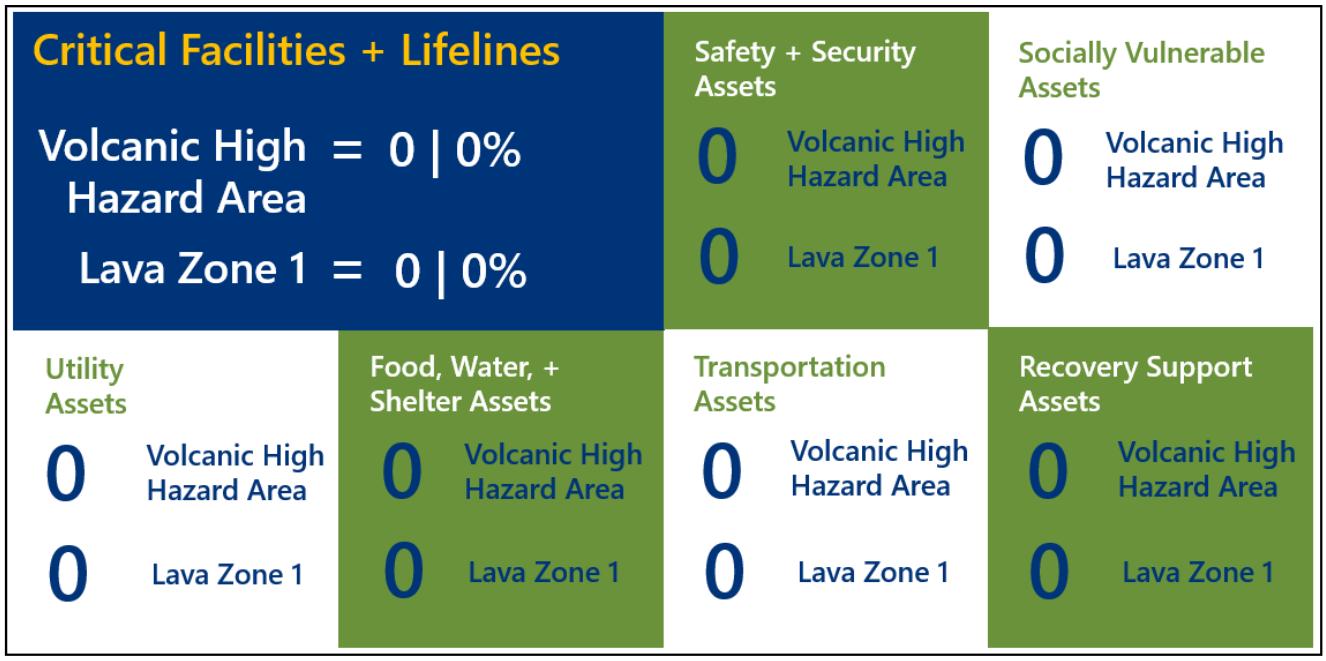


Figure 4-125. North Kohala Parcels with Structures Constructed Pre-1985 in the Volcanic High Hazard Area

4.6.5 CRITICAL FACILITIES AND LIFELINES



Note: All percentages are relative to the North Kohala District

Figure 4-126. North Kohala Critical Facilities and Lifelines Located in the Volcanic High Hazard Area and Lava Zone 1

Through the development of the volcanic risk assessment, 30 critical facilities and lifelines were identified in North Kohala. The critical facility and lifeline categories align with the 2015 County Hazard Mitigation Plan asset categories.

Table 4-84 summarizes the exposure of these critical facilities to volcanic hazards. Overall, none (0%) of North Kohala's critical facilities are located in the Volcanic High Hazard Area (***see Figure 4-127***). One hundred percent of North Kohala's 30 critical facilities and lifelines are located in lava zone 9. Of those, over 80% are also located in another high hazard area. Similarly, there are no roads that intersect the Volcanic High Hazard Area but may be prone to other natural hazard impacts.

Similar to the discussion on structures constructed pre-1985, there are a number of critical facilities in North Kohala constructed prior to 1985 and therefore more vulnerable to earthquake damage (during a volcanic eruption or occurring separately). Based on year-built data, 83.3% of North Kohala's critical facilities and lifelines were constructed prior to 1985 (the second highest percentage in the County). 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 4-84. North 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)	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%
VHHA with Additional Natural High Hazard Area	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%	0 / 0%
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.

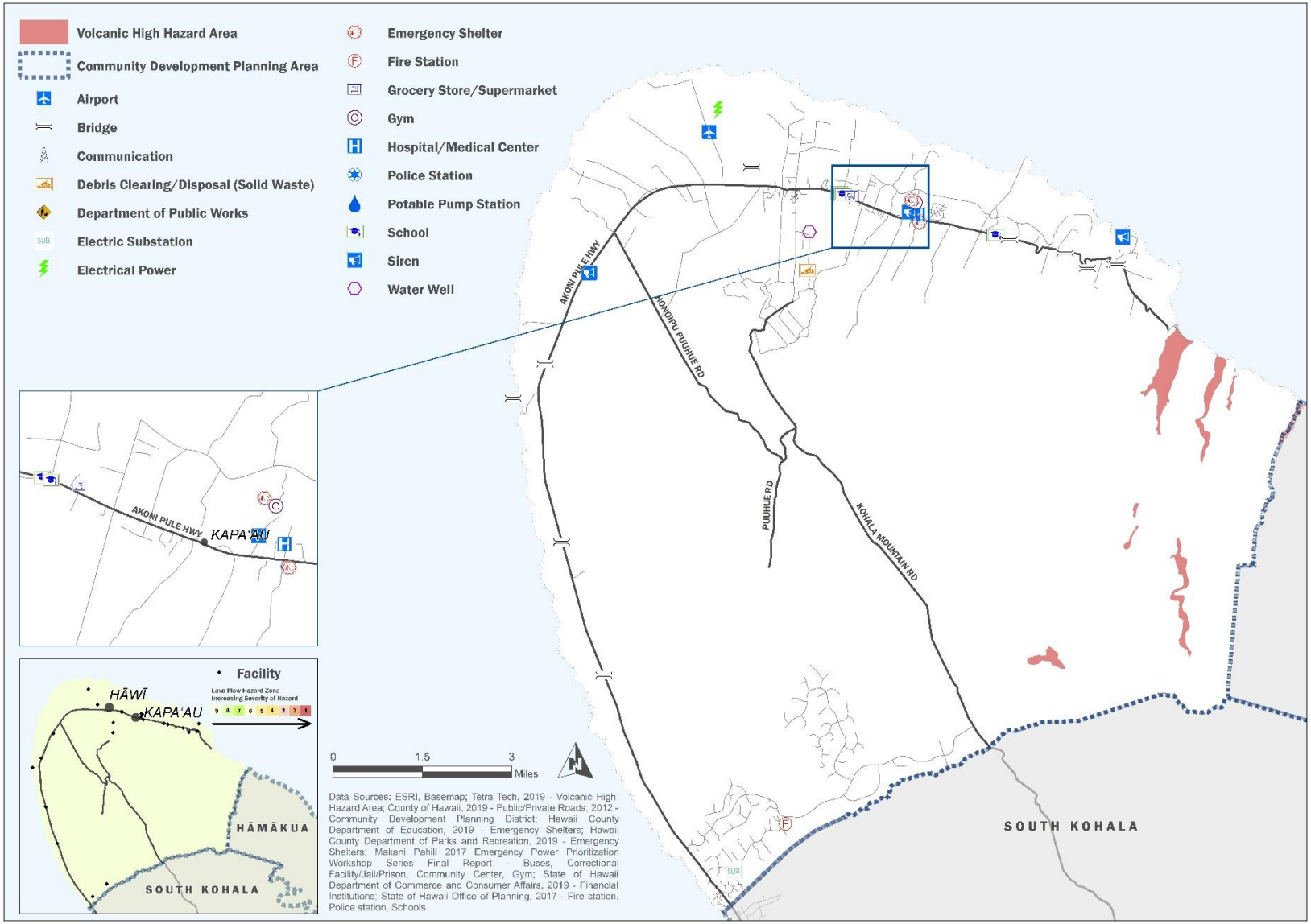
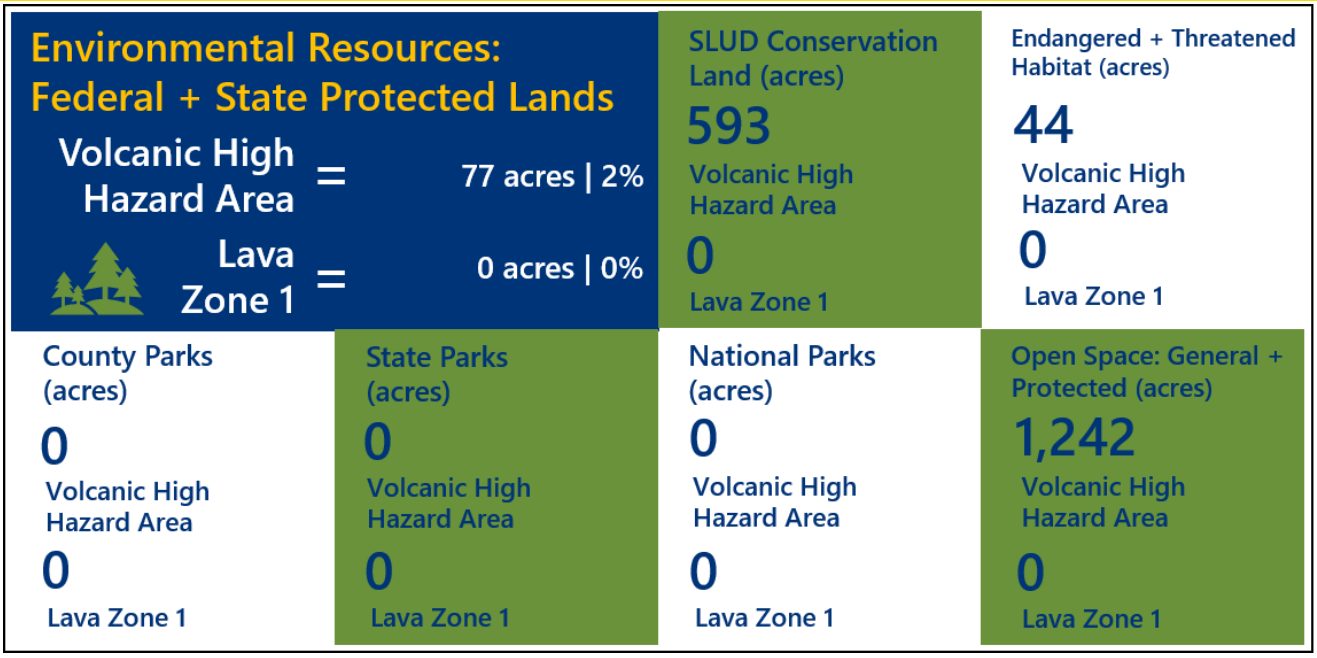


Figure 4-127. North Kohala Critical Facilities Located in the Volcanic High Hazard Area and Lava Zones

4.6.6 ENVIRONMENT



Note: All percentages are relative to the North Kohala District

Figure 4-128. North Kohala Environmental Resources Located in the Volcanic High Hazard Area and Lava Zone 1

Well over half of land in North Kohala (69.7%) is undeveloped, meaning according to the County assessor there are zero (0) structures on the parcel. As previously discussed, the majority of North Kohala's population is centered around the two primary towns in the District: Hāwī and Kapa'au. Outside of these communities, North Kohala maintains a distinct rural context complete with majority agricultural and conservation land. Some of North Kohala's undeveloped land contains the following environmental resources: protected land under federal or state management (77 acres), endangered or threatened areas (3,342 acres), and agricultural land of importance (43,101 acres). Nearly 10% of North Kohala's wetland area is located in the Volcanic High Hazard Area. Agriculture in North Kohala includes majority macadamia nuts, dairy, tropical fruits, flowers/foliage, and diversified crops (***see Figure 4-130*** and ***Figure 4-129***).

Environmental assets identified as part of the County of Hawai'i General Plan update (in progress) were used for this risk assessment (see ***Table 4-85***). ***Figure 4-128*** and ***Figure 4-131*** illustrate the environmental resources in North Kohala relative to the Volcanic High Hazard Areas.

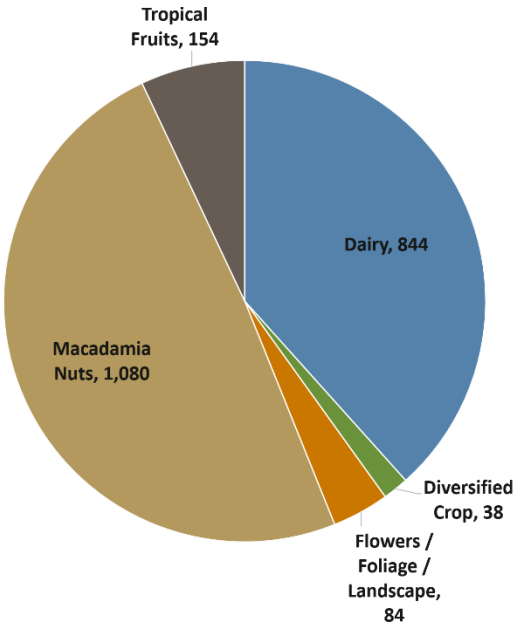


Figure 4-129. North Kohala Crop Land (Acres)