Pulelehua

Preliminary Drainage Report

November 2017

Prepared by:

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Introduction

Pulelehua is a multi-family development consisting of work force and market-rate housing in Lahaina, Hawaii. The site consists of approximately 304.3 acres and is located at the intersection of Honoapiilani Highway and Akahele Street.

At full build-out the development is planned to construct approximately 900 affordable and market-rate, multi-family residential units (roughly 90 buildings with 10 units each), 150 single-family units, 150 ohanas, a 10-acre community park, 2 retail centers totaling 70,000 square feet, and open space of varying levels of use. A future school site is also planned for the site, situated on approximately 13 acres.

The purpose of this Preliminary Drainage Study is to describe the existing drainage patterns affecting development of the Pulelehua project and present the general methodology that will be used to ultimately size and design future onsite drainage improvements. A final drainage study will accompany the improvement plans for each phase of development. These final drainage studies will provide detailed analysis of the proposed site improvements and the drainage improvements included within each phase. All onsite improvements will be designed in accordance with the County's storm drainage design regulations as presented in, *Rules for the Design of Storm Drainage Facilities in the County of Maui*, Title MC-15, Chapter 4, November 12, 1995.

Site Description

Pulelehua consists of approximately 304.3 acres and is located at the intersection of Honoapiilani Highway and Akahele Street. The project is identified as T.M.K.:(2) 4-3-01:82 and T.M.K.:(2) 4-3-01:83. The property was previously owned and operated by Maui Land and Pineapple (MLP) as a pineapple plantation, but is currently undeveloped and covered with dense, chest-high grass and clusters of large bushes. A Final Environmental Impact Statement was prepared by MLP for Pulelehua in August 2005. The site plan as proposed at that time has been revised (see Exhibit 3) to provide a less dense development than was originally contemplated. However, the project elements have remained the same.

The irregular-shaped site is bordered by the Honoapi'ilani Highway to the west, with existing residential neighborhoods and resort condominiums beyond; existing residential subdivisions to the north and west (Kahana Hui and Kahana Ridge); Kahanaiki Gulch traverses the northern boundary and joins the Kahana Stream before it crosses under the Highway; the Kapalua West Maui Airport extends along the east side of the site; and former pineapple fields are located to the south (see Exhibits 1 and 2). Pokaku-Ka'anapali Gulch and Mahinahina Gulch, running east to west through the site, divide the project into three distinct areas. Akahele Street intersects the property in a west-to-east direction, providing access to the airport from Honoapi'ilani Highway and will continue to function as the main entrance into the project site.

Elevations at the site range from 80 feet above mean sea level at the southwest corner of the site to approximately 260 feet above mean sea level at the airport. The average slope across the site is approximately 8%.

Pre-Development Conditions

Existing runoff generally flows from east to west and is diverted by onsite swales and berms to each of the gulches which pass through the site. The airport runway improvements divert a significant portion of off-site flows mauka of the airport to the north and south and into the gulches. There are two 144-inch culverts where Honoapi'ilani Highway crosses Mahinahina Gulch. These were designed to accommodate a 100-year flow of 4,275 cfs. A 120-inch culvert diverts runoff from Pohaku-Ka'anapali Gulch under Honoapi'ilani Highway with a 100-year design flow of 674 cfs. And a bridge along Honoapi'ilani Highway crosses the 100-year discharge flow of 7,540 cfs from the Kahanaiki Stream and Kahana Stream. Once under the Highway, runoff from all three drainage ways is conveyed to the ocean.

As part of the Kahana Ridge Subdivision, a drainage system consisting of culverts and open channels was constructed along the eastern boundary of the subdivision. The northerly 80% of the drainage system conveys the intercepted runoff into Kahanaiki Gulch. The remaining 20% is conveyed into the subdivisions' drainage system.

According to Panel No. 1500030263F, 1500030264F and 1500030351F of the Flood Insurance Rate Maps, dated September 19, 2012, the Project is situated in Flood Zones X and A (see Exhibit 4). Flood Zone A is designated as special flood hazard areas subject to inundation by the 1% annual flood (100-year flood), also known as the base flood. It is the flood that has a 1% chance of being equaled or exceeded in any given year. No base flood elevations have been determined for this zone. Flood Zone X is designated as areas outside the 0.2% annual chance flood plain.

Kahanaiki Gulch, boarding the north edge of the property, contains a portion of special flood hazard Zone AE. This gulch has been studied and 100-year base flood elevations have been determined. The Pokaku-Ka'anapali and Mahinahina Gulches do not have regulatory floodplain designations.

Based on the County of Maui's storm drain design criteria, the existing runoff from the site for the 50-year, pre-developed storm event was determined using the Rational Method. These results are presented below for reference. Refer to the Pre-Development Drainage Map for the location and size of pre-development drainage areas.

50-Year Pre-Development Storm Event Runoff Calculations

Basin	C	L (ft)	Tc (min)	I* (in/hr)	A (acre)	Q_{50} (cfs)
A	0.32	3,629	30	3.8	67.32	81.9
B	0.32	2,636	22	4.1	80.11	105.1
C	0.32	2,370	20	4.4	16.26	22.9
D	0.32	2,580	22	4.1	27	35.4
E	0.32	4,308	36	3.4	157.05	170.9

All hydrologic calculations are based on the *Drainage Master Plan for the County of Maui*, and the *Rainfall Frequency Atlas of the Hawaiian Islands*, Technical Paper No. 43, U.S. Department of Commerce, Weather Bureau.

Rational Formula Used: $Q=CIA$

Where
- Q = rate of flow (cfs)
- C = rainfall coeffiecient
- I = rainfall intensity for a duration equal to the time of concentration (inches/hour)
- A = drainage area (acres)

As previously described in the approved Final Environmental Impact Study, development of the Pulelehua project is not expected to have a significant adverse effect on downstream properties or coastal marine waters. The post development runoff from the Pulelehua site is estimated to be 851 cfs, an increase of 451 cfs over existing conditions. However, additional runoff due to development of the community will be detained onsite in a series of detention basins, with no increased flow to downstream properties (including Honoapi'ilani Highway and the Kahana Hui and Kahana Ridge subdivisions), or into the existing drainage ways, desilting basins, or the ocean.

Post-Development Conditions

The Project will be developed in multiple phases. Residential units, parking fields and access roadways will be terraced into the hillside as illustrated on the attached Preliminary Site Plan (see Exhibit 3). The school site will be developed by others.

Offsite flows will be allowed to flow to the gulches as they have historically done. Where offsite flows affect onsite development, they will be directed around residential units using swales. The swales will convey offsite runoff north and south to the gulches following historic drainage patterns.

In total, it is estimated that the post-development runoff from the Pulelehua development will be 851 cfs, an increase of 491 cfs over existing conditions for a 50-year storm event.

Pre-development site flow = CIA = (0.32)(3.7)(304.3 acres) = 360 cfs

Post-development site flow = (0.65)(4.3)(304.3 acres) = 851 cfs

Onsite runoff will be collected in the landscaping areas and streets and conveyed to detention basins located throughout the development via a combination of surface flow and storm drain improvements. The anticipated detention basin locations are illustrated on the accompanying Preliminary Detention Basin Location Exhibit (see Exhibit 5). The detention basins will provide sufficient volume to ensure post-development flows do not exceed pre-developed flows as required by Maui County. Onsite storm drains will be sized to convey the 10-year storm event. 100-year flows will be conveyed in the streets and storm drains to onsite detention basins in accordance with County standards. All finished floor elevations will be established to ensure they are free from inundation during the 100-year storm event.

Detailed drainage studies will be prepared to accompany the improvement plans for each phase of development. These studies will include storm drain inlet and pipe sizing calculations, detention basin sizing and draw-down calculations and the design of onsite storm drain related features.

Detention and Water Quality Calculations

Onsite detention basins will be located throughout the site to collect and treat onsite stormwater runoff as required by the County of Maui. The detention basin volumes will be determined using the Modified Rational Method for the 50-year storm event. Each basin will be sized to detain runoff from its contributing watershed, reduce post-development flows to pre-development levels and provide water quality treatment prior to releasing water into the gulches.

Generally basins will be designed to a depth of 3-5 ft with 1 ft of freeboard and 4:1 side slopes. In some locations basins may be terraced and interconnected by storm drain pipes to achieve the necessary volumes due to grading limitations caused by topography. Sufficient volume will be provided in each basin to reduce the post-development flows to pre-development levels. Conceptual detention basin locations are presented in the Preliminary Detention Basin Location Exhibit (see Exhibit 5).

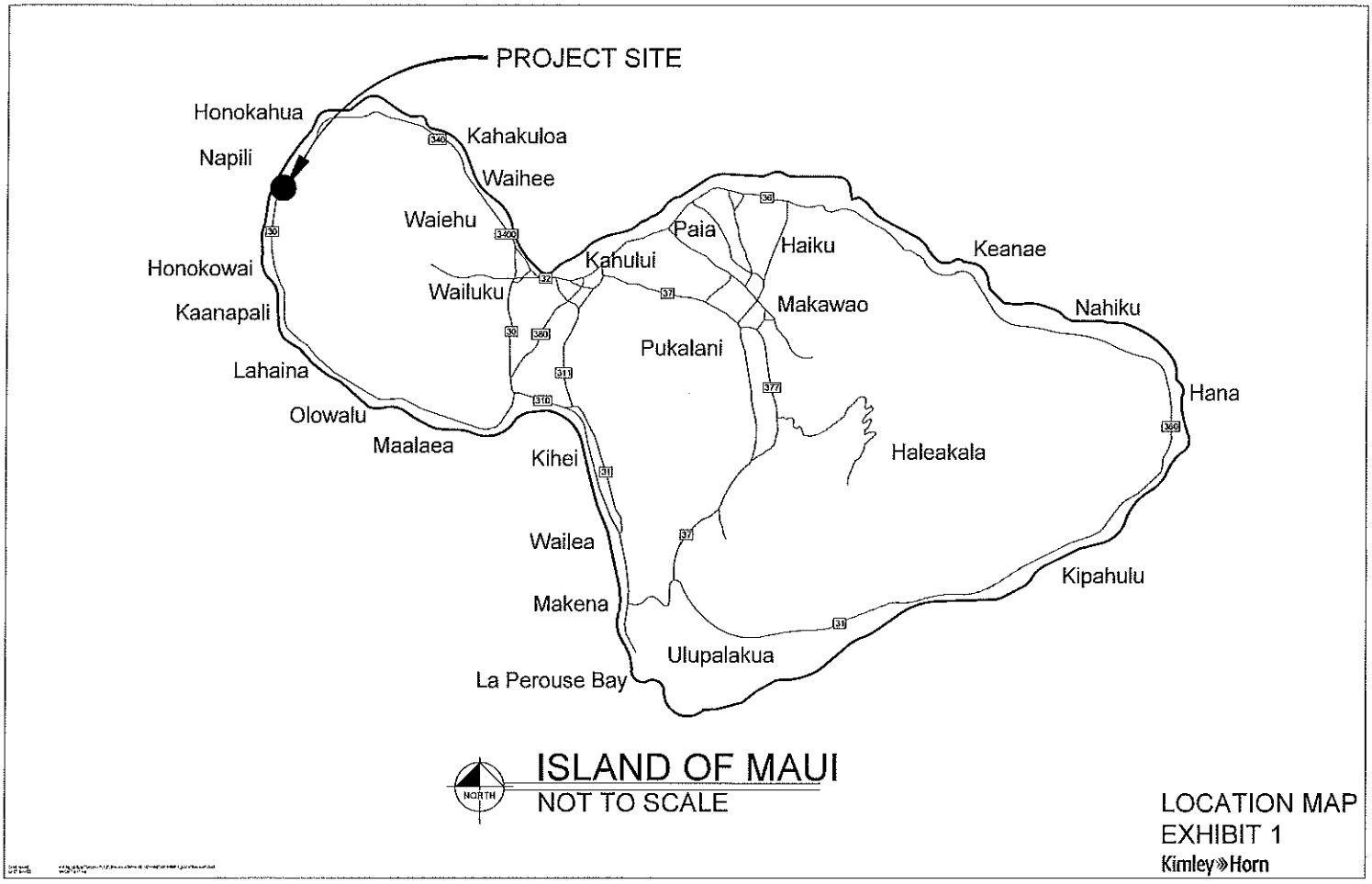
Each basin will utilize an outfall structure to regulate discharge from the basin to the adjacent gulch which will consist of the following:

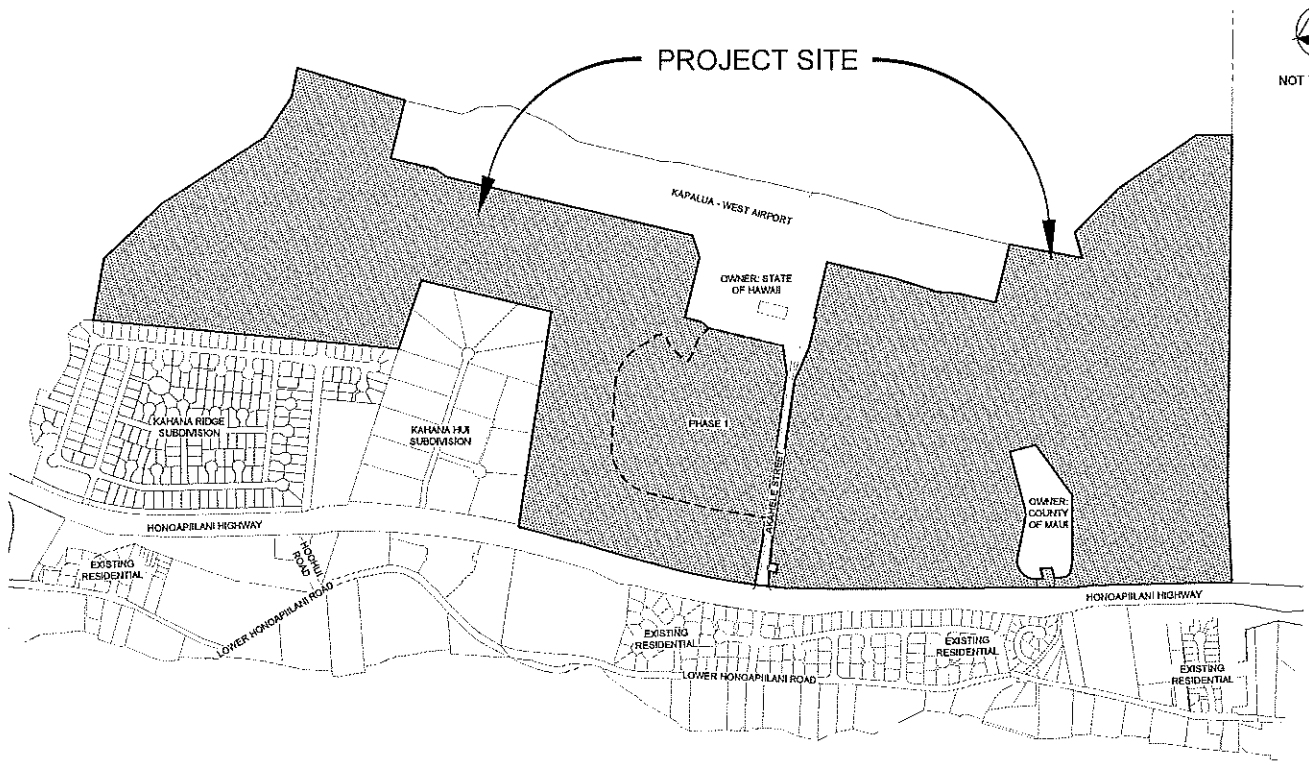
- Junction box with two cut-out openings.
    - Bottom opening: small circular opening set at the bottom of the pond. This opening is intended to promote extended release to meet the water quality requirement.
    - Top opening: rectangular opening set at the water quality water surface elevation. This opening is sized to reduce peak flow rates to pre-development rates for the 50-year storm event.
- Outfall pipe to convey the detention pond release rates to the gulch.

No additional runoff will be released into the existing drainageways or onto Honoapi'ilani Highway. The net result of the proposed drainage improvements will be no increase in runoff from the project site to the downstream properties.

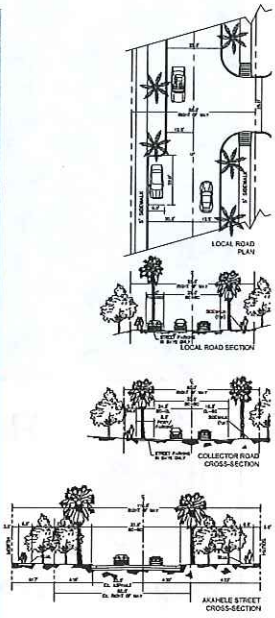
Exhibits

1. Location Map
2. Vicinity Map
3. Preliminary Site Plan Exhibit
4. FEMA FIRM maps
5. Preliminary Detention Basin Location Exhibit
6. Preliminary Hydrologic Calculations
7. Pre-Development Drainage Area Map


PROJECT SITE
Honokahua
Napili
Kahakuloa
Waihee
Waiehu
Honokowai
Kaanapali
Wailuku
Kahului
Paia
Haiku
Keanae
Nahiku
Makawao
Pukalani
Lahaina
Olowalu
Maalaea
Kihei
Haleakala
Hana
Wailea
Kipahulu
Makena
Ulupalakua
La Perouse Bay
NORTH
ISLAND OF MAUI
NOT TO SCALE
LOCATION MAP
EXHIBIT 1
Kimley»Horn



VICINITY MAP
EXHIBIT 2
Kimley»Horn



CONCEPTUAL PLAN

Pulelehua

Mahinahina & Kahana, Lahaina
Island of Maui, Hawai'i

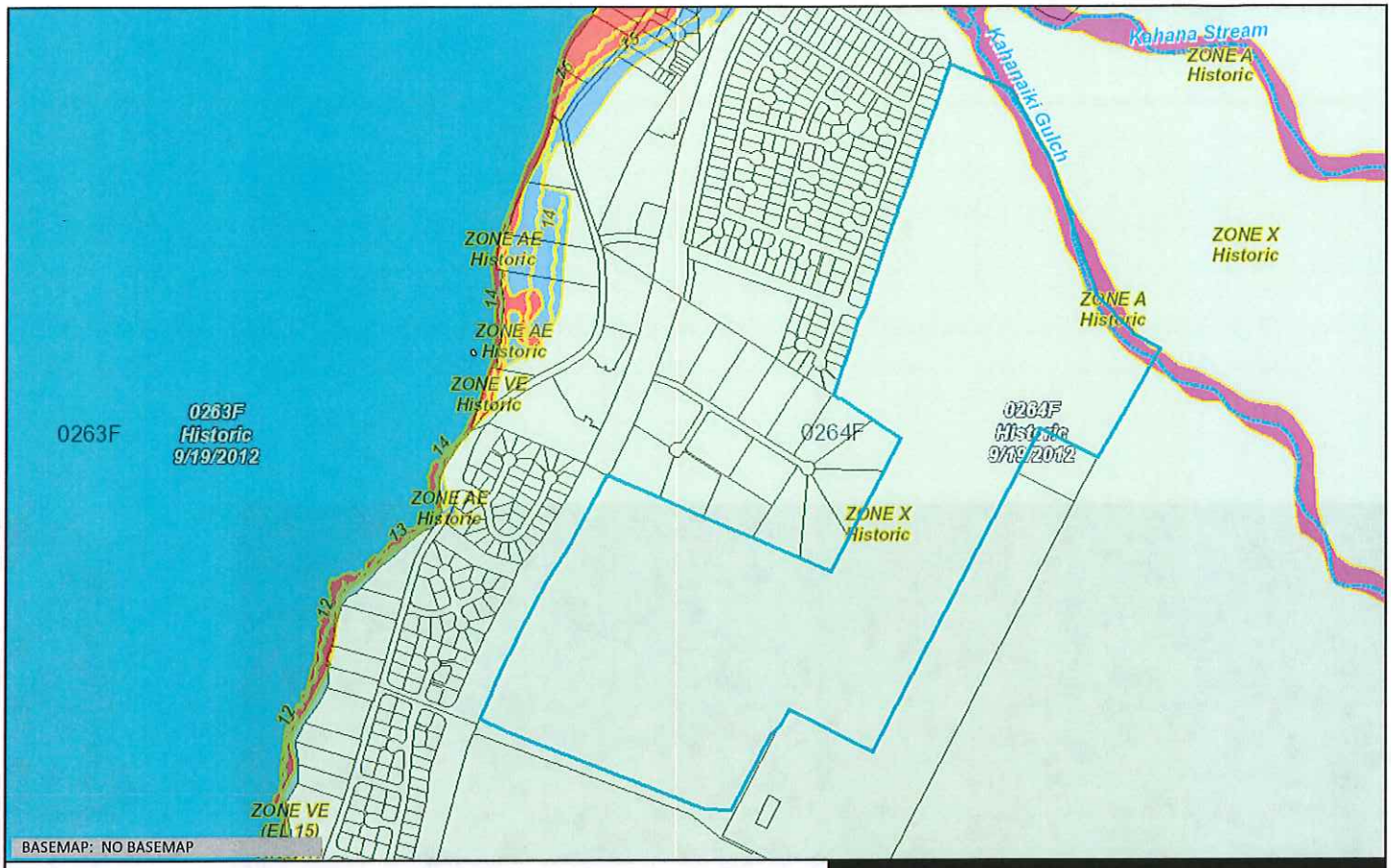
INFRASTRUCTURE INVESTMENTS (USA)

PRITCHARD PWS Architects, Inc.

Kimley»Horn

T.H. PRITCHETT / Associates
Landscape Architects

EXHIBIT 3



Flood Hazard Assessment Report

www.hawaiinfip.org

Property Information

COUNTY:	MAUI
TMK NO:	(2) 4-3-001:083
WATERSHED:	HONOKOWAI; KAHANA
PARCEL ADDRESS:	0 HONOAPIILANI HWY LAHAINA, HI 96761

Notes:

Flood Hazard Information

FIRM INDEX DATE:	NOVEMBER 04, 2015
LETTER OF MAP CHANGE(S):	NONE
FEMA FIRM PANEL - EFFECTIVE DATE:	1500030263F - SEPTEMBER 19, 2012 1500030264F - SEPTEMBER 19, 2012

THIS PROPERTY IS WITHIN A TSUNAMI EVACUTION ZONE: NO
FOR MORE INFO, VISIT: http://www.scd.hawaii.gov/

THIS PROPERTY IS WITHIN A DAM EVACUATION ZONE: YES (MA-0132; MA-0142; MA-0143)
FOR MORE INFO, VISIT: http://dlnreng.hawaii.gov/dam/

0 600 1,200 ft

Disclaimer: The Hawaii Department of Land and Natural Resources (DLNR) assumes no responsibility arising from the use, accuracy, completeness, and timeliness of any information contained in this report. Viewers/Users are responsible for verifying the accuracy of the information and agree to indemnify the DLNR, its officers, and employees from any liability which may arise from its use of its data or information.

If this map has been identified as 'PRELIMINARY', please note that it is being provided for informational purposes and is not to be used for flood insurance rating. Contact your county floodplain manager for flood zone determinations to be used for compliance with local floodplain management regulations.

FLOOD HAZARD ASSESSMENT TOOL LAYER LEGEND
(Note: legend does not correspond with NFHL)

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD - The 1% annual chance flood (100-year), also know as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. SFHAs include Zone A, AE, AH, AO, V, and VE. The Base Flood Elevation (BFE) is the water surface elevation of the 1% annual chance flood. Mandatory flood insurance purchase applies in these zones:

	Zone A: No BFE determined.
	Zone AE: BFE determined.
	Zone AH: Flood depths of 1 to 3 feet (usually areas of ponding); BFE determined.
	Zone AO: Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined.
	Zone V: Coastal flood zone with velocity hazard (wave action); no BFE determined.
	Zone VE: Coastal flood zone with velocity hazard (wave action); BFE determined.
	Zone AEF: Floodway areas in Zone AE. The floodway is the channel of stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without increasing the BFE.

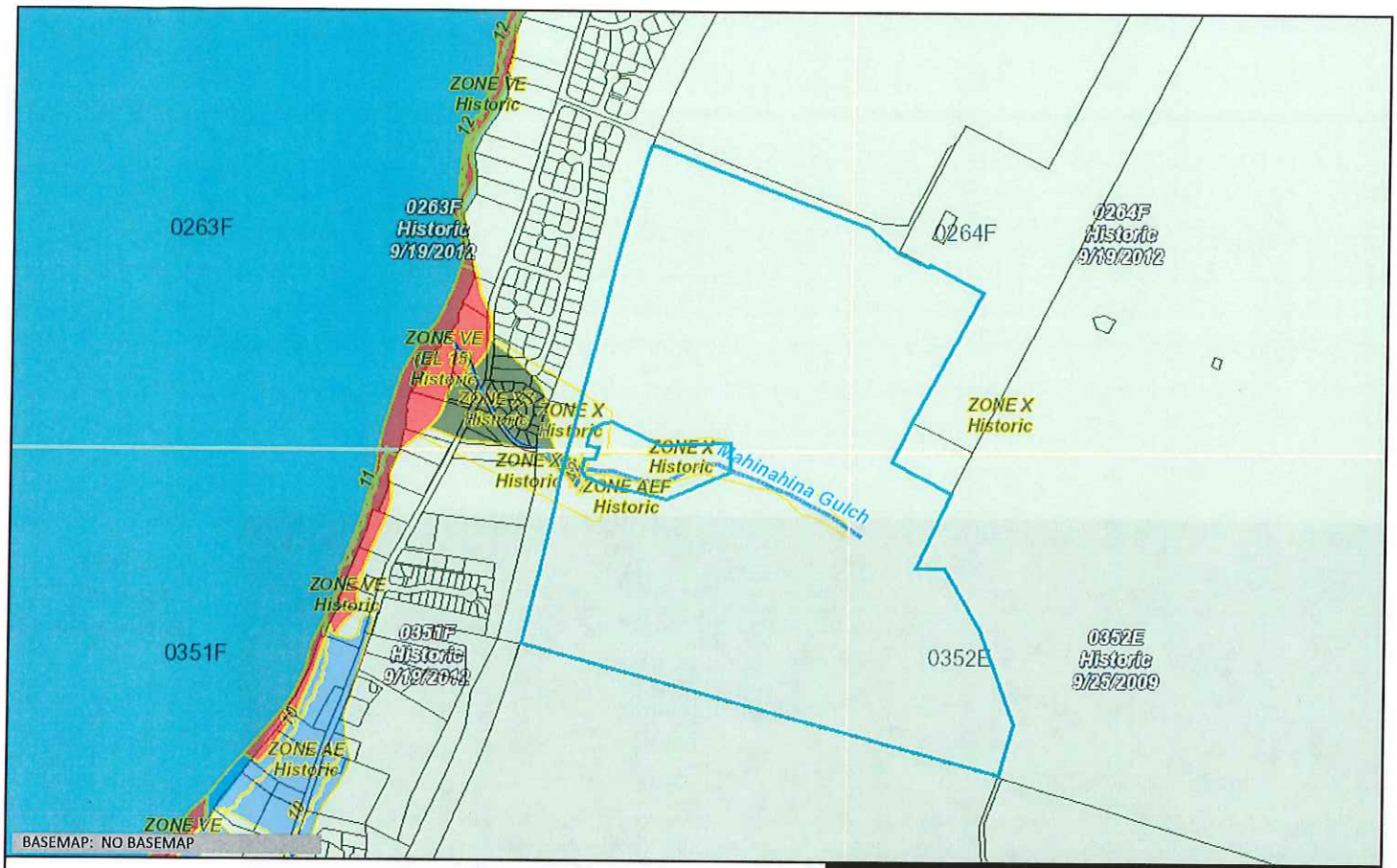
NON-SPECIAL FLOOD HAZARD AREA - An area in a low-to-moderate risk flood zone. No mandatory flood insurance purchase requirements apply, but coverage is available in participating communities.

	Zone XS (X shaded): Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.
	Zone X: Areas determined to be outside the 0.2% annual chance floodplain.

OTHER FLOOD AREAS

	Zone D: Unstudied areas where flood hazards are undetermined, but flooding is possible. No mandatory flood insurance purchase apply, but coverage is available in participating communities.

EXHIBIT 4



Flood Hazard Assessment Report

www.hawaiinfip.org

Property Information

COUNTY:	MAUI
TMK NO:	(2) 4-3-001:082
WATERSHED:	HONOKOWAI
PARCEL ADDRESS:	0 HONOAPIILANI HWY

Notes:

Flood Hazard Information

FIRM INDEX DATE:	NOVEMBER 04, 2015
LETTER OF MAP CHANGE(S):	NONE
FEMA FIRM PANEL - EFFECTIVE DATE:	1500030263F - SEPTEMBER 19, 2012 1500030264F - SEPTEMBER 19, 2012 1500030351F - SEPTEMBER 19, 2012 1500030352E - SEPTEMBER 25, 2009

THIS PROPERTY IS WITHIN A TSUNAMI EVACUTION ZONE: NO
FOR MORE INFO, VISIT: http://www.scd.hawaii.gov/

THIS PROPERTY IS WITHIN A DAM EVACUATION ZONE: YES (MA-0142; MA-0143; MA-0144)
FOR MORE INFO, VISIT: http://dlnreng.hawaii.gov/dam/

0 600 1,200 ft

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- **Zone A:** No BFE determined.
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- **Zone XS (X shaded):** Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.
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OTHER FLOOD AREAS

- **Zone D:** Unstudied areas where flood hazards are undetermined, but flooding is possible. No mandatory flood insurance purchase apply, but coverage is available in participating communities.

EXHIBIT 4

LEGEND

PROPOSED DETENTION BASIN LOCATION

PROPOSED DETENTION BASIN LOCATION EXHIBIT

Pulelehua

Mahinahina & Kahana, Lahaina
Island of Maui, Hawai'i

Kimley»Horn

EXHIBIT 5

Hydrologic Calculations
Exhibit 6

Purpose: Determine the increase in onsite surface runoff from the development of the proposed project based on a 50-year storm.

A. Determine Runoff Coefficient (C) (Table 1):

Existing Conditions:

Infiltration (medium)		= 0.14
Relief (rolling)		= 0.03
Vegetal Cover (high)		= 0.00
Development Type (open)		= 0.15
	C	= 0.32

Developed Conditions:

Infiltration (negligible)		= 0.20
Relief (flat)		= 0.00
Vegetal Cover (poor)		= 0.05
Development Type (residential)		= 0.40
	C	= 0.65

B. Determine the 50-year 1-hour rainfall (Plate 7):

i_{50} = 2.7 inches

Adjust for time of concentration to compute Rainfall Intensity (I) (Plate 2):

Existing Conditions:

Tc = 30 min

I = 3.7 inches/hour

Developed Conditions:

Tc = 15 min

I = 4.3 inches/hour

C. Drainage Area (A) = 304.3 acres

D. Calculate 50-year storm runoff volume (Q):

Q=CIA

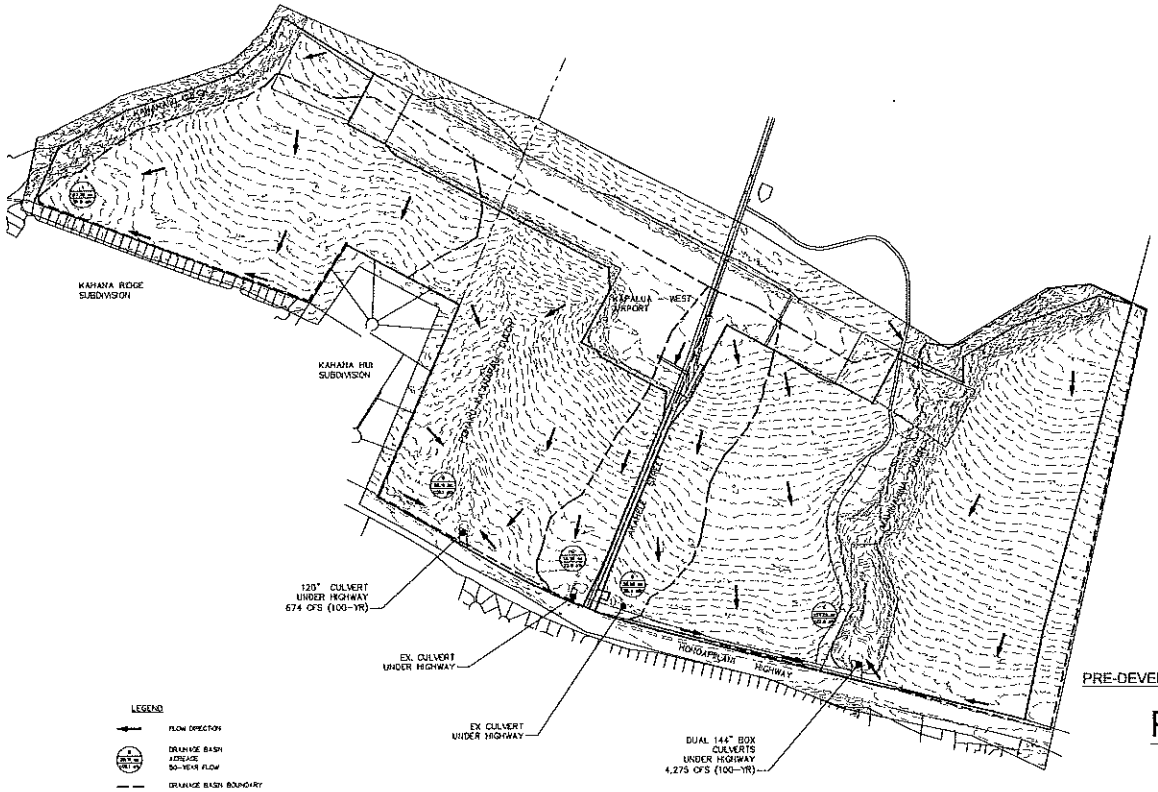
Existing Conditions:

Q = (0.32)(3.7)(304.3) = 360.3 cfs

Developed Conditions:

Q = (0.65)(4.3)(304.3) = 850.5 cfs

The increase in runoff due to the proposed development is 850.5 – 360.3 = 490.2 cfs.



PRE-DEVELOPMENT DRAINAGE AREA MAP
EXHIBIT 7

Pulelehua

Mahinahina & Kahana, Lahaina
Island of Maui, Hawai'i

Kimley»Horn