

APPENDIX H
PRELIMINARY DRAINAGE REPORT

PRELIMINARY DRAINAGE REPORT

NĀ PUA MAKANI WIND FARM

Kahuku, O'ahu, Hawai'i

Tax Map Keys: 5-6-006:018,047,051,055; 5-6-005:018, 5-6-008:006

February 2016

Prepared for:

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2014.33.1001

1 PROJECT DESCRIPTION

1.1 GENERAL

The Nā Pua Makani Wind Farm project (Project) is located at the northeast coast of O‘ahu, in Kahuku and Ka‘ena Town, Tax Map Key (TMK) 5-6-006:018,047,051,055; 5-6-005:018, 5-6-008:006. See Figure 1 – Location Map. The 707 acre project area is approximately 9,000 feet inland from the coast on a steep sloping ridge with elevations ranging from 13- to 400-feet above mean sea level.

Alternatives evaluated in the Project EIS are: Alternative 1 – No Action, Alternative 2 – Proposed Action Wind Project of up to 10 turbines (up to approximately 25 megawatts (MW)), Alternative 2a – Modified Proposed Action of up to 9 turbines (up to approximately 25-MW) and Alternative 3 – Larger Generation Wind Project of up to 12 turbines (up to 42-MW). Under Alternative 1, there will be no new construction of wind turbines, meteorological towers, supporting structures, and access roadways. Thus, the main focus of this report will only discuss Alternative 2, 2a and 3.

Alternative 2 and 2a entails the construction and operation of an approximately 25 MW wind generation facility, consisting of up to 9 to 10 wind turbines, meteorological tower, operations and maintenance facility, electrical collections system, transmission line, and 16-foot- wide internal access roads using compacted gravel. The 9 wind turbines for Alternative 2a would have a larger generating capacity than Alternative 2.

Alternative 3 entails the construction and operation of an approximately 42 MW wind generation facility, consisting of up to 12 wind turbines, meteorological tower, operations and maintenance facility, electrical collections system, transmission line, and 16-foot-wide access roads using compacted gravel.

1.2 EXISTING DRAINAGE

The developed portions of the project area consist mostly of agricultural and vegetated fields. Runoff generated onsite and offsite is routed through three gulches located in the project site. Farthest north of the project site is ‘Ōhi‘a‘ai Gulch, Kea‘aalu Gulch is located in the middle of the project site, and Lamaloa Gulch is to the south of the project site. Runoff from the three gulches discharges into Mālaekahana Stream or its tributaries just upstream of Kamehameha Highway which discharges directly to the Pacific Ocean.

2 REGULATORY REQUIREMENTS

2.1 CITY AND COUNTY OF HONOLULU (CCH) STORM DRAINAGE STANDARDS

The City and County of Honolulu Rules Relating to Storm Drainage Standards requires developments to manage storm water runoff such that there is no adverse impact to downstream properties, typically resulting from an increase in storm water runoff or a change in drainage

patterns. On-site disposal or retention of the net increase in storm water runoff is proposed to mitigate any adverse downstream impact.

2.2 FLOOD HAZARD AREA

According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM Panel 15003C0045G, effective date January 19, 2011), a portion of the project site is located within Zone AE, or areas where base flood elevations (BFEs) are determined; Zone A, or areas where no BFE is determined; Zone X, or areas determined to be outside of the 0.2% annual chance floodplain; and Zone D, or unstudied areas where flood hazards are undetermined but flooding is possible. See Figure 2 – Flood Zones. The AEF zone immediately adjacent to Kamehameha Highway is designated as a floodway.

Chapter 21-9.10-5 of the Revised Ordinances of Honolulu prohibits encroachments, including fill, new construction, substantial improvements, and other development within the adopted regulatory floodway unless it has been demonstrated through hydrological and hydraulic analyses that such encroachments would not result in any increased flood levels within the community during the occurrence of the base flood discharge.

3 ANALYSIS AND RESULTS

The approximate total area of proposed roadways, wind turbines, and structures is 10 acres, 9 acres and 11 acres for Alternative 2, 2a and 3, respectively. The net change in runoff is computed using the rational method and the 10-year, 1-hour design storm. The on-site retention volume is computed using the modified rational method and the 50-year, 1-hour design storm. The design storm durations are equal to the time of concentration.

The runoff rate from the area to be occupied by the proposed improvements is computed for the existing and developed conditions and the net increase determined. Under the 10-year, 1-hour design storm, the net increase in storm water runoff is 11.92 cfs, 10.85 cfs and 13.00 cfs for Alternative 2, 2a and 3, respectively. See Appendix A for computations.

To mitigate any adverse downstream impact, the project will need to either dispose or store the net increase in runoff on-site. The criteria for disposal is a 10-year, 1-hour design storm and is limited to the installation of seepage pits or drywells. Additional subsurface investigation is needed to characterize the disposal rate of the project area. The alternative is to retain the runoff on-site using open detention areas or subsurface storage. The required storage volume, determined using the 50-year, 1-hour design storm, is 3.3 ac-ft, 3.0 ac-ft and 3.6 ac-ft for Alternative 2, 2a and 3, respectively, which may be provided in one or several distributed locations. The design of the on-site disposal or storage facilities would be developed in conjunction with preparation of detailed construction plans.

4 CONCLUSION

No adverse impacts to neighboring properties are expected. The net increase in runoff due to the proposed improvements will be mitigated through the use of on-site disposal and/or on-site detention. Drainage drywells or seepage pits may be used to dispose of the net increase in storm water runoff. Alternatively, the net increase in storm water runoff may be stored on-site using retention basins. The use of on-site disposal and retention, individually or in combination, will address the net increase in storm water runoff.

Improvements within the floodway are limited to surface pavements and overhead power transmission lines. The conveyance capacity of the floodway is not expected to change as a result of these improvements, consequently, no rise in the BFE is expected.

5 REFERENCES

- Flood Insurance Study, Volume 1 and 2, City and County of Honolulu, Hawai'i, Federal Emergency Management Agency, Revised November 26, 2010.
- Flood Insurance Rate Map, Map Number 15003C0045G, Federal Emergency Management Agency, Map Revised January 19, 2011.
- Rules Relating to Storm Drainage Standards, City and County of Honolulu, Hawai'i, Department of Planning and Permitting, Revised October 2012.

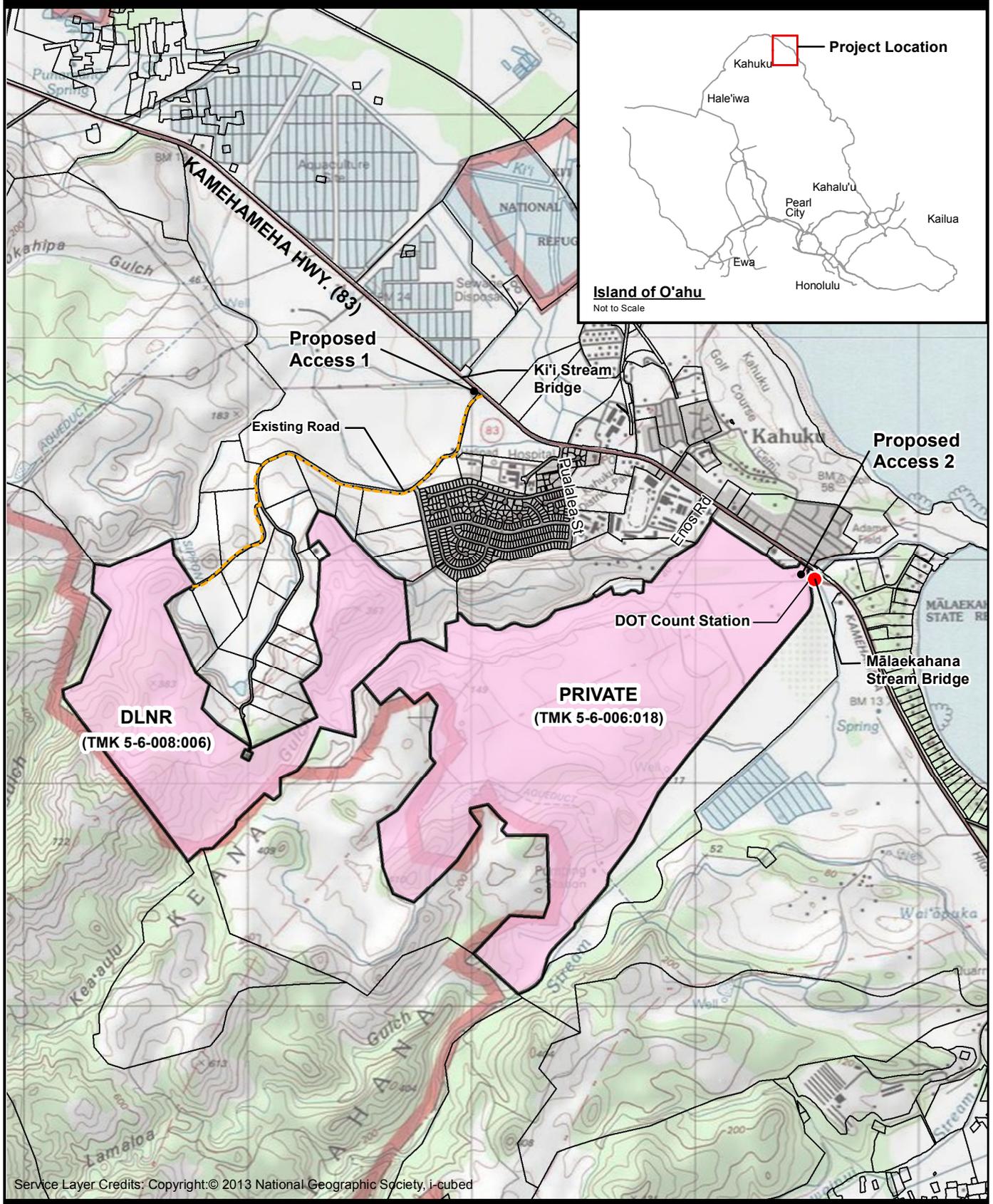
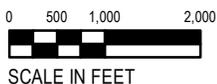
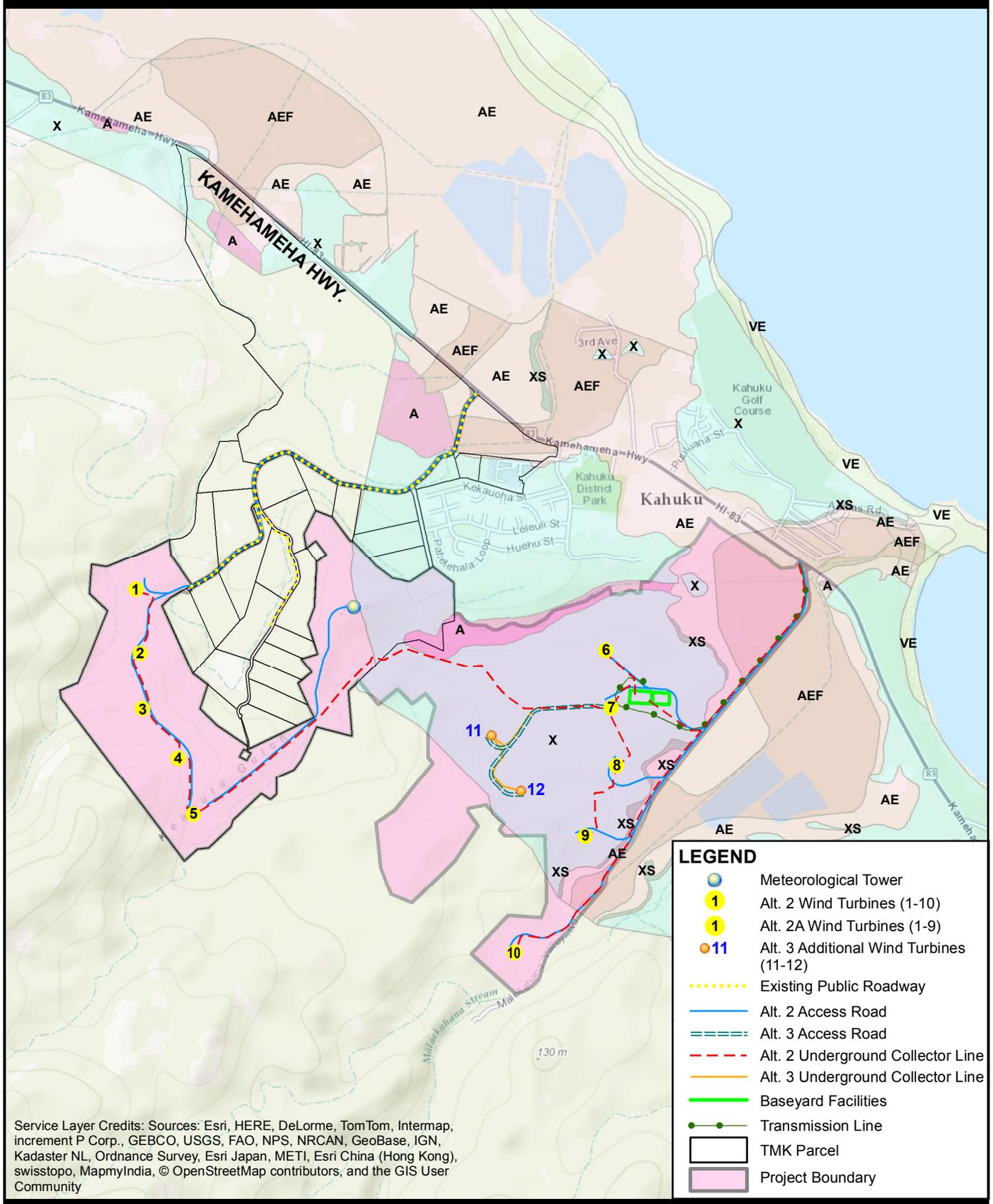


Figure 1
LOCATION MAP

Nā Pua Makani Wind Farm
Champlin Oahu Wind Holdings LLC
January 2016

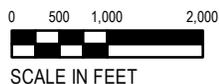


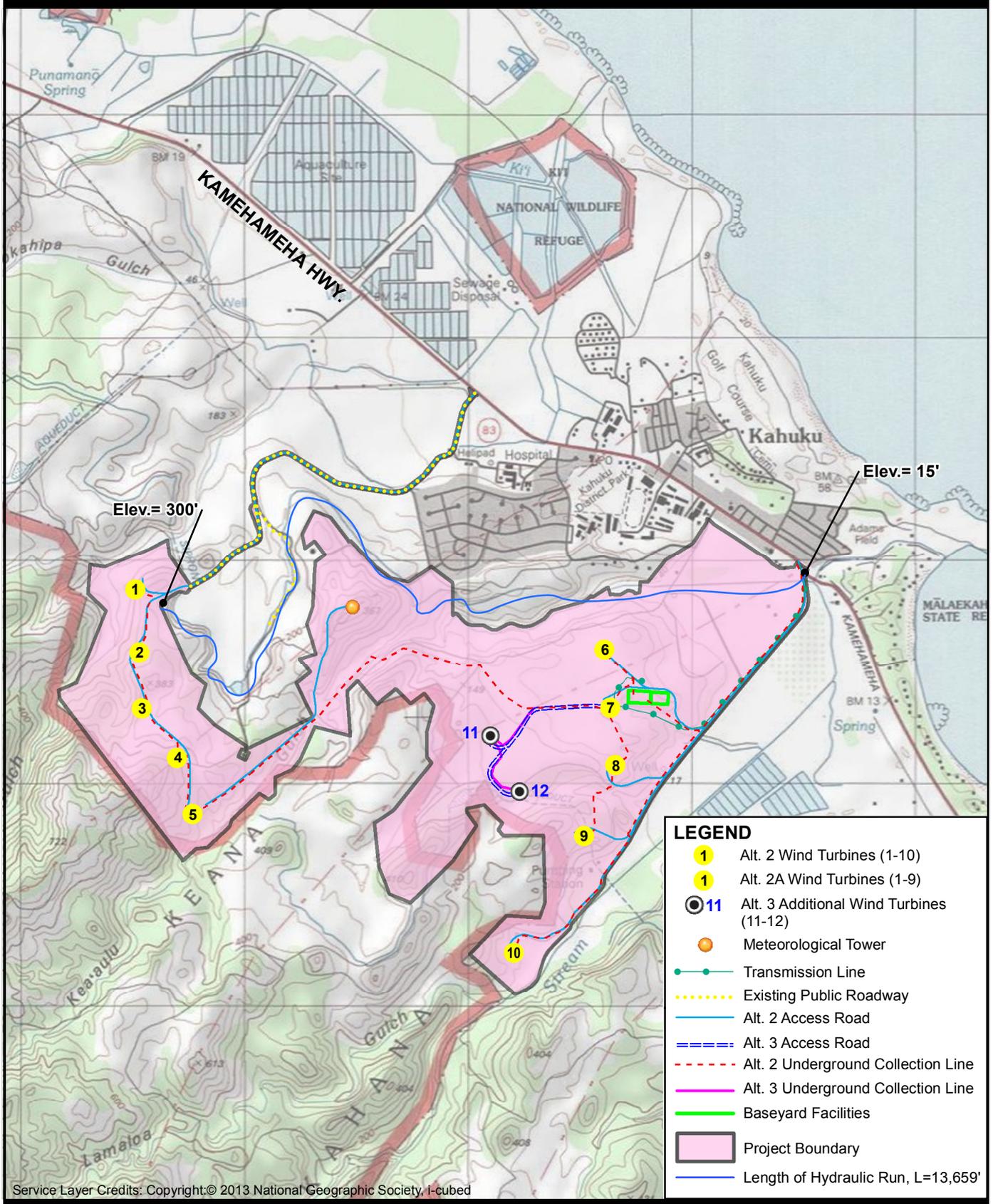


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**Figure 2
FLOOD ZONES**

Na Pua Makani Wind Farm
Champlin Oahu Wind Holdings LLC
January 2016





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Figure 3
TIME OF CONCENTRATION

Nā Pua Makani Wind Farm
Champlin Oahu Wind Holdings LLC
January 2016





PROJECT: Nā Pua Makani Wind Farm
 CLIENT: Champlin O'ahu Wind Holdings LLC
 SUBJECT: Preliminary Drainage Calculations Alternative 2
 FILE: M:\Na Pua Makani Wind Farm\2014331001 Drainage Study\05 Basis of Design\Calculations\[Alternative 2 Runoff Calcs 2015_12_23.xlsx]Runoff-Storage

JOB NO: 2014.33.1001
 DATE: 21-Jan-16
 BY: JC/CKL

Runoff Coefficient, C

	Length (ft)	Width (ft)	Area (ac)	C Value	Composite C
<u>Existing Condition</u>					
Agriculture Areas	n/a	n/a	10	0.3	
<u>Developed Condition</u>					
Buildings and Yards	n/a	n/a	2.4	0.9	2.16
New gravel roads	20,755	16	<u>7.4</u>	0.70	<u>5.2</u>
			10		0.75

Time of Concentration, Tc

Length Hydraulic Run (ft)	13659
Start Elevation (ft)	300
End Elevation (ft)	15
Slope	2.1%
Open Channel Velocity (fps)	1.5
Tc (min)	151.8
Tc (hrs)	2.53

Runoff Rates

	Area (ac)	I _{10Y-1H} (in.)	I _{50Y-1H} (in.)	C	Q ₁₀ (cfs)	Q ₅₀ (cfs)
Existing Condition	10	2.70	3.60	0.30	7.97	10.63
Developed Condition	10	2.70	3.60	0.75	19.89	26.52
Total Increase in Runoff (cfs) =					11.92	15.90

On-site Detention

Volume to store runoff (Q ₅₀ x Tc)	144,764	cf
Total on-site retention requirement =		3.3 ac-ft



PROJECT: Nā Pua Makani Wind Farm
 CLIENT: Champlin O'ahu Wind Holdings LLC
 SUBJECT: Preliminary Drainage Calculations Alternative 2A
 FILE: M:\Na Pua Makani Wind Farm\2014331001 Drainage Study\05 Basis of Design\Calculations\[Alternative 2A Runoff Calcs 2015_12_23.xlsx]Runoff-Storage

JOB NO: 2014.33.1001
 DATE: 21-Jan-16
 BY: JC/CKL

Runoff Coefficient, C

	Length (ft)	Width (ft)	Area (ac)	C Value	Composite C
<u>Existing Condition</u>					
Agriculture Areas	n/a	n/a	9	0.3	
<u>Developed Condition</u>					
Buildings and Yards	n/a	n/a	2.39	0.9	2.151
New gravel roads	20,755	16	<u>6.46</u>	0.70	<u>4.5</u>
			9		0.75

Time of Concentration, Tc

Length Hydraulic Run (ft)	13659
Start Elevation (ft)	300
End Elevation (ft)	15
Slope	2.1%
Open Channel Velocity (fps)	1.5
Tc (min)	151.8
Tc (hrs)	2.53

Runoff Rates

	Area (ac)	I _{10Y-1H} (in.)	I _{50Y-1H} (in.)	C	Q ₁₀ (cfs)	Q ₅₀ (cfs)
Existing Condition	9	2.70	3.60	0.30	7.17	9.56
Developed Condition	9	2.70	3.60	0.75	18.02	24.02
Total Increase in Runoff (cfs) =					10.85	14.46

On-site Detention

Volume to store runoff (Q ₅₀ x Tc)	131,716	cf
Total on-site retention requirement =		3.0 ac-ft



PROJECT: Nā Pua Makani Wind Farm
 CLIENT: Champlin O'ahu Wind Holdings LLC
 SUBJECT: Preliminary Drainage Calculations Alternative 3
 FILE: M:\Na Pua Makani Wind Farm\2014331001 Drainage Study\05 Basis of Design\Calculations\[Alternative 3 Runoff Calcs 2015_12_23.xlsx]Runoff-Storage

JOB NO: 2014.33.1001
 DATE: 21-Jan-16
 BY: JC/CKL

Runoff Coefficient, C

	Length (ft)	Width (ft)	Area (ac)	C Value	Composite C
<u>Existing Condition</u>					
Agriculture Areas	n/a	n/a	11	0.3	
<u>Developed Condition</u>					
Buildings and Yards	n/a	n/a	2.4	0.9	2.1800664
New gravel roads	24,057	16	<u>8.4</u>	0.70	<u>5.9</u>
			11		0.74

Time of Concentration, Tc

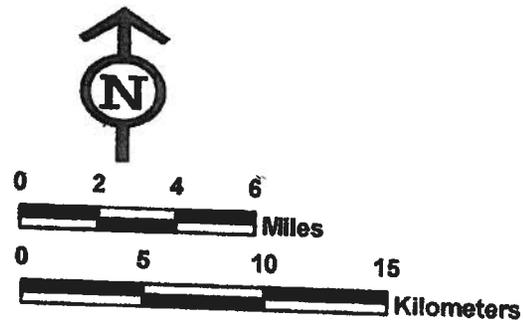
Length Hydraulic Run (ft)	13659
Start Elevation (ft)	300
End Elevation (ft)	15
Slope	2.1%
Open Channel Velocity (fps)	1.5
Tc (min)	151.8
Tc (hrs)	2.53

Runoff Rates

	Area (ac)	I _{10Y-1H*} (in.)	I _{50Y-1H**} (in.)	C	Q ₁₀ (cfs)	Q ₅₀ (cfs)
Existing Condition	11	2.70	3.60	0.30	8.77	11.69
Developed Condition	11	2.70	3.60	0.74	21.76	29.02
Total Increase in Runoff (cfs) =					13.0	17.33

On-site Detention

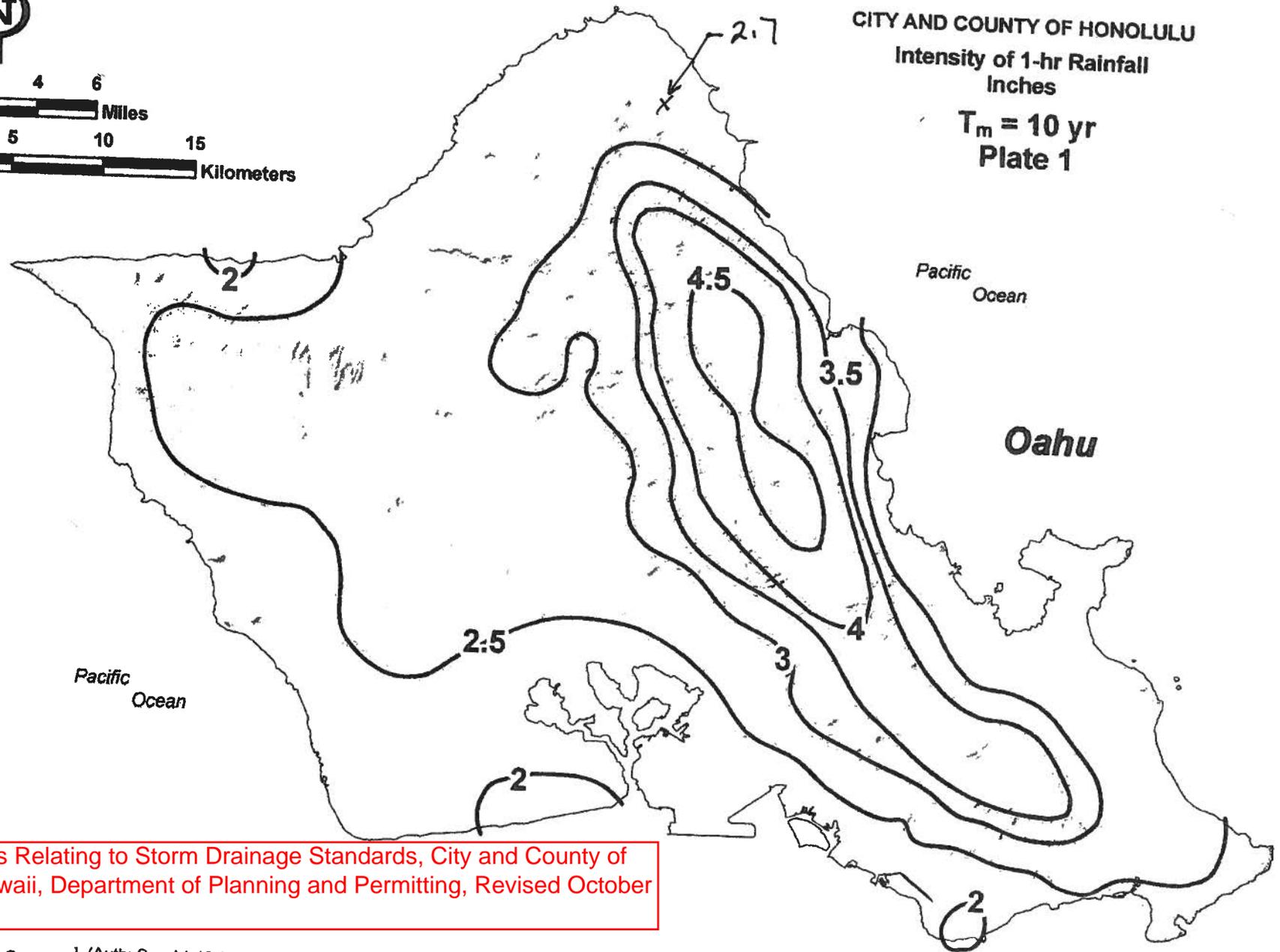
Volume to store runoff (Q ₅₀ x Tc)	157,790	cf
Total on-site retention requirement =		3.6 ac-ft



CITY AND COUNTY OF HONOLULU

**Intensity of 1-hr Rainfall
Inches**

**$T_m = 10$ yr
Plate 1**

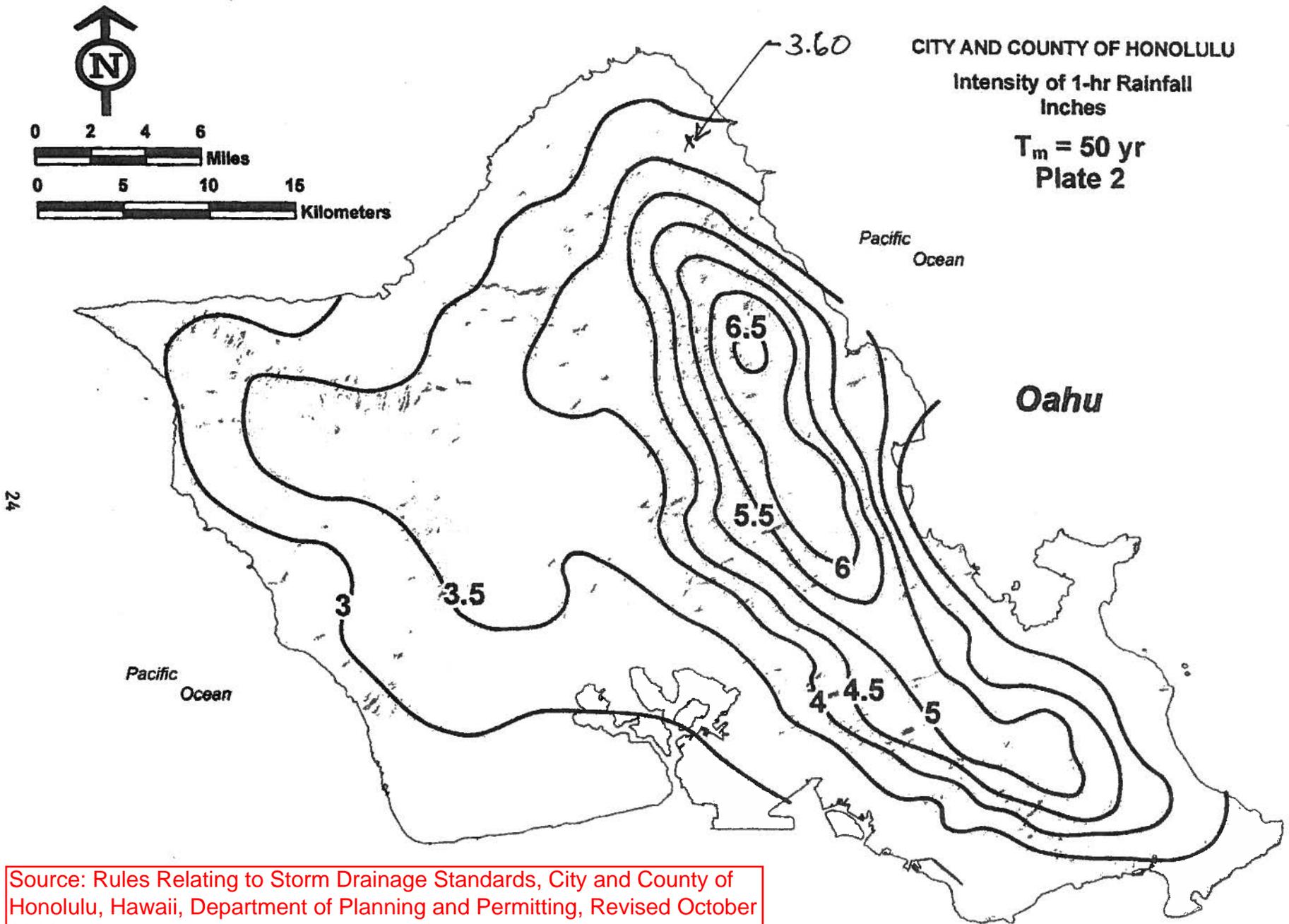


23

Source: Rules Relating to Storm Drainage Standards, City and County of Honolulu, Hawaii, Department of Planning and Permitting, Revised October 2012.

[Eff. **APR 08 2011**] (Auth: Sec 14-12.31, ROH) (Imp: Sec 14-12.31, ROH)

Source: National Oceanic and Atmospheric Administration (NOAA), National Weather Service, Silver Spring, Maryland, 2009



Source: Rules Relating to Storm Drainage Standards, City and County of Honolulu, Hawaii, Department of Planning and Permitting, Revised October 2012.