Miki Basin Industrial Park
Environmental Assessment

Exhibit D

Drainage Study

DRAINAGE REPORT

Project: Miki Basin 200-Acre Industrial Drainage Study
Lanai City, Lanai
TMK: (2)4-9-14: 18

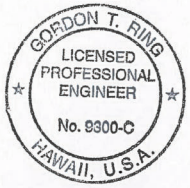
Owner: Pulama Lanai

Consultant: R. M. Towill Corporation
2024 North King Street, Suite 200
Honolulu, Hawaii 96819

Prepared by: David Ardo

Checked by: Gordon Ring

Date: January 22, 2019



This work was prepared by me or under my supervision. Construction of this project will be under my observation.

Signature 4/30/20
Lic. Expiration

1.0 PURPOSE

To determine the offsite and onsite drainage system requirements for the proposed Miki 200 Acre Industrial Site that meets the County of Maui Storm Drainage Standards. The Miki 200 Acre Industrial Site project involves development of 3 large parcels adjacent to Miki Road, consisting of a 65-acre light industrial parcel, 100-acre heavy industrial parcel, and a 35-acre light industrial parcel. For the location of the proposed site, see Figure 1.

2.0 REFERENCES

2.1 *Rules for the Design of Storm Drainage Facilities in the County of Maui*, Department of Public Works and Waste Management, County of Maui, July 14, 1995.

2.2 LIDAR Countour Maps provided by Pulama Lanai dated December 2006.

2.3 Hydraflow Hydrographs Extensions for AutoCAD Program by Auto Desk dated August 2017 to February 2018.

2.4 *Grading and Drainage Report for Miki Basin Heavy Industrial Site*, Austin Tsutsumi & Associates, October 2015.

3.0 EXISTING SITE CONDITIONS

The proposed project site is mostly undeveloped except for the existing Miki Basin Industrial Condominium site and MECO facility. Existing improvements within the project site include the Miki Basin Industrial Condominium project and MECO facility. The existing onsite terrain is covered with vegetation and slopes at about 5% from Miki Road toward the southeast. There is no existing storm drain system within the project area. Runoff collected in Drain Area 1 and 2 of the project site flows into existing natural drainage ways and discharges into the existing Miki Basin sump, located approximately 2000 feet away (see Figure 2). Runoff collected in Drain Area 3 flows to the existing Palawai Basin.

Southeast of the proposed 100 acre heavy industrial area are the Miki Basin Industrial CPR and an existing MECO facility (see Figure 2). Runoff generated within the existing Miki Basin Industrial CPR site is collected by an onsite drainage system and is discharged offsite. Runoff from the Miki Basin Industrial CPR site will not impact the proposed development since it has a separate discharge point, located south of the heavy industrial parcel. See "Grading and Drainage Report for Miki Basin Heavy Industrial Site" by Austin Tsutsumi & Associates, Inc. for drainage calculations. Offsite runoff, including runoff generated from the MECO facility, is diverted around the Miki Basin Industrial CPR site (within the heavy industrial parcel) and is discharged into the existing drainage way. These existing offsite flows will need to be addressed by the development of the heavy industrial parcel.

Offsite runoff generated from the area north of Miki Road sheet flows and is intercepted by an unlined ditch along Miki Road (see Figure 2). Once in the unlined ditch, the runoff flows towards the southeast direction to a low point in Miki Road, near the existing MECO facility.

4.0 PROPOSED SITE CONDITIONS

The proposed 200 acre industrial development will consist of a 65-acre light industrial parcel (Drain Area 1), 100-acre heavy industrial parcel (Drain Area 2), and a 35-acre light industrial parcel (Drain Area 3). This development will increase the amount of impervious area within the project. Offsite runoff will be intercepted before entering the project site by proposed drainage ditches. The drainage ditches will divert runoff around the perimeter of the project site to an offsite discharge point downstream. Onsite runoff will be collected by a proposed underground storm drain system consisting of pipes and inlets. Runoff from 65-acre light industrial parcel, 100-acre heavy industrial parcel, and DA Offsite 1 through 3 will be discharged to the existing drainageway that drains to Miki Basin (see Figure 4). Runoff generated from the 35-acre light industrial parcel and DA Offsite 4 drain to the existing Palawai Basin.

5.0 CALCULATIONS FOR RUNOFF INCREASE

Onsite

Runoff flow rates for areas less than 100 acres were calculated for a 10-year, 1-hour storm event using the rational method for the existing and proposed site conditions of Drain Area 1 and Drain Area 3. The runoff flow rate for a 100-year, 24-hour storm event were calculated using the SCS method for the existing and proposed site conditions of Drain Area 2 since the drainage area is 100 acres. See Tables 1 and 2 for a summary of the existing and proposed runoff quantities. The proposed industrial parcels will increase the runoff generated within the project site by 339.88 cfs (see Table 3).

Offsite

Runoff flow rates for a 100-year, 24-hour storm event were calculated using the SCS method for the existing site conditions of DA Offsite 1 and DA Offsite 2, since these offsite areas are greater than 100 acres. Runoff flow rates for a 10-year, 1-hour storm event were calculated using the rational method for the existing and proposed site conditions of DA Offsite 3 and DA Offsite 4, since these offsite areas are less than 100 acres. See Tables 1 and 2 for the existing and proposed runoff quantities.

Runoff generated from areas DA Offsite 1, 2, and 4 will be collected by interceptor ditches located along the project site exterior boundary and will ultimately discharge into the existing drainageway south of the project site and to Miki Basin per existing conditions. Offsite runoff for DA Offsite 3 will be diverted under Miki Road by a culvert and around the existing Miki Basin Warehouse area. Runoff from DA Offsite 3 will be discharged into an existing offsite drainageway adjacent to the industrial CPR site. Therefore, the offsite runoff will not affect the design of the onsite drain systems.

At a depth of 10 feet, the existing Miki Basin has a capacity of 891 ac-ft. Since the increase in runoff from Drain Area 1 and Drain Area 2 only contributes 38.1 acre-feet, the increase in runoff depth and flow rate will be contained within the existing basin. See Table 4 for the volume summary.

At a depth of 10 feet, the existing Palawai Basin has a capacity of 3010 ac-ft. Since the increase in runoff from Drain Area 3 contributes only 2.5 acre-feet, the increase in runoff depth and flow rate will be contained within the existing basin. See Table 4 for the volume summary.

Table 1 – Existing Runoff Quantities

Drainage Area Name	Area (Acres)	Q_{10} (cfs)	Q_{100} (cfs)
DA 1*	65.0	87.36	-
DA 2**	100.0	-	576.00
DA 3*	32.6	25.56	-
DA OFFSITE 1**	155.3	-	316.5
DA OFFSITE 2**	81.7	-	166.5
DA OFFSITE 3*	88.5	71.86	-
DA OFFSITE 4*	8.6	11.56	-
	Total	196.34	1059.00

* Calculated using Rational Method
**Calculated using SCS Method

Table 2 – Proposed Runoff Quantities

Drainage Area Name	Area (Acres)	Q_{10} (cfs)	Q_{100} (cfs)
DA 1*	65.0	249.60	-
DA 2**	100.0	-	667.20
DA 3*	35.0	112.00	-
DA OFFSITE 1**	155.3	-	316.5
DA OFFSITE 2**	81.7	-	166.5
DA OFFSITE 3*	86.1	69.91	-
DA OFFSITE 4*	8.6	11.56	-
	Total	443.07	1100.20

* Calculated using Rational Method
**Calculated using SCS Method

Table 3 – Runoff Summary

Drainage Area Name	Existing Q (cfs)	Proposed Q (cfs)	Increase in Q (cfs)
DA 1	87.36	249.60	162.24
DA 2	576.00	667.20	91.20
DA 3	25.56	112.00	86.44
		Total	339.88

Table 4 – Volume Summary

Drainage Area Name	Existing Volume (ac-ft)	Proposed Volume (ac-ft)	Increase in Volume (ac-ft)
DA 1 + DA 2 (to Miki Basin)	74.9	113.0	38.1
DA 3 (to Palawai Basin)	3.2	5.7	2.5

6.0 STORM WATER MANAGEMENT

Existing drainage patterns will be maintained by discharging intercepted offsite runoff to its original flow path. Offsite runoff will be collected by interceptor ditches located on the perimeter of the site that discharge to existing drainage way and ultimately to Miki Basin (see Figure 4). The proposed concrete rectangular drainage ditches vary in size from 8 feet by 8 feet to 2 feet by 3 feet. The ditches are sized to accommodate the peak runoff flow from the 100-yr, 24-hour storm and 10-yr, 1-hour storm where necessary and provide a minimum 2-foot freeboard.

Runoff from the proposed 65-acre light industrial area (Drain Area 1) will be discharged to the interceptor ditch at the southwest corner of the parcel (see Figure 4). Runoff flow for this area is 249.60 cfs and ultimately flows to Miki Basin. Offsite runoff from DA Offsite 1 flowing towards the 65-acre parcel is 316.50 cfs and will be intercepted by a 6 ft. by 6 ft. interceptor ditch on the north perimeter of the parcel.

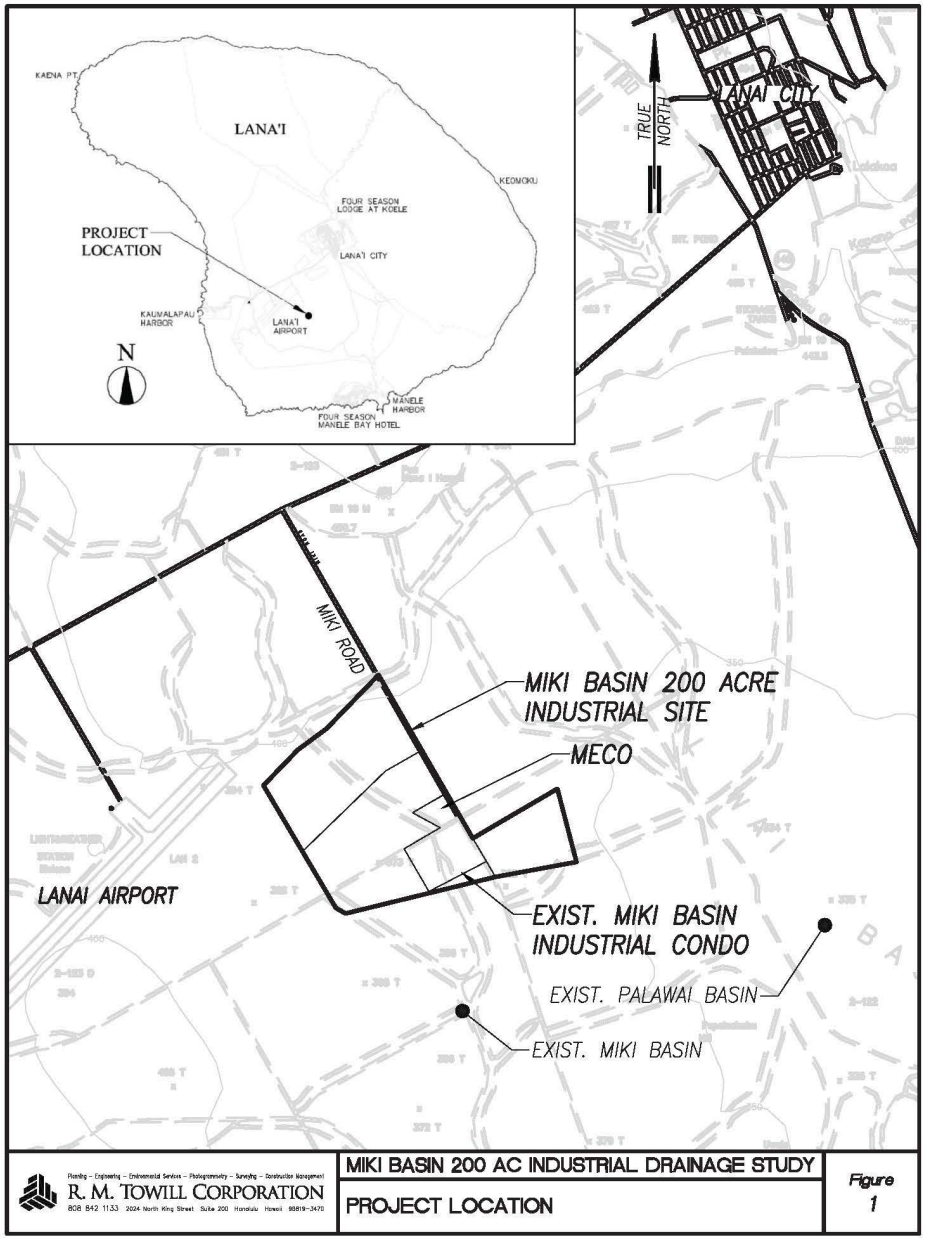
Runoff from the proposed 100-acre heavy industrial area (Drain Area 2) will be discharged at the south end of the parcel (see Figure 4). Runoff flow for this area is 667.20 cfs. The runoff from DA Offsite 3 that is diverted around the existing Miki Basin Industrial site is also discharged at the south end of the parcel. Runoff flow for DA Offsite 3 is 69.91 cfs. Both the runoff flow from the proposed 100-acre site and the DA Offsite 3 flow to Miki Basin. Design of the drainage system for the 100-acre site should consider the impacts of incorporating the existing flows into the proposed drainage system versus keeping them separate. Offsite runoff from DA Offsite 2 flowing towards the 100-acre parcel is 166.50 cfs and will be intercepted an 8 ft. by 8 ft. interceptor ditch on the west perimeter of the parcel. Runoff from the proposed 35-acre light industrial area (Drain Area 3) will be discharged at the eastern side of the parcel (see Figure 4). Onsite runoff flow for this area is 112.00 cfs and ultimately flows to Palawai Basin. Offsite runoff south of the 35-acre parcel from DA Offsite 4 will be intercepted by a 2 ft. by 3ft. interceptor ditch on the south perimeter of the parcel and will discharge to Palawai Basin. Runoff flow for the offsite area is 11.56 cfs.

The increase in onsite runoff volume from Drain Area 1 and Drain Area 2 will be conveyed to the existing drainage way and can be easily accommodated in the existing Miki Basin. The additional runoff volume is negligible compared to the available basin capacity. The increase in onsite runoff volume from Drain Area 3 will be conveyed to the existing Palawai Basin. The additional runoff volume is negligible compared to the available basin capacity.

Storm water treatment will not be provided for this project since the runoff flows into an existing offsite sump with no outlet to the ocean.

7.0 CONCLUSION

The development of the proposed industrial parcels will increase the runoff onsite by 339.88 cfs (see Table 3). The additional flow generated within the proposed parcels can be accommodated by the existing Miki Basin and Palawai Basin. Therefore, the proposed 200-acre industrial development will not have an adverse impact on any existing downstream properties.

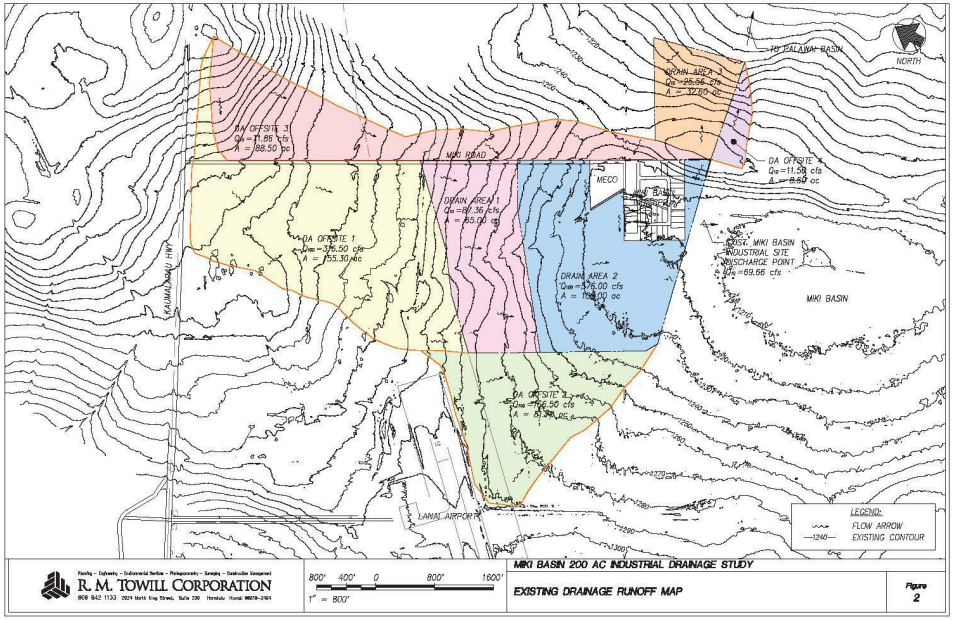


Planning – Engineering – Environmental Services – Photogrammetry – Surveying – Construction Management
R. M. TOWILL CORPORATION
808 842 1133 2024 North King Street Suite 200 Honolulu Hawaii 96819-3470

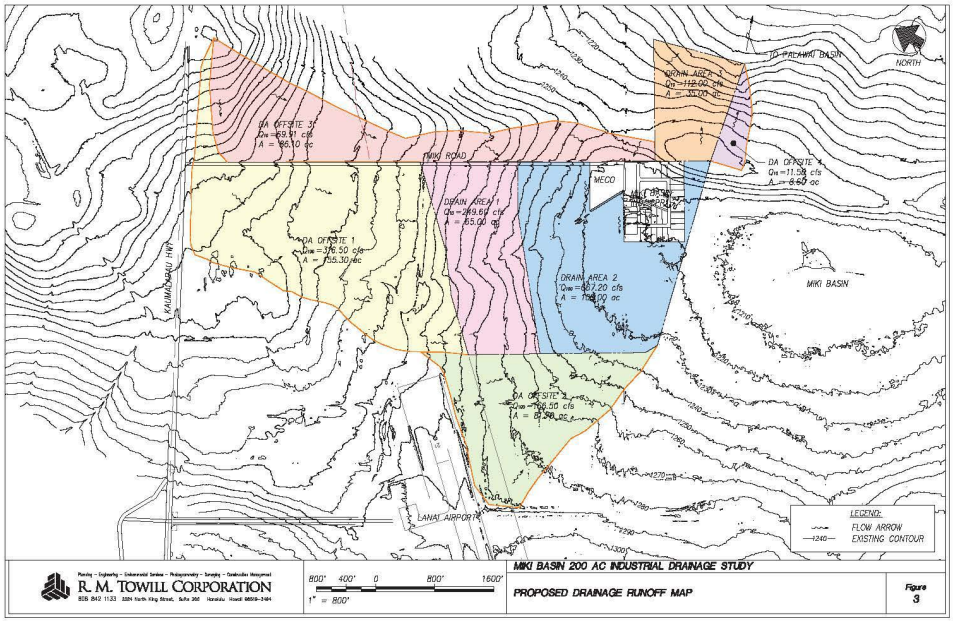
MIKI BASIN 200 AC INDUSTRIAL DRAINAGE STUDY

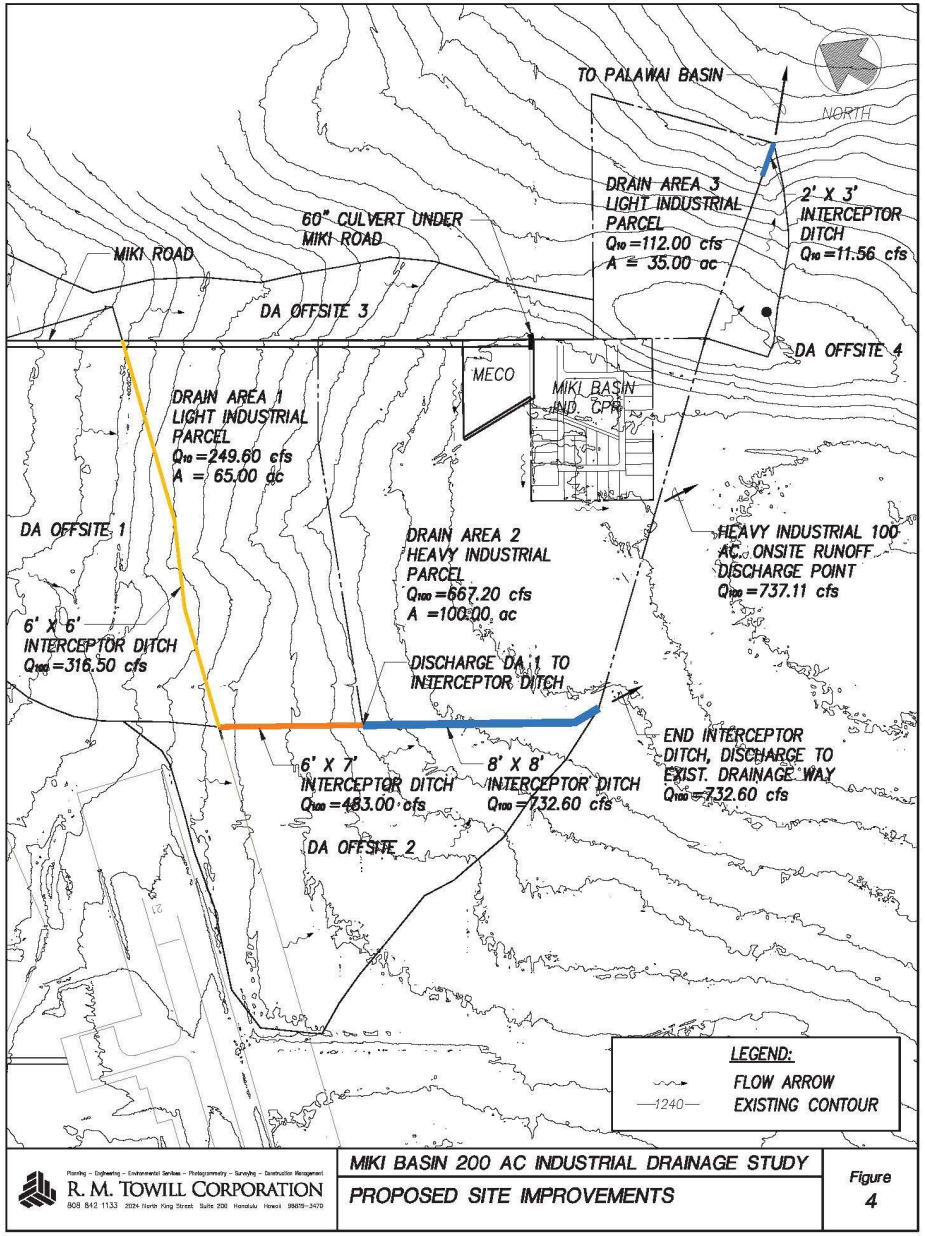
PROJECT LOCATION

Figure 1



Planning – Engineering – Environmental Services – Photogrammetry – Surveying – Construction Management
R. M. TOWILL CORPORATION
808 842 1133 2024 North King Street Suite 200 Honolulu Hawaii 96819-3469


TO PALAWAI BASIN
NORTH
DRAIN AREA 3
Q100 =112.00 cfs
A = 35.00 ac
DA OFFSITE 3
Q100 =69.91 cfs
A = 66.10 ac
MIKI ROAD
DA OFFSITE 4
Q100 =11.56 cfs
A = 8.60 ac
MECO
MIKI BASIN IND. CPR
DRAIN AREA 1
Q100 =249.60 cfs
A = 65.00 ac
DA OFFSITE 1
Q100 =316.50 cfs
A = 255.30 ac
DRAIN AREA 2
Q100 =667.20 cfs
A = 100.00 ac
MIKI BASIN
KAUMALAPAU HWY
DA OFFSITE 2
Q100 =483.00 cfs
A = 81.96 ac
LANAI AIRPORT
LEGEND:
FLOW ARROW
1240 EXISTING CONTOUR
R. M. TOWILL CORPORATION
808 842 1133 2024 North King Street Suite 200 Honolulu Hawaii 96819-3420
800' 400' 0 800' 1600'
1" = 800'
MIKI BASIN 200 AC INDUSTRIAL DRAINAGE STUDY
PROPOSED DRAINAGE RUNOFF MAP
Figure 3


TO PALAWAI BASIN
NORTH
60" CULVERT UNDER MIKI ROAD
MIKI ROAD
DRAIN AREA 3
LIGHT INDUSTRIAL PARCEL
Q10 =112.00 cfs
A = 35.00 ac
2' X 3' INTERCEPTOR DITCH
Q10 =11.56 cfs
DA OFFSITE 3
DA OFFSITE 4
MECO
MIKI BASIN IND. CPR
DRAIN AREA 1
LIGHT INDUSTRIAL PARCEL
Q10 =249.60 cfs
A = 65.00 ac
DA OFFSITE 1
DRAIN AREA 2
HEAVY INDUSTRIAL PARCEL
Q100 =667.20 cfs
A =100.00 ac
HEAVY INDUSTRIAL 100 AC ONSITE RUNOFF DISCHARGE POINT
Q100 =737.11 cfs
6' X 6' INTERCEPTOR DITCH
Q100 =316.50 cfs
DISCHARGE DA 1 TO INTERCEPTOR DITCH
END INTERCEPTOR DITCH, DISCHARGE TO EXIST. DRAINAGE WAY
Q100 =732.60 cfs
6' X 7' INTERCEPTOR DITCH
Q100 =483.00 cfs
8' X 8' INTERCEPTOR DITCH
Q100 =732.60 cfs
DA OFFSITE 2
LEGEND:
FLOW ARROW
1240 EXISTING CONTOUR
R. M. TOWILL CORPORATION
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MIKI BASIN 200 AC INDUSTRIAL DRAINAGE STUDY
PROPOSED SITE IMPROVEMENTS
Figure 4

APPENDIX

HYDROLOGIC AND HYDRAULIC CALCULATIONS

R. M. TOWILL CORPORATION

2024 N King Street, Suite 200, Honolulu, Hawaii 96819
Ph. (808) 842-1133 Fax (808) 842-1937

Project:	Miki Industrial	Job No.			
Location:	Lanai	Prepared By:	DAA	Date:	11/5/2018
Item:	Runoff Calculations	Checked By:	GR	Date:	11/5/2018

Purpose: Determine the existing runoff from project site.

Assumptions

Rational Method

Runoff Coefficient, C

RUNOFF COEFFICIENT FOR SMALL AGRICULTURAL AREAS

Watershed Characteristics	Description	Value
Infiltration	Medium	0.07
Relief	Rolling	0.03
Vegetal Cover	Good	0.03
Development Type	Agricultural	0.15
Sum		0.28

Small agriculatural areas = 0.28
Light Industrial Areas = 0.8
Heavy Industrial Areas = 0.9

Rainfall Intensity, I (10 Year-1 hr)

I = 1.85 in /hr NOAA Data

See TC spreadsheet for adjusted rainfall intensities.

SCS Method

	Curve No. (CN)
Existing Condition	91
Proposed Condition	79

RESULTS

Calculate Peak Runoff, Q

EXISTING CONDITION

Drainage Area Name	Area (Acres)	C	I (in/hr)	Q (cfs)
DA 1*	65.00	0.28	4.8	87.36
DA2**	100.00	-	-	576.00
DA 3*	32.6	0.28	2.8	25.56
DA OFFSITE 1**	155.3	-	-	316.5
DA OFFSITE 2**	81.7	-	-	166.5
DA OFFSITE 3*	88.5	0.28	2.9	71.86
DA OFFSITE 4*	8.6	0.28	4.8	11.56

R. M. TOWILL CORPORATION

2024 N King Street, Suite 200, Honolulu, Hawaii 96819
Ph. (808) 842-1133 Fax (808) 842-1937

Project:	Miki Industrial	Job No.			
Location:	Lanai	Prepared By:	DAA	Date:	11/5/2018
Item:	Runoff Calculations	Checked By:	GR	Date:	11/5/2018

Calculate Peak Runoff, Q

PROPOSED CONDITION

Drainage Area Name	Area (Acres)	C	I (in/hr)	Q (cfs)
DA 1*	65.00	0.80	4.8	249.60
DA2**	100.00	-	-	667.20
DA 3*	35	0.80	4	112.00
DA OFFSITE 1**	155.3	-	-	316.5
DA OFFSITE 2**	81.7	-	-	166.5
DA OFFSITE 3*	86.1	0.28	2.9	69.91
DA OFFSITE 4*	8.6	0.28	4.8	11.56

*Calculated using Rational Method
**Calculated using SCS Method

Drainage Area Name	Existing Q	Proposed Q	Increase in Q
DA 1*	87.36	249.60	162.24
DA 2**	576.00	667.20	91.20
DA 3*	25.56	112.00	86.44

Miki Basin
Maui County Drainage Standards - Rational Method
11-05-18

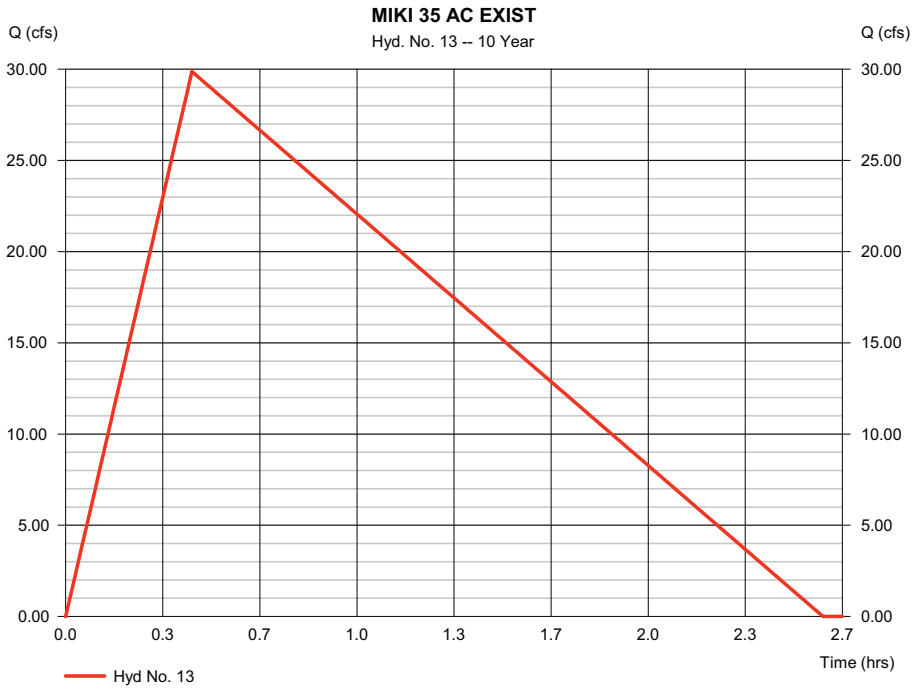
	TRIBUTARY SUBAREAS	AREA (acres)	WEIGHTED RUNOFF COEFFICIENT "C"	MAXIMUM LENGTH OF TRAVEL (feet)	DIFFERENCE IN ELEVATION (feet)	Slope %	k-value	TIME OF CONCENTRATION "Tc" (minutes)	10-YEAR "I" (in/hr)
EXISTING	DA 1 (Light Industrial)	65.00	0.28	1140	56.0	4.91%	5143.6	5.6	4.80
	DA 3 (Light Industrial)	32.60	0.28	1600	100.0	6.25%	6400.0	26.0	2.80
	DA OFFSITE 3	88.50	0.28	7570	272.0	3.59%	39935.5	27.2	2.90
	DA OFFSITE 4	8.60	0.28	1330	85.0	6.39%	5261.0	5.7	4.8
PROPOSED	DA 1 (Light Industrial)	65.00	0.80	-	-	-	-	15.0	3.6
	DA 3 (Light Industrial)	35.00	0.80	-	-	-	-	10.0	4
	DA OFFSITE 3	86.10	0.28	7570.00	272.00	3.59%	39935.52	27.24	2.90
	DA OFFSITE 4	8.6	0.28	1330	85.0	6.39%	5261.0	5.7	4.8

Hydrograph Report

Hyd. No. 13

MIKI 35 AC EXIST

Hydrograph type	= Rational	Peak discharge	= 29.87 cfs
Storm frequency	= 10 yrs	Time to peak	= 0.43 hrs
Time interval	= 1 min	Hyd. volume	= 139,813 cuft
Drainage area	= 35.000 ac	Runoff coeff.	= 0.28
Intensity	= 3.048 in/hr	Tc by User	= 26.00 min
IDF Curve	= MIKI NOAA DATA.IDF	Asc/Rec limb fact	= 1/5



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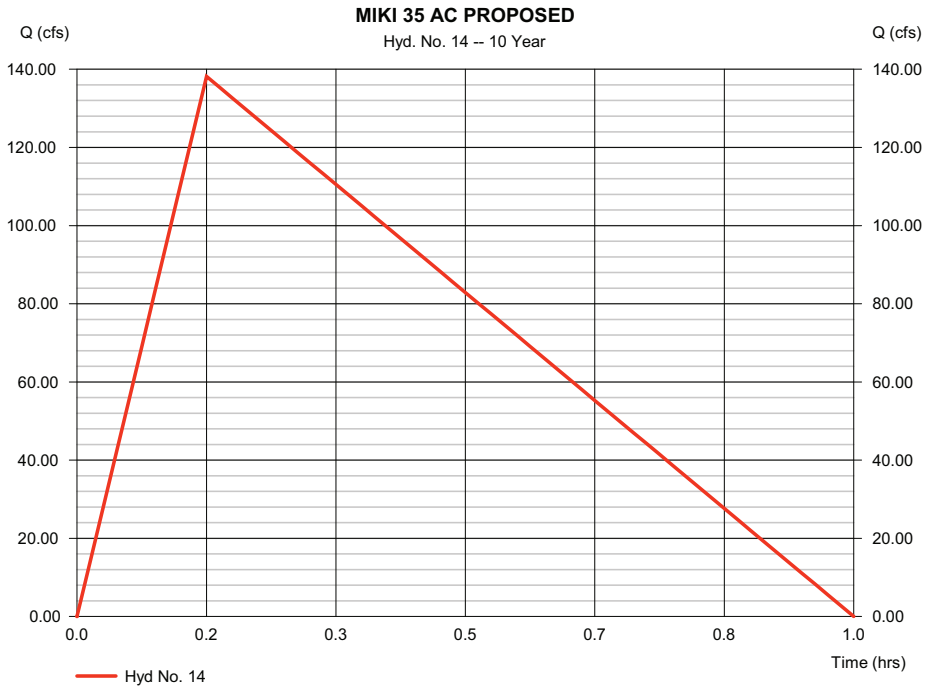
Hydrograph Report

Hyd. No. 14

MIKI 35 AC PROPOSED

Hydrograph type	= Rational	Peak discharge	= 138.15 cfs
Storm frequency	= 10 yrs	Time to peak	= 0.17 hrs
Time interval	= 1 min	Hyd. volume	= 248,674 cuft
Drainage area	= 35.000 ac	Runoff coeff.	= 0.8
Intensity	= 4.934 in/hr	Tc by User	= 10.00 min
IDF Curve	= MIKI NOAA DATA.IDF	Asc/Rec limb fact	= 1/5



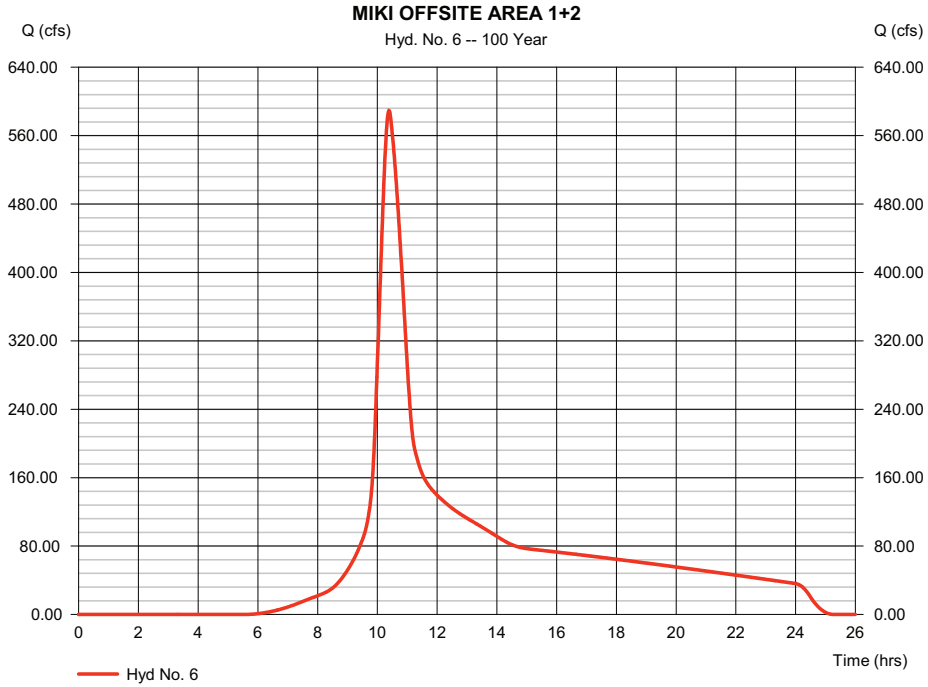
Hydrograph Report

Hyd. No. 6

MIKI OFFSITE AREA 1+2

Hydrograph type	= SCS Runoff	Peak discharge	= 589.22 cfs
Storm frequency	= 100 yrs	Time to peak	= 10.38 hrs
Time interval	= 1 min	Hyd. volume	= 5,943,357 cuft
Drainage area	= 302.000 ac	Curve number	= 65*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 48.50 min
Total precip.	= 9.86 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(1455.000 x 62)] / 302.000



1

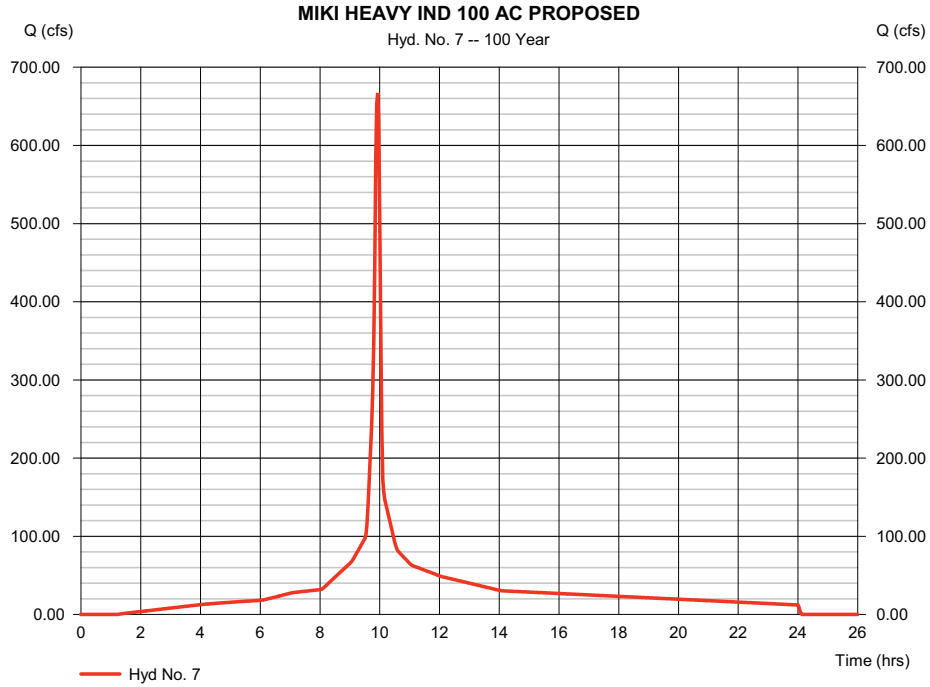
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2018 by Autodesk, Inc. v12 Monday, 11 / 5 / 2018

Hyd. No. 7

MIKI HEAVY IND 100 AC PROPOSED

Hydrograph type	= SCS Runoff	Peak discharge	= 667.18 cfs
Storm frequency	= 100 yrs	Time to peak	= 9.93 hrs
Time interval	= 2 min	Hyd. volume	= 2,982,844 cuft
Drainage area	= 100.000 ac	Curve number	= 91
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 4.00 min
Total precip.	= 9.86 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484



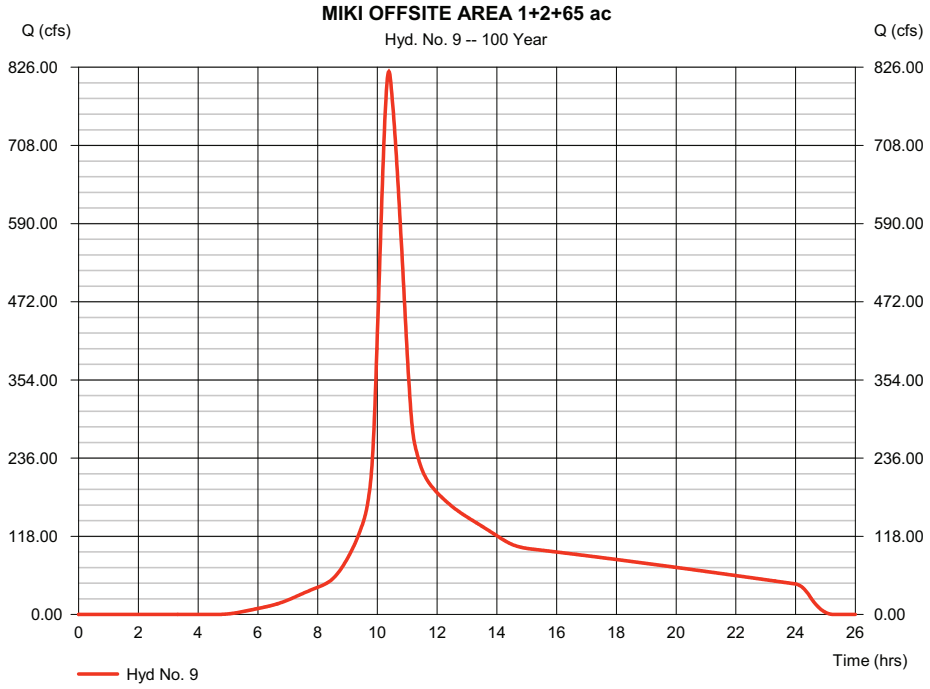
Hydrograph Report

Hyd. No. 9

MIKI OFFSITE AREA 1+2+65 ac

Hydrograph type	= SCS Runoff	Peak discharge	= 819.67 cfs
Storm frequency	= 100 yrs	Time to peak	= 10.38 hrs
Time interval	= 1 min	Hyd. volume	= 8,090,571 cuft
Drainage area	= 367.000 ac	Curve number	= 70*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 48.50 min
Total precip.	= 9.86 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(302.000 x 65) + (65.000 x 91)] / 367.000



1

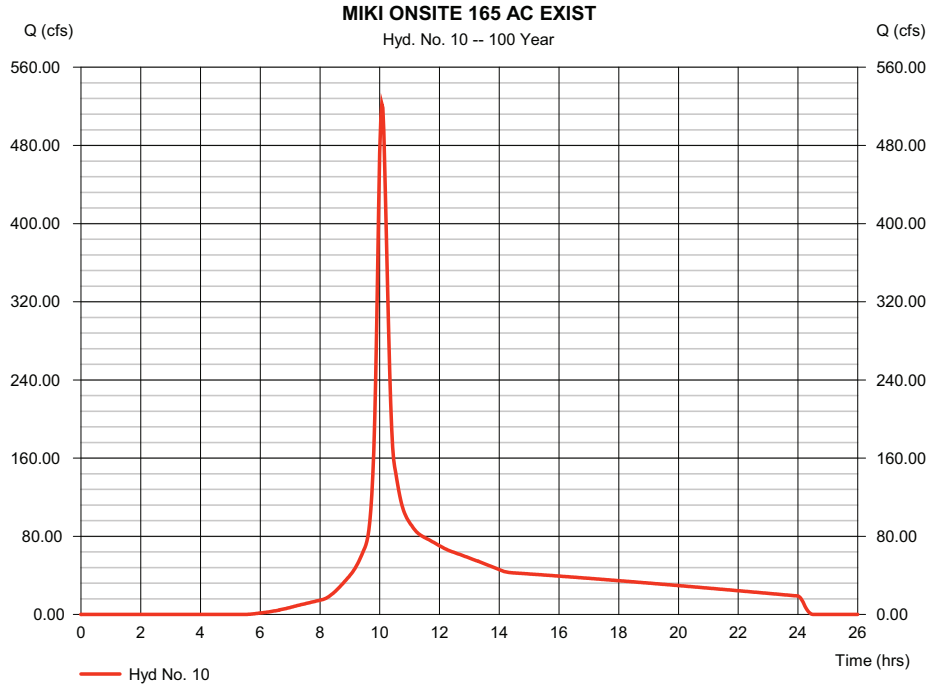
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2018 by Autodesk, Inc. v12 Monday, 11 / 5 / 2018

Hyd. No. 10

MIKI ONSITE 165 AC EXIST

Hydrograph type	= SCS Runoff	Peak discharge	= 522.53 cfs
Storm frequency	= 100 yrs	Time to peak	= 10.07 hrs
Time interval	= 2 min	Hyd. volume	= 3,261,255 cuft
Drainage area	= 165.000 ac	Curve number	= 65
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 17.00 min
Total precip.	= 9.86 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484



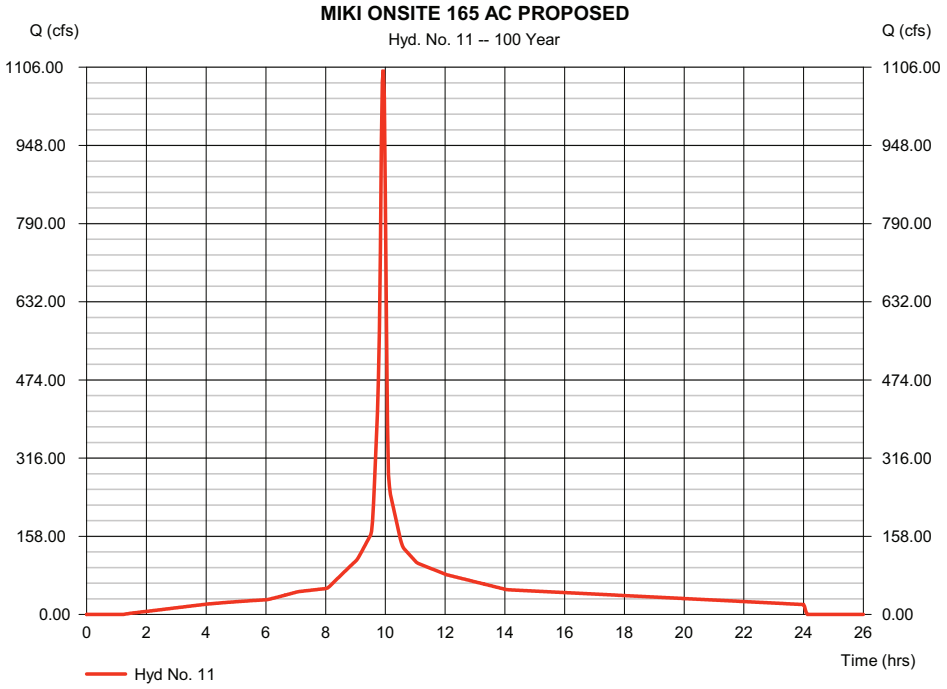
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2018 by Autodesk, Inc. v12 — Monday, 11 / 5 / 2018

Hyd. No. 11

MIKI ONSITE 165 AC PROPOSED

Hydrograph type	= SCS Runoff	Peak discharge	= 1100.85 cfs
Storm frequency	= 100 yrs	Time to peak	= 9.93 hrs
Time interval	= 2 min	Hyd. volume	= 4,921,690 cuft
Drainage area	= 165.000 ac	Curve number	= 91
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 6.50 min
Total precip.	= 9.86 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. — Monday, Nov 5 2018

8' X 8' Interceptor Ditch

Rectangular

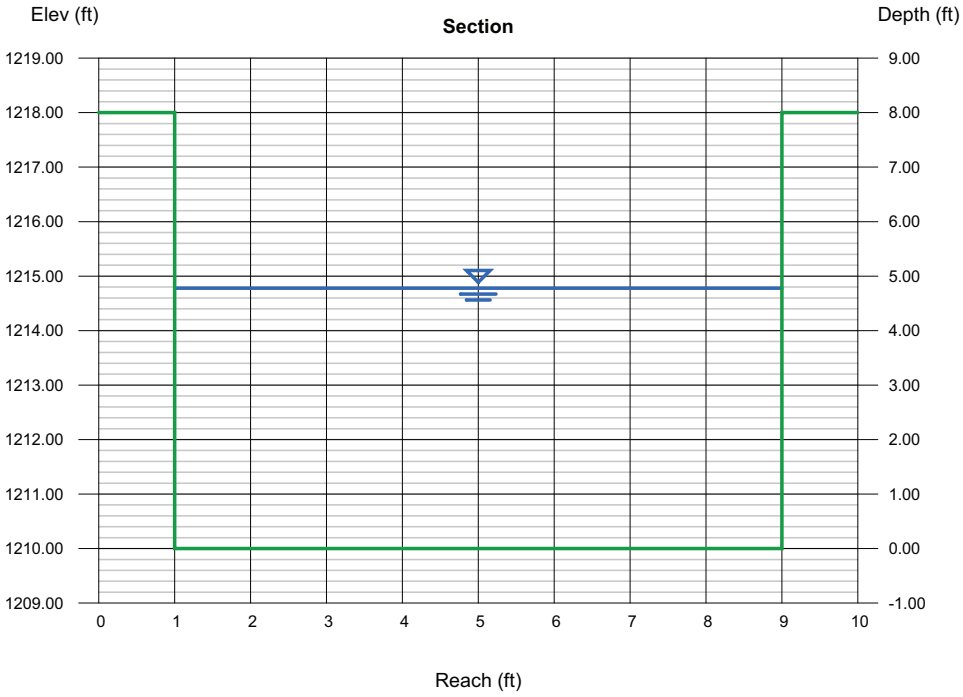
Bottom Width (ft)	= 8.00
Total Depth (ft)	= 8.00
Invert Elev (ft)	= 1210.00
Slope (%)	= 1.00
N-Value	= 0.013

Calculations

Compute by:	Known Q
Known Q (cfs)	= 732.60

Highlighted

Depth (ft)	= 4.78
Q (cfs)	= 732.60
Area (sqft)	= 38.24
Velocity (ft/s)	= 19.16
Wetted Perim (ft)	= 17.56
Crit Depth, Yc (ft)	= 6.39
Top Width (ft)	= 8.00
EGL (ft)	= 10.49

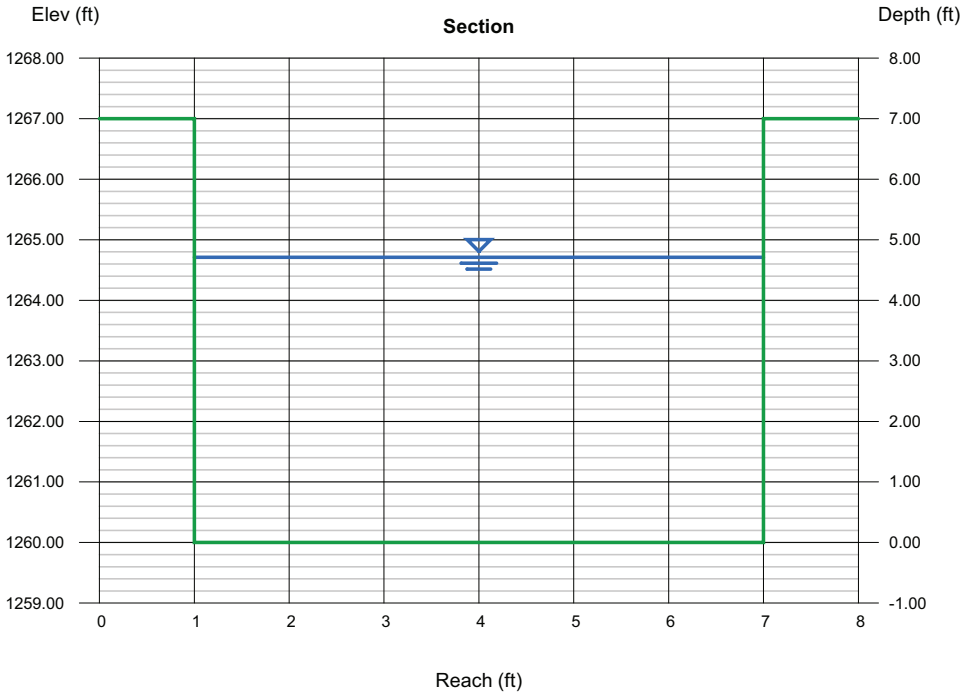


Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Monday, Nov 5 2018

6' X 7' Interceptor Ditch

Rectangular		Highlighted	
Bottom Width (ft)	= 6.00	Depth (ft)	= 4.71
Total Depth (ft)	= 7.00	Q (cfs)	= 483.00
		Area (sqft)	= 28.26
Invert Elev (ft)	= 1260.00	Velocity (ft/s)	= 17.09
Slope (%)	= 1.00	Wetted Perim (ft)	= 15.42
N-Value	= 0.013	Crit Depth, Yc (ft)	= 5.87
		Top Width (ft)	= 6.00
Calculations		EGL (ft)	= 9.25
Compute by:	Known Q		
Known Q (cfs)	= 483.00		

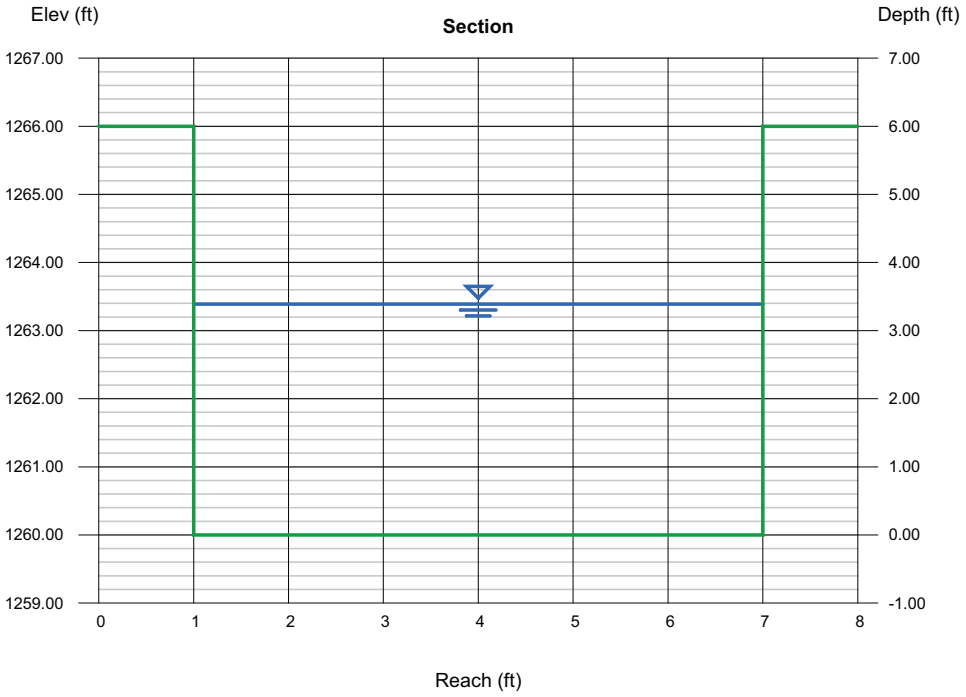


Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Monday, Nov 5 2018

6' X 6' Interceptor Ditch

Rectangular		Highlighted	
Bottom Width (ft)	= 6.00	Depth (ft)	= 3.39
Total Depth (ft)	= 6.00	Q (cfs)	= 316.50
		Area (sqft)	= 20.34
Invert Elev (ft)	= 1260.00	Velocity (ft/s)	= 15.56
Slope (%)	= 1.00	Wetted Perim (ft)	= 12.78
N-Value	= 0.013	Crit Depth, Yc (ft)	= 4.43
		Top Width (ft)	= 6.00
Calculations		EGL (ft)	= 7.15
Compute by:	Known Q		
Known Q (cfs)	= 316.50		



Channel Report

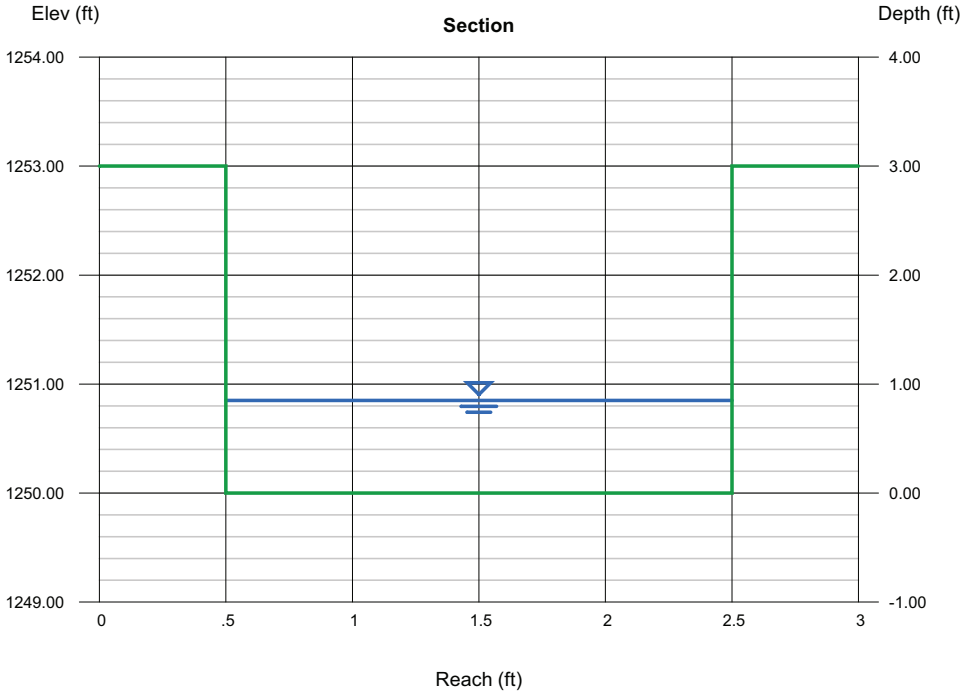
Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Monday, Nov 5 2018

2' X 3' Interceptor Ditch

Rectangular	
Bottom Width (ft)	= 2.00
Total Depth (ft)	= 3.00
Invert Elev (ft)	= 1250.00
Slope (%)	= 1.00
N-Value	= 0.013

Calculations	
Compute by:	Known Q
Known Q (cfs)	= 11.56

Highlighted	
Depth (ft)	= 0.85
Q (cfs)	= 11.56
Area (sqft)	= 1.70
Velocity (ft/s)	= 6.80
Wetted Perim (ft)	= 3.70
Crit Depth, Yc (ft)	= 1.02
Top Width (ft)	= 2.00
EGL (ft)	= 1.57



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Nov 2 2018

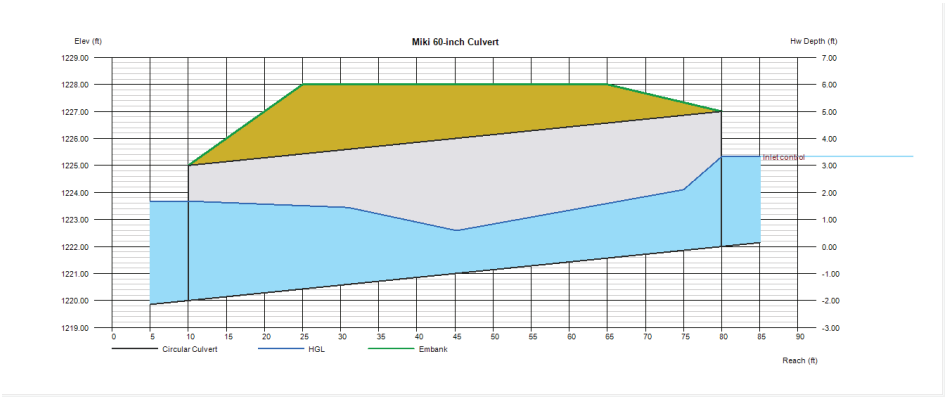
Miki 60-inch Culvert

Invert Elev Dn (ft)	= 1220.00
Pipe Length (ft)	= 70.00
Slope (%)	= 2.86
Invert Elev Up (ft)	= 1222.00
Rise (in)	= 60.0
Shape	= Circular
Span (in)	= 60.0
No. Barrels	= 1
n-Value	= 0.012
Culvert Type	= Circular Concrete
Culvert Entrance	= Square edge w/headwall (C)
Coeff. K,M,c,Y,k	= 0.0098, 2, 0.0398, 0.67, 0.5

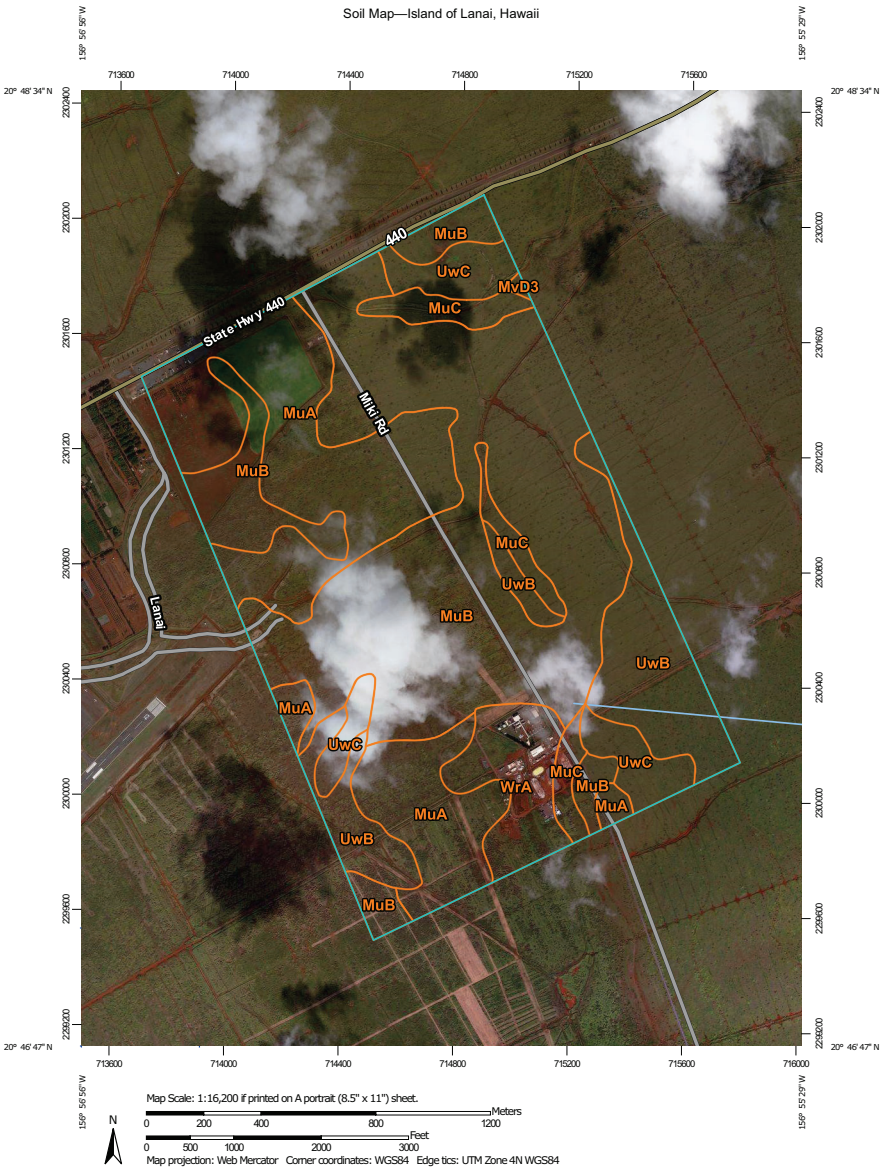
Embankment	
Top Elevation (ft)	= 1228.00
Top Width (ft)	= 40.00
Crest Width (ft)	= 80.00

Calculations	
Qmin (cfs)	= 69.91
Qmax (cfs)	= 69.91
Tailwater Elev (ft)	= (dc+D)/2

Highlighted	
Qtotal (cfs)	= 69.91
Qpipe (cfs)	= 69.91
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 4.51
Veloc Up (ft/s)	= 7.68
HGL Dn (ft)	= 1223.68
HGL Up (ft)	= 1224.36
Hw Elev (ft)	= 1225.33
Hw/D (ft)	= 0.67
Flow Regime	= Inlet Control



Soil Map—Island of Lanai, Hawaii



MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Island of Lanai, Hawaii
Survey Area Data: Version 13, Sep 11, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Dec 31, 2009—Feb 12, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
MuA	Molokai silty clay loam, 0 to 3 percent slopes, MLRA 158	193.2	26.3%
MuB	Molokai silty clay loam, 3 to 7 percent slopes, MLRA 158	346.1	47.1%
MuC	Molokai silty clay loam, 7 to 15 percent slopes, MLRA 158	29.0	3.9%
MvD3	Lithic Eutrotorrox, 15 to 25 percent slopes, severely eroded, MLRA 158	1.0	0.1%
UwB	Uwala silty clay loam, 2 to 7 percent slopes	84.6	11.5%
UwC	Uwala silty clay loam, 7 to 15 percent slopes	42.3	5.8%
WrA	Waikapu silty clay loam, 0 to 3 percent slopes, MLRA 158	38.8	5.3%
Totals for Area of Interest		**735.0**	**100.0%**

PROPOSED CONDITION CN
SOIL GROUP C

Table 2-2a Runoff curve numbers for urban areas [1]

Cover description: Cover type and hydrologic condition	Average percent impervious area [2]	Curve numbers for hydrologic soil group: A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

[1] Average runoff condition, and I_a = 0.2S.
[2] The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.
[3] CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.
[4] Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.
[5] Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

EXISTING CONDITION CN
SOIL GROUP C

Table 2-2c Runoff curve numbers for other agricultural lands [1]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. [2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element. [3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 [4]	48	65	73
Woods—grass combination (orchard or tree farm). [5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods. [6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 [4]	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

1 Average runoff condition, and $I_a = 0.2S$.
2 *Poor:* <50%) ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: > 75% ground cover and lightly or only occasionally grazed.
3 *Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.
4 Actual curve number is less than 30; use CN = 30 for runoff computations.
5 CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.
6 *Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

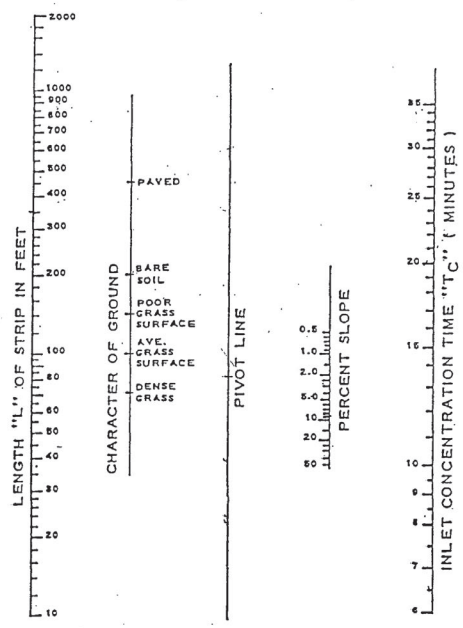
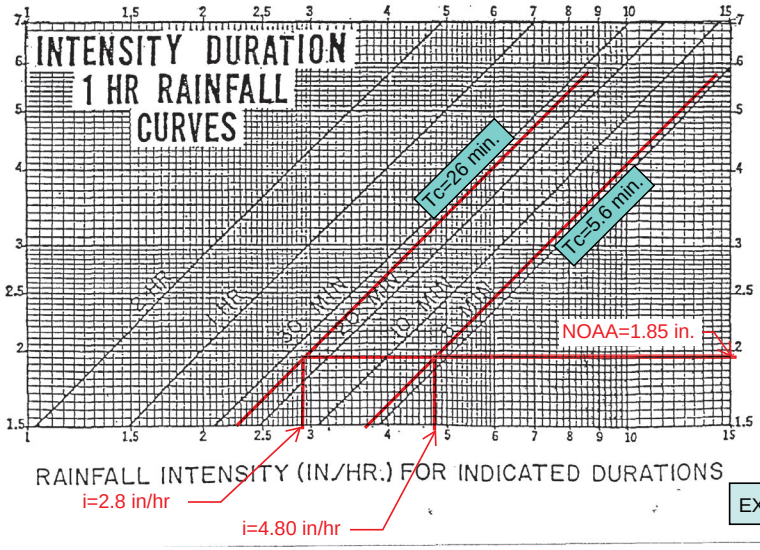


Plate 1

Overland Flow Chart

Plate 2



EXISTING

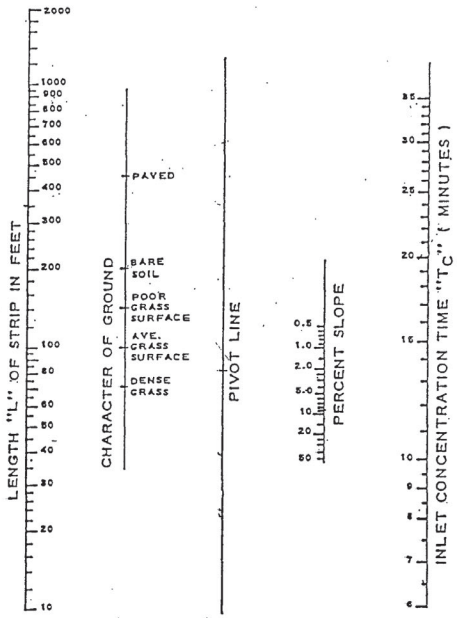
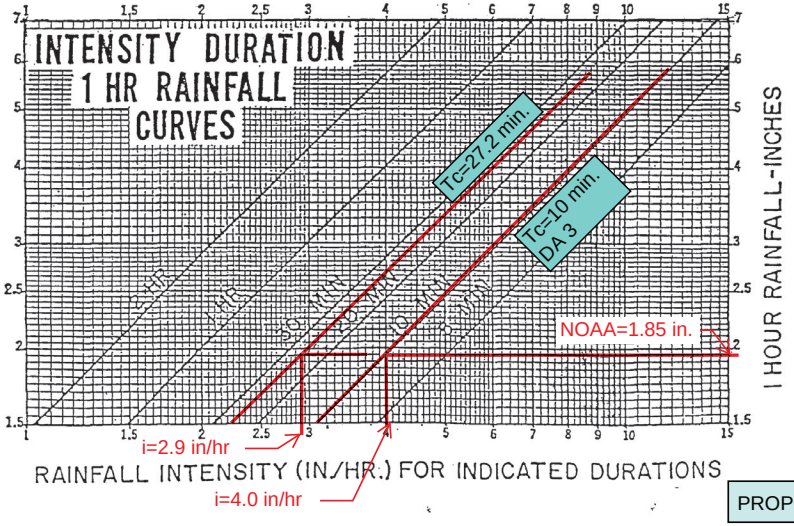


Plate 1

Overland Flow Chart

Plate 2



PROPOSED

NOAA Atlas 14, Volume 4, Version 3
Location name: Lanai City, Hawaii, USA*
Latitude: 20.7936°, Longitude: -156.9374°
Elevation: 1295.93 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

S. Perica, D. Martin, B. Lin, T. Parzybok, D. Riley, M. Yekta, L. Hiner, L.-C. Chen, D. Brewer, F. Yan, K. Maitaria, C. Trypaluk, G. M. Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.235 (0.208-0.293)	0.320 (0.260-0.388)	0.440 (0.354-0.534)	0.536 (0.430-0.655)	0.679 (0.535-0.838)	0.794 (0.621-0.992)	0.918 (0.708-1.16)	1.05 (0.798-1.35)	1.25 (0.922-1.63)	1.41 (1.02-1.88)
10-min	0.349 (0.308-0.434)	0.474 (0.386-0.575)	0.652 (0.525-0.792)	0.794 (0.638-0.971)	1.01 (0.794-1.24)	1.18 (0.921-1.47)	1.36 (1.05-1.72)	1.56 (1.18-2.00)	1.85 (1.37-2.42)	2.09 (1.51-2.78)
15-min	0.438 (0.387-0.545)	0.595 (0.485-0.722)	0.819 (0.660-0.994)	0.997 (0.801-1.22)	1.26 (0.997-1.56)	1.48 (1.16-1.85)	1.71 (1.32-2.16)	1.96 (1.49-2.51)	2.33 (1.72-3.04)	2.63 (1.90-3.49)
30-min	0.616 (0.544-0.768)	0.838 (0.682-1.02)	1.15 (0.929-1.40)	1.40 (1.13-1.72)	1.78 (1.40-2.20)	2.08 (1.63-2.60)	2.41 (1.85-3.04)	2.76 (2.09-3.54)	3.27 (2.42-4.28)	3.70 (2.67-4.91)
60-min	0.811 (0.716-1.01)	1.10 (0.898-1.34)	1.52 (1.22-1.84)	1.85 (1.48-2.26)	2.34 (1.85-2.89)	2.74 (2.14-3.42)	3.17 (2.44-4.00)	3.63 (2.75-4.65)	4.31 (3.18-5.63)	4.87 (3.51-6.47)
2-hr	1.12 (0.952-1.33)	1.48 (1.21-1.80)	2.04 (1.64-2.48)	2.47 (1.98-3.01)	3.08 (2.44-3.80)	3.58 (2.80-4.45)	4.08 (3.15-5.14)	4.63 (3.51-5.91)	5.41 (3.99-7.04)	6.02 (4.35-7.98)
3-hr	1.25 (1.05-1.48)	1.67 (1.36-2.02)	2.29 (1.85-2.78)	2.77 (2.23-3.38)	3.47 (2.75-4.28)	4.02 (3.15-5.01)	4.59 (3.55-5.79)	5.20 (3.94-6.64)	6.04 (4.47-7.89)	6.72 (4.86-8.92)
6-hr	1.58 (1.31-1.88)	2.09 (1.70-2.52)	2.88 (2.32-3.49)	3.50 (2.81-4.27)	4.38 (3.48-5.41)	5.08 (3.99-6.33)	5.82 (4.49-7.34)	6.59 (5.00-8.42)	7.67 (5.66-10.0)	8.53 (6.14-11.3)
12-hr	1.96 (1.62-2.36)	2.66 (2.16-3.22)	3.68 (2.97-4.47)	4.51 (3.62-5.51)	5.69 (4.52-7.03)	6.66 (5.22-8.29)	7.67 (5.92-9.66)	8.76 (6.64-11.2)	10.3 (7.60-13.4)	11.5 (8.30-15.3)
24-hr	2.37 (1.98-2.82)	3.26 (2.72-3.90)	4.57 (3.80-5.47)	5.64 (4.67-6.77)	7.20 (5.90-8.69)	8.48 (6.90-10.3)	9.86 (7.92-12.0)	11.4 (9.00-14.0)	13.6 (10.5-16.8)	15.4 (11.7-19.2)
2-day	2.75 (2.32-3.27)	3.82 (3.22-4.55)	5.36 (4.50-6.41)	6.65 (5.54-7.97)	8.50 (7.01-10.2)	10.0 (8.21-12.2)	11.7 (9.43-14.3)	13.5 (10.7-16.6)	16.1 (12.5-20.0)	18.2 (13.9-22.9)
3-day	2.93	4.07	5.71	7.06	8.99	10.6	12.3	14.2	16.8	19.0

	(2.48-3.49)	(3.43-4.85)	(4.79-6.83)	(5.89-8.47)	(7.43-10.8)	(8.67-12.8)	(9.94-15.0)	(11.3-17.4)	(13.1-20.9)	(14.5-23.8)
4-day	**3.12** (2.64-3.71)	**4.32** (3.65-5.15)	**6.06** (5.09-7.24)	**7.47** (6.24-8.96)	**9.49** (7.86-11.5)	**11.2** (9.14-13.5)	**12.9** (10.5-15.8)	**14.8** (11.8-18.2)	**17.5** (13.7-21.8)	**19.8** (15.1-24.8)
7-day	**3.60** (3.03-4.28)	**4.96** (4.17-5.92)	**6.91** (5.78-8.24)	**8.47** (7.04-10.1)	**10.7** (8.78-12.8)	**12.4** (10.1-15.1)	**14.3** (11.5-17.4)	**16.3** (12.9-20.0)	**19.1** (14.8-23.6)	**21.4** (16.2-26.7)
10-day	**4.03** (3.43-4.74)	**5.55** (4.71-6.54)	**7.67** (6.48-9.06)	**9.36** (7.87-11.1)	**11.7** (9.74-13.9)	**13.6** (11.2-16.2)	**15.5** (12.6-18.7)	**17.6** (14.1-21.3)	**20.4** (16.0-25.0)	**22.7** (17.4-28.0)
20-day	**5.12** (4.36-6.04)	**7.01** (5.94-8.27)	**9.59** (8.09-11.3)	**11.6** (9.72-13.7)	**14.3** (11.9-17.1)	**16.4** (13.5-19.7)	**18.5** (15.1-22.4)	**20.8** (16.6-25.2)	**23.8** (18.6-29.2)	**26.1** (20.0-32.3)
30-day	**5.82** (4.94-6.85)	**7.94** (6.73-9.37)	**10.8** (9.14-12.8)	**13.1** (11.0-15.5)	**16.1** (13.4-19.2)	**18.4** (15.2-22.1)	**20.8** (16.9-25.1)	**23.3** (18.6-28.3)	**26.6** (20.8-32.6)	**29.1** (22.4-36.1)
45-day	**7.16** (6.08-8.42)	**9.77** (8.28-11.5)	**13.3** (11.2-15.7)	**16.0** (13.4-19.0)	**19.6** (16.3-23.4)	**22.3** (18.3-26.8)	**25.1** (20.4-30.3)	**27.9** (22.3-33.9)	**31.7** (24.8-38.9)	**34.5** (26.5-42.8)
60-day	**8.07** (6.85-9.50)	**11.0** (9.30-13.0)	**14.9** (12.5-17.6)	**17.8** (14.9-21.1)	**21.7** (18.0-25.9)	**24.7** (20.3-29.6)	**27.7** (22.5-33.4)	**30.7** (24.6-37.3)	**34.7** (27.1-42.6)	**37.7** (28.9-46.7)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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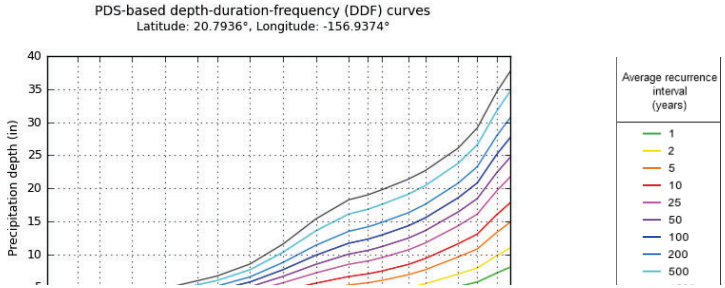
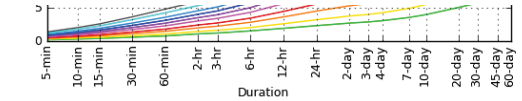
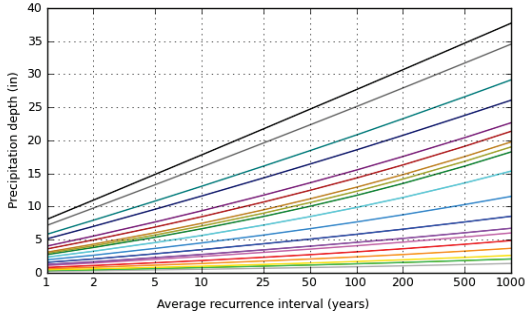
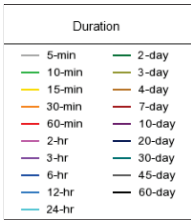
PF graphical









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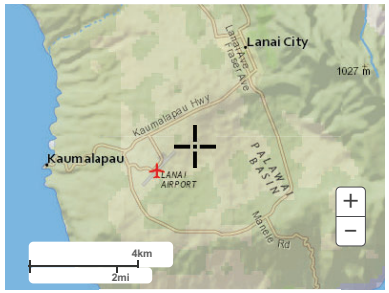
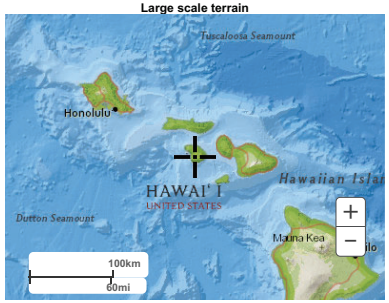
Small scale terrain

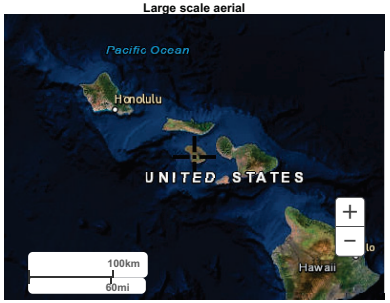


Large scale terrain



Large scale map

Large scale aerial



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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

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NOAA Atlas 14, Volume 4, Version 3
Location name: Lanai City, Hawaii, USA*
Latitude: 20.7907°, Longitude: -156.9376°
Elevation: 1246.73 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

S. Perica, D. Martin, B. Lin, T. Parzybok, D. Riley, M. Yekta, L. Hiner, L.-C. Chen, D. Brewer, F. Yan, K. Maitaria, C. Trypaluk, G. M. Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	2.82 (2.50-3.52)	3.84 (3.12-4.66)	5.28 (4.25-6.41)	6.43 (5.16-7.86)	8.15 (6.42-10.1)	9.53 (7.45-11.9)	11.0 (8.50-13.9)	12.6 (9.58-16.2)	15.0 (11.1-19.6)	16.9 (12.2-22.5)
10-min	2.09 (1.85-2.60)	2.84 (2.32-3.45)	3.91 (3.15-4.75)	4.76 (3.83-5.83)	6.04 (4.76-7.45)	7.06 (5.53-8.83)	8.17 (6.29-10.3)	9.37 (7.10-12.0)	11.1 (8.20-14.5)	12.6 (9.05-16.7)
15-min	1.75 (1.55-2.18)	2.38 (1.94-2.89)	3.28 (2.64-3.98)	3.99 (3.20-4.88)	5.06 (3.99-6.24)	5.91 (4.63-7.39)	6.84 (5.27-8.63)	7.85 (5.94-10.0)	9.30 (6.87-12.2)	10.5 (7.58-14.0)
30-min	1.23 (1.09-1.54)	1.68 (1.36-2.03)	2.30 (1.86-2.80)	2.81 (2.25-3.43)	3.56 (2.81-4.39)	4.16 (3.26-5.20)	4.81 (3.71-6.08)	5.52 (4.18-7.07)	6.55 (4.83-8.56)	7.39 (5.33-9.83)
60-min	0.811 (0.716-1.01)	1.10 (0.898-1.34)	1.52 (1.22-1.84)	1.85 (1.48-2.26)	2.34 (1.85-2.89)	2.74 (2.14-3.42)	3.17 (2.44-4.00)	3.63 (2.75-4.65)	4.31 (3.18-5.63)	4.87 (3.51-6.47)
2-hr	0.561 (0.476-0.666)	0.742 (0.604-0.898)	1.02 (0.822-1.24)	1.24 (0.989-1.51)	1.54 (1.22-1.90)	1.79 (1.40-2.22)	2.04 (1.58-2.57)	2.31 (1.76-2.96)	2.70 (1.99-3.52)	3.01 (2.17-3.99)
3-hr	0.417 (0.350-0.494)	0.554 (0.452-0.671)	0.763 (0.615-0.925)	0.923 (0.742-1.13)	1.15 (0.915-1.43)	1.34 (1.05-1.67)	1.53 (1.18-1.93)	1.73 (1.31-2.21)	2.01 (1.49-2.63)	2.24 (1.62-2.97)
6-hr	0.263 (0.219-0.315)	0.349 (0.283-0.421)	0.480 (0.388-0.583)	0.584 (0.469-0.713)	0.731 (0.581-0.903)	0.849 (0.665-1.06)	0.971 (0.750-1.23)	1.10 (0.835-1.41)	1.28 (0.946-1.67)	1.43 (1.03-1.89)
12-hr	0.163 (0.134-0.196)	0.220 (0.179-0.267)	0.306 (0.247-0.371)	0.374 (0.301-0.457)	0.473 (0.375-0.584)	0.553 (0.433-0.688)	0.637 (0.491-0.802)	0.727 (0.551-0.928)	0.855 (0.631-1.11)	0.958 (0.689-1.27)
24-hr	0.099 (0.082-0.118)	0.136 (0.114-0.163)	0.190 (0.158-0.228)	0.235 (0.195-0.282)	0.300 (0.246-0.362)	0.353 (0.287-0.429)	0.411 (0.330-0.502)	0.474 (0.375-0.582)	0.565 (0.438-0.702)	0.640 (0.486-0.802)
2-day	0.057 (0.048-0.068)	0.080 (0.067-0.095)	0.112 (0.094-0.133)	0.138 (0.115-0.166)	0.177 (0.146-0.213)	0.209 (0.171-0.253)	0.243 (0.197-0.297)	0.281 (0.224-0.345)	0.335 (0.261-0.416)	0.380 (0.290-0.476)
3-day	0.041 (0.034-0.048)	0.057 (0.048-0.067)	0.079 (0.067-0.095)	0.098 (0.082-0.118)	0.125 (0.103-0.151)	0.147 (0.120-0.178)	0.171 (0.138-0.208)	0.197 (0.157-0.242)	0.234 (0.182-0.290)	0.264 (0.202-0.331)
4-day	0.032 (0.027-0.039)	0.045 (0.038-0.054)	0.063 (0.053-0.075)	0.078 (0.065-0.093)	0.099 (0.082-0.119)	0.116 (0.095-0.141)	0.135 (0.109-0.164)	0.154 (0.123-0.190)	0.183 (0.143-0.227)	0.206 (0.157-0.258)
7-day	0.021 (0.018-0.025)	0.030 (0.025-0.035)	0.041 (0.034-0.049)	0.050 (0.042-0.060)	0.064 (0.052-0.076)	0.074 (0.060-0.090)	0.085 (0.069-0.104)	0.097 (0.077-0.119)	0.114 (0.088-0.141)	0.127 (0.097-0.159)
10-day	0.017 (0.014-0.020)	0.023 (0.020-0.027)	0.032 (0.027-0.038)	0.039 (0.033-0.046)	0.049 (0.041-0.058)	0.057 (0.047-0.068)	0.065 (0.053-0.078)	0.073 (0.059-0.089)	0.085 (0.067-0.104)	0.094 (0.073-0.117)
20-day	0.011 (0.009-0.013)	0.015 (0.012-0.017)	0.020 (0.017-0.024)	0.024 (0.020-0.029)	0.030 (0.025-0.036)	0.034 (0.028-0.041)	0.039 (0.031-0.047)	0.043 (0.035-0.053)	0.049 (0.039-0.061)	0.054 (0.042-0.067)
30-day	0.008 (0.007-0.010)	0.011 (0.009-0.013)	0.015 (0.013-0.018)	0.018 (0.015-0.022)	0.022 (0.019-0.027)	0.026 (0.021-0.031)	0.029 (0.023-0.035)	0.032 (0.026-0.039)	0.037 (0.029-0.045)	0.040 (0.031-0.050)
45-day	0.007 (0.006-0.008)	0.009 (0.008-0.011)	0.012 (0.010-0.015)	0.015 (0.012-0.018)	0.018 (0.015-0.022)	0.021 (0.017-0.025)	0.023 (0.019-0.028)	0.026 (0.021-0.031)	0.029 (0.023-0.036)	0.032 (0.025-0.040)
60-day	0.006 (0.005-0.007)	0.008 (0.006-0.009)	0.010 (0.009-0.012)	0.012 (0.010-0.015)	0.015 (0.013-0.018)	0.017 (0.014-0.021)	0.019 (0.016-0.023)	0.021 (0.017-0.026)	0.024 (0.019-0.030)	0.026 (0.020-0.032)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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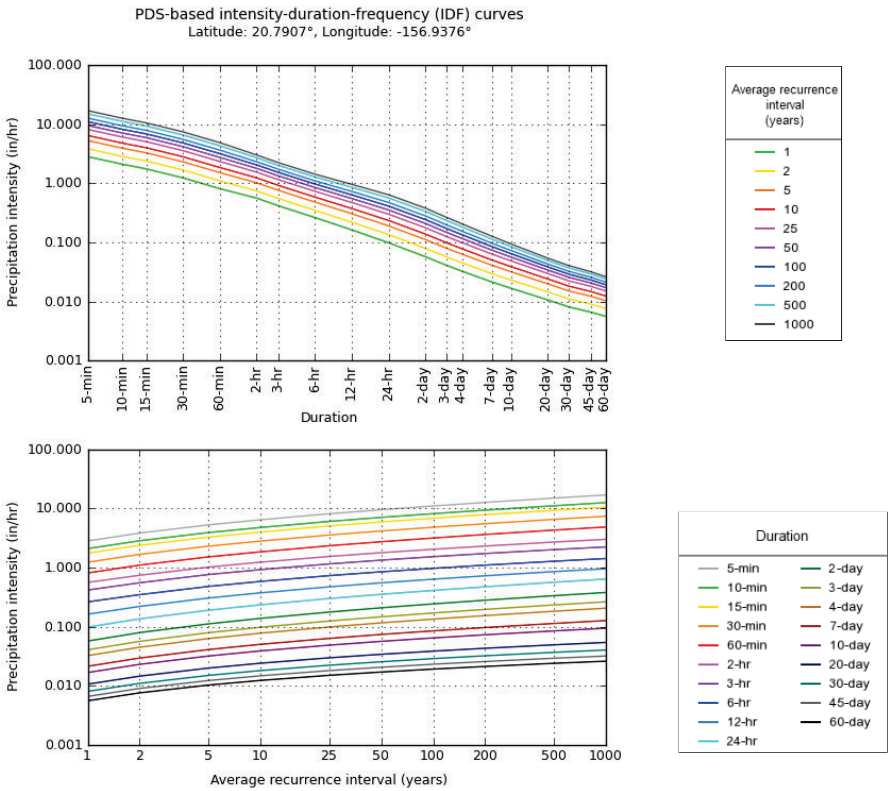
PF graphical



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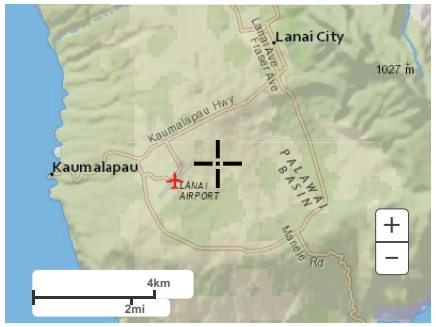
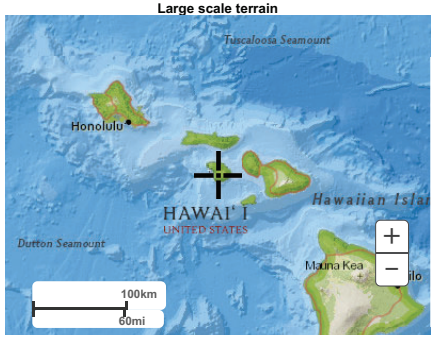
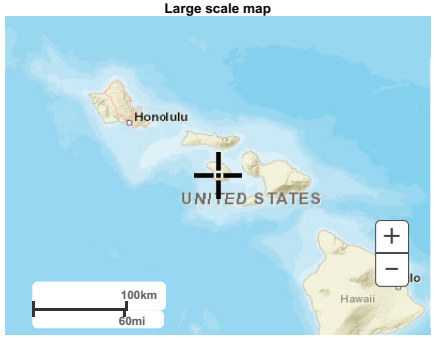


Large scale terrain



Large scale map



Large scale aerial

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National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

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Table 1

GUIDE FOR THE DETERMINATION OF RUNOFF COEFFICIENTS FOR BUILT-UP AREAS*

WATERSHED CHARACTERISTICS	EXTREME	HIGH	MODERATE	LOW
INFILTRATION	NEGLIGIBLE 0.20	SLOW 0.14	MEDIUM 0.07	HIGH 0.0
RELIEF	STEEP (> 25%) 0.08	HILLY (15 - 25%) 0.06	ROLLING (5 - 15%) 0.03	FLAT (0 - 5%) 0.0
VEGETAL COVER	NONE 0.07	POOR (< 10%) 0.05	GOOD (10 - 50%) 0.03	HIGH (50 - 90%) 0.0
DEVELOPMENT TYPE	INDUSTRIAL & BUSINESS 0.55	HOTEL - APARTMENT 0.45	RESIDENTIAL 0.40	AGRICULTURAL 0.15

NOTE: The design coefficient "c" must result from a total of the values for all four watershed characteristics of the site.

Table 2

RUNOFF COEFFICIENTS

Type of Drainage Area	Runoff Coefficient C
Business:	
Downtown areas	0.95
Neighborhood areas	0.70
Residential:	
Single-family areas	0.50
Multi-units, detached	0.60
Multi-units, attached	0.75
Suburban	0.40
Apartment dwelling areas	0.70
Industrial:	
Light areas	0.80
Heavy areas	0.90
Parks, cemeteries	0.25
Playgrounds	0.35
Railroad-yard areas	0.40
Unimproved areas	0.30
Streets:	
Asphaltic	0.95
Concrete	0.95
Brick	0.85
Drive and walks	0.85
Roofs	0.95
Lawns:	
Sandy, soil, flat, 2%	0.10
Sandy, soil, avg., 2-7%	0.15
Sandy, soil, steep, 7%	0.20
Heavy soil, flat, 2%	0.17
Heavy soil, avg., 2-7%	0.22
Heavy soil, steep, 7%	0.35

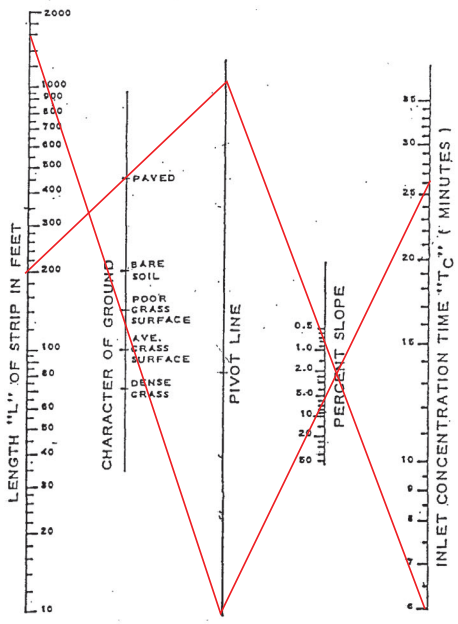

Plate 1

Overland Flow Chart

Plate 2