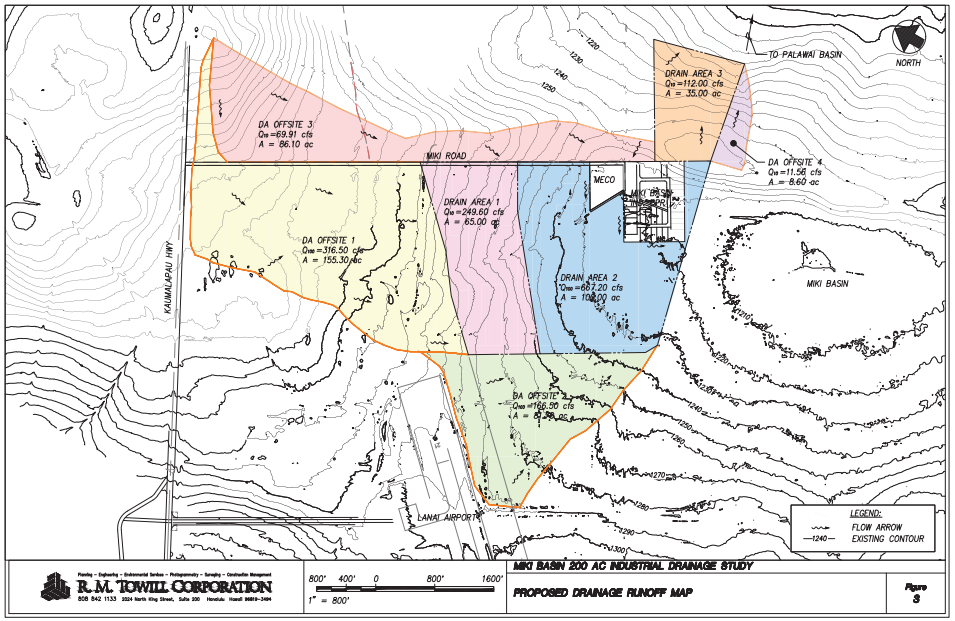
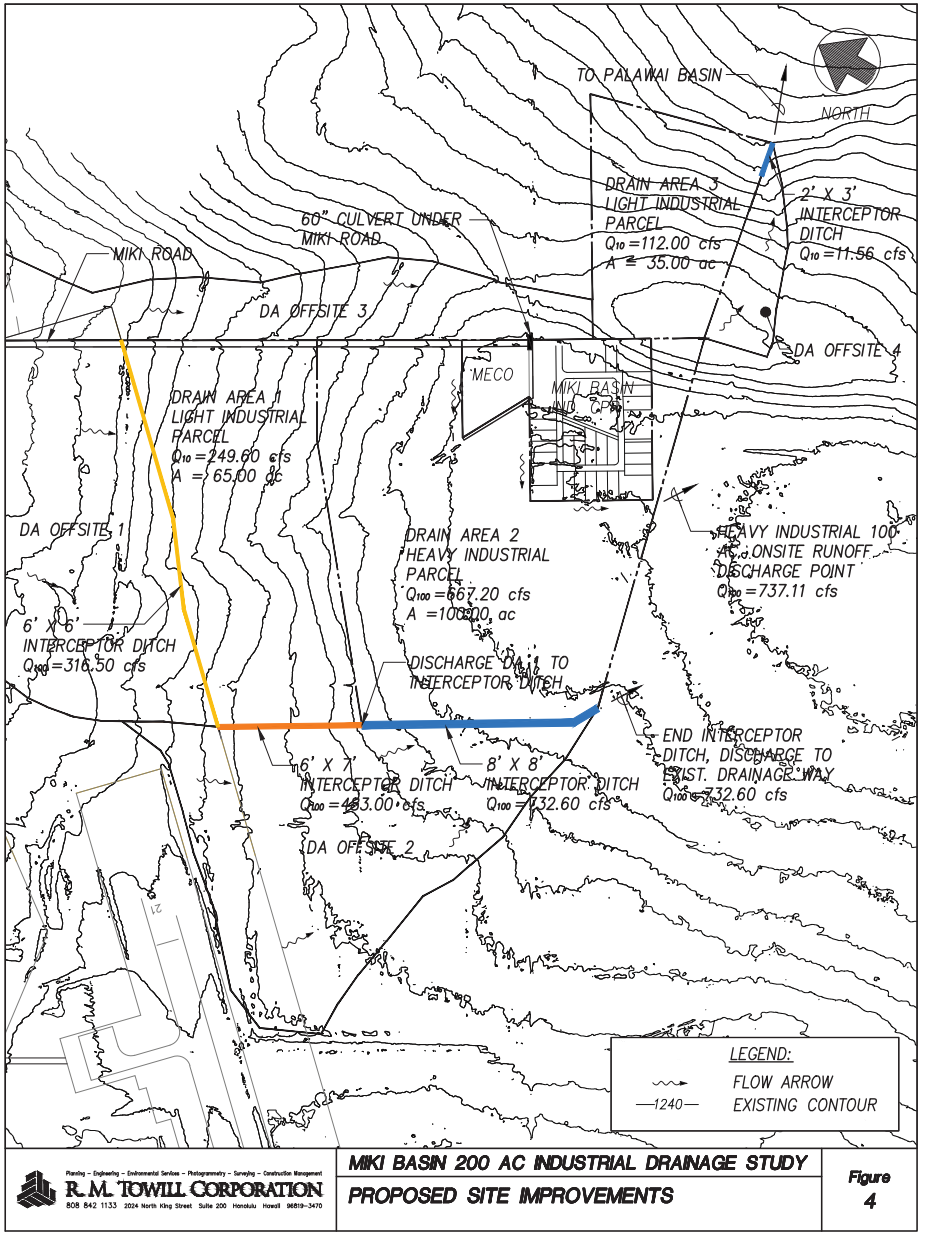

DA OFFSITE 3
Q100=69.91 cfs
A = 86.10 ac
DRAIN AREA 3
Q100=112.00 cfs
A = 35.00 ac
TO PALAWAI BASIN
NORTH
MIKI ROAD
DA OFFSITE 4
Q100=11.56 cfs
A = 8.60 ac
MECO
MIKI BASIN
DRAIN AREA 1
Q100=249.60 cfs
A = 65.00 ac
DA OFFSITE 1
Q100=316.50 cfs
A = 155.30 ac
DRAIN AREA 2
Q100=667.20 cfs
A = 100.00 ac
KAUMALAPAU HWY
DA OFFSITE 2
Q100=166.50 cfs
A = 82.70 ac
LANAI AIRPORT
LEGEND:
FLOW ARROW
1240 EXISTING CONTOUR
R.M. TOWILL CORPORATION
808 842 1133 2024 North King Street Suite 200 Honolulu Hawaii 96819-3404
800' 400' 0 800' 1600'
1" = 800'
MIKI BASIN 200 AC INDUSTRIAL DRAINAGE STUDY
PROPOSED DRAINAGE RUNOFF MAP
Figure 3


TO PALAWAI BASIN
NORTH
DRAIN AREA 3
LIGHT INDUSTRIAL
PARCEL
Q10 =112.00 cfs
A = 35.00 ac
2' X 3'
INTERCEPTOR
DITCH
Q10 =11.56 cfs
60" CULVERT UNDER
MIKI ROAD
MIKI ROAD
DA OFFSITE 3
DA OFFSITE 4
MECO
MIKI BASIN
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
808 842 1133 2024 North King Street Suite 200 Honolulu Hawaii 96819-3470
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

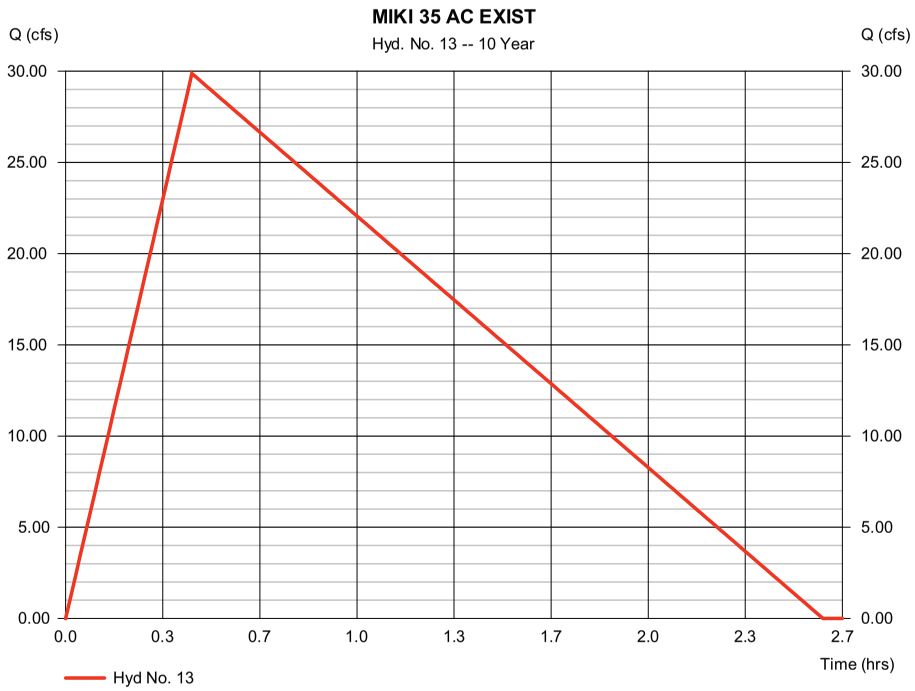
	TRIBUTARY SUBAREAS	AREA (acres)	WEIGHTED RUNOFF COEFFICIENT "C"	MAXIMUM LENGTH OF TRAVEL (feet)	DIFFERENCE IN ELEVATION (feet)	Slope %	k-value	TIME OF CONCENTRATION "Tc" (minutes)	10-YEAR "I" (in/hr)
EXISTING	DA 1 (Light Industrial)	65.00	0.28	1140	56.0	4.91%	5143.6	5.6	4.80
	DA 3 (Light Industrial)	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



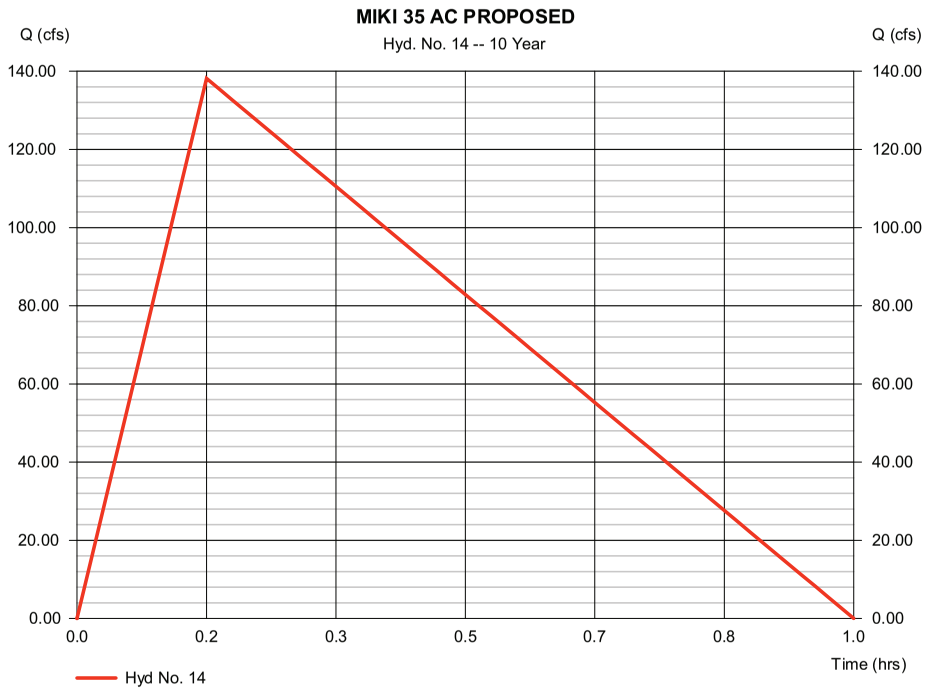
1

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



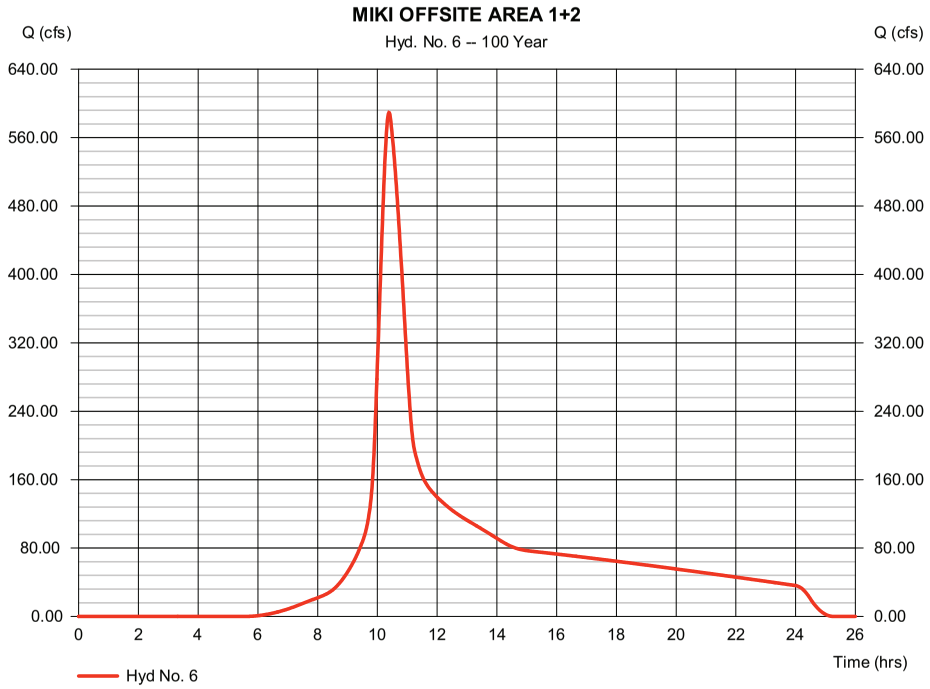
Hydrograph Report

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



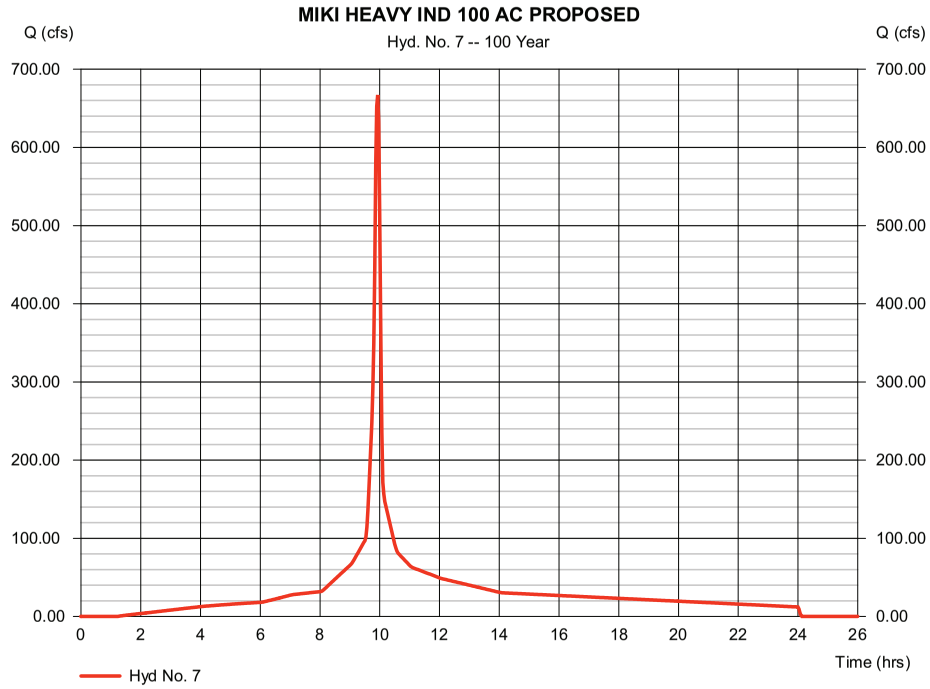
1

Hydrograph Report

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



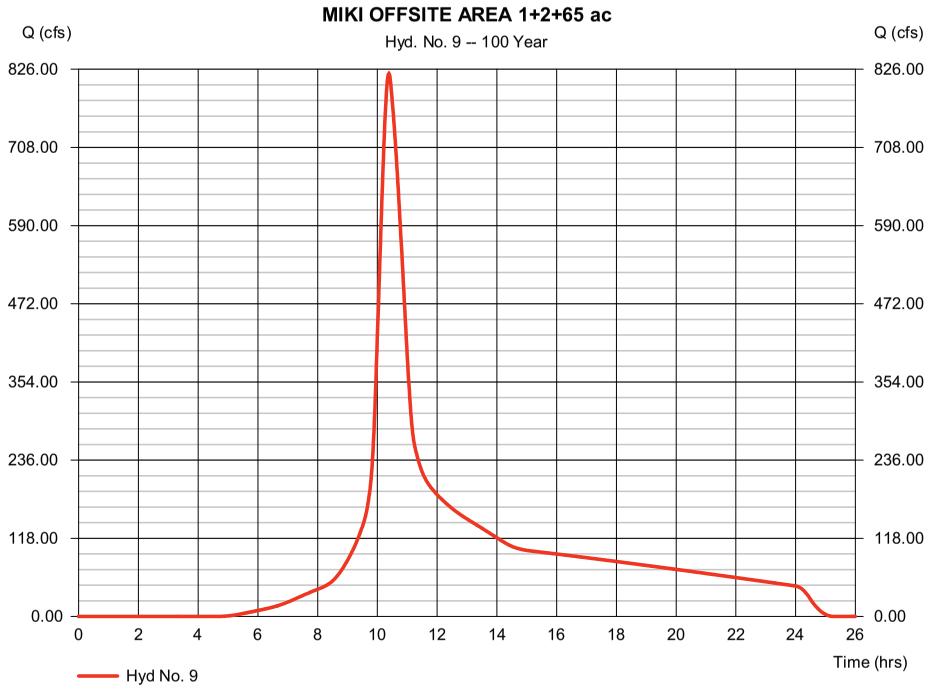
Hydrograph Report

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



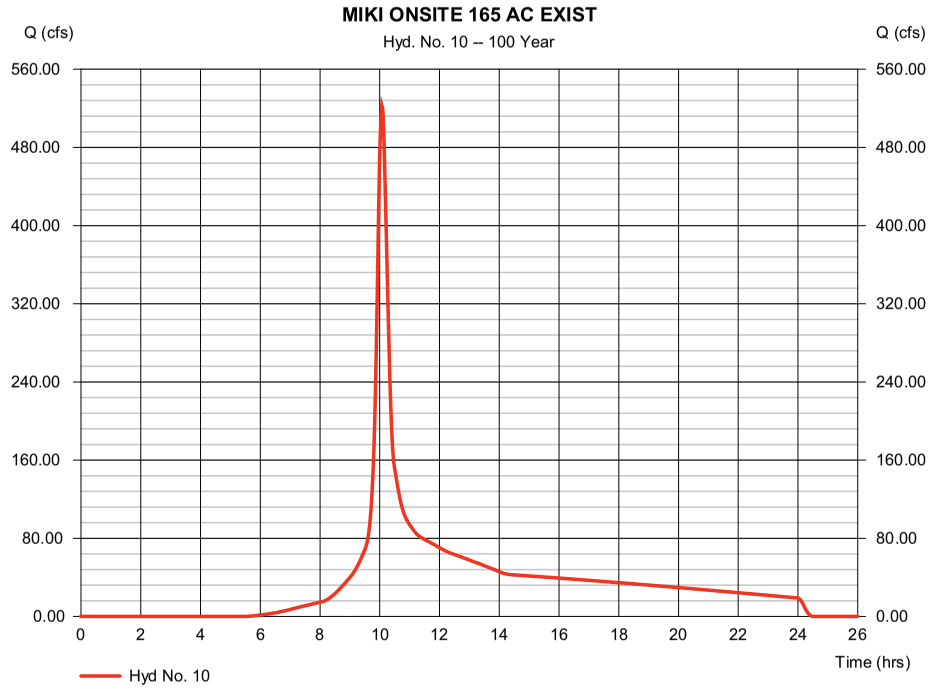
1

Hydrograph Report

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



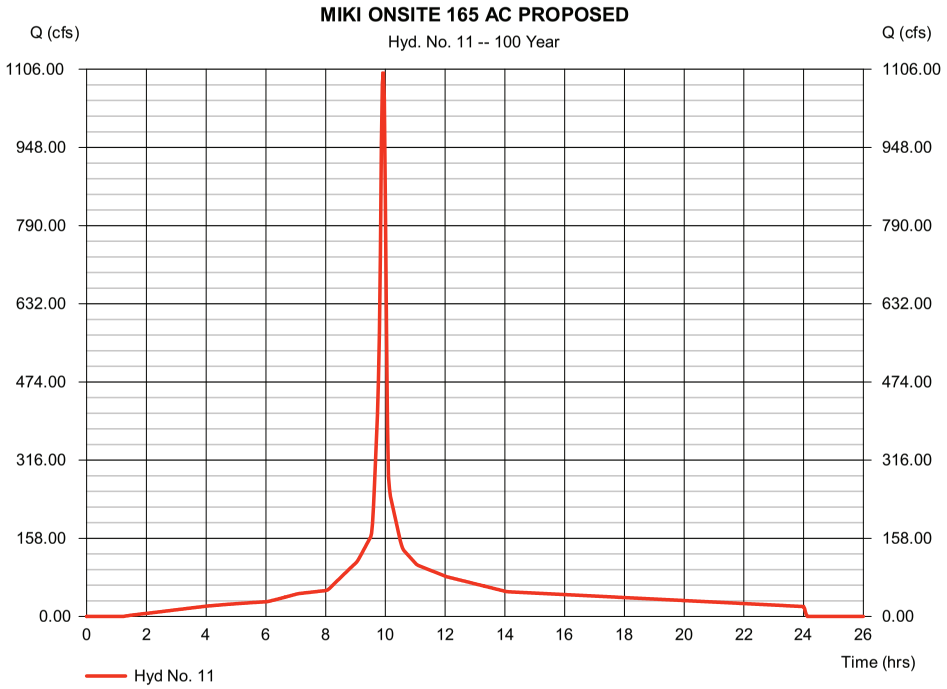
Hydrograph Report

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

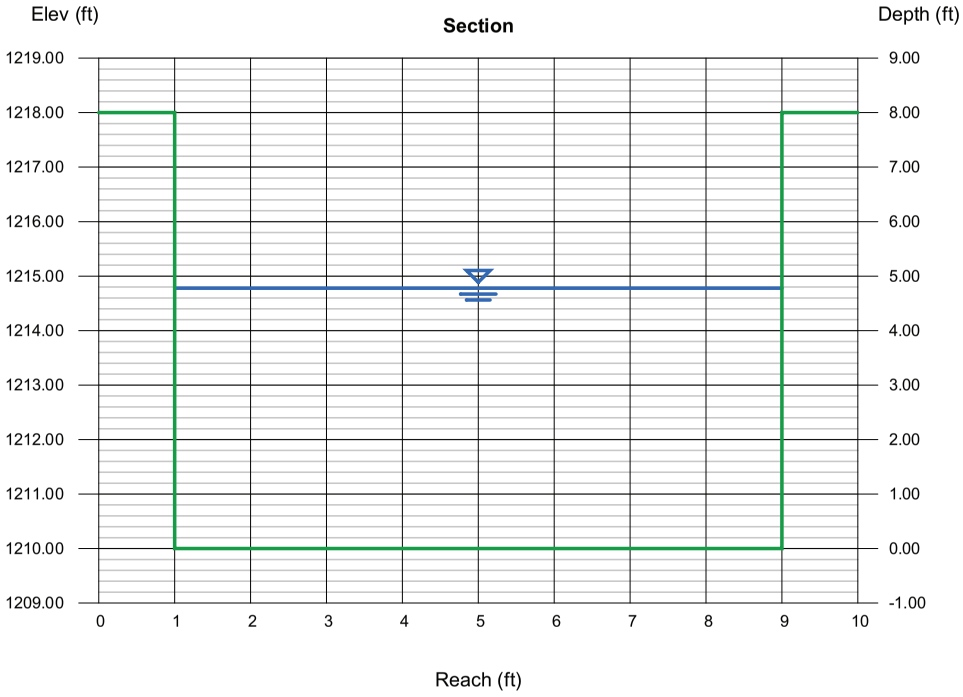
Bottom Width (ft)	= 8.00
Total Depth (ft)	= 8.00
Invert Elev (ft)	= 1210.00
Slope (%)	= 1.00
N-Value	= 0.013

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

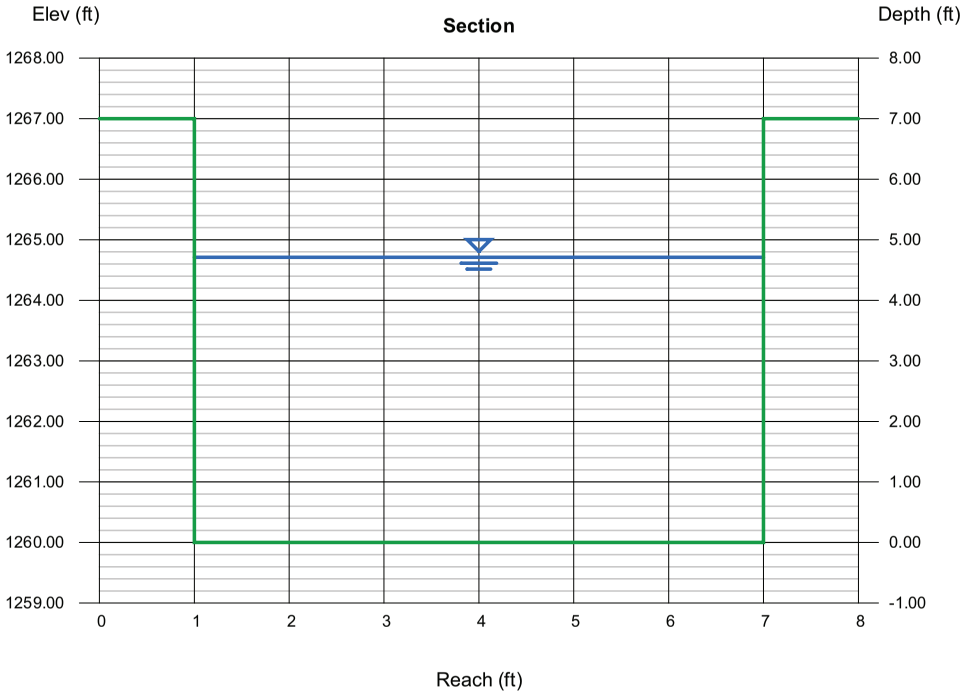


Channel Report

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		

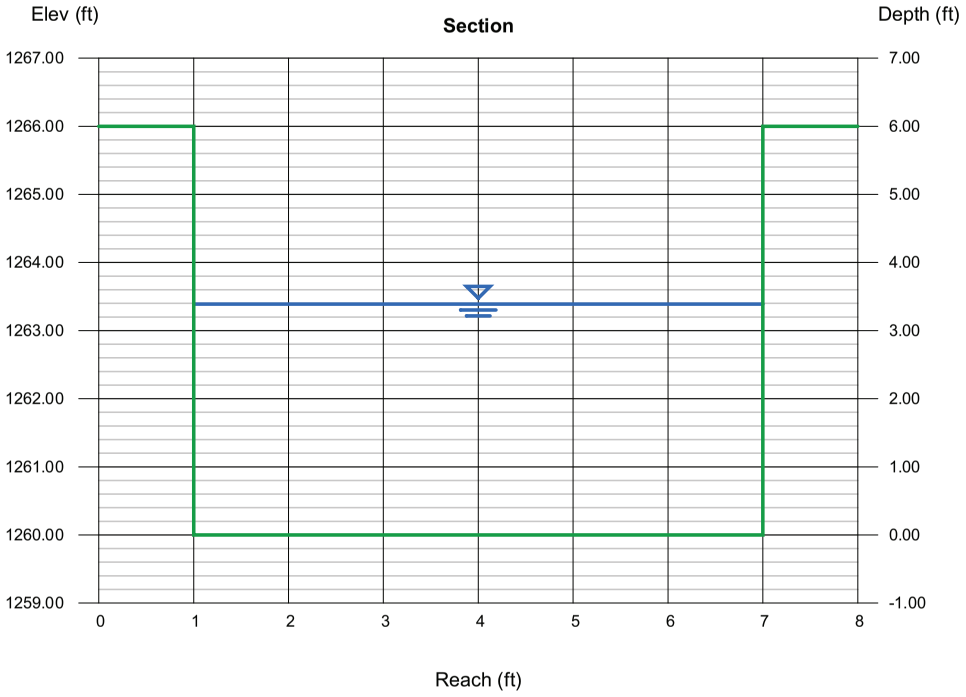


Channel Report

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

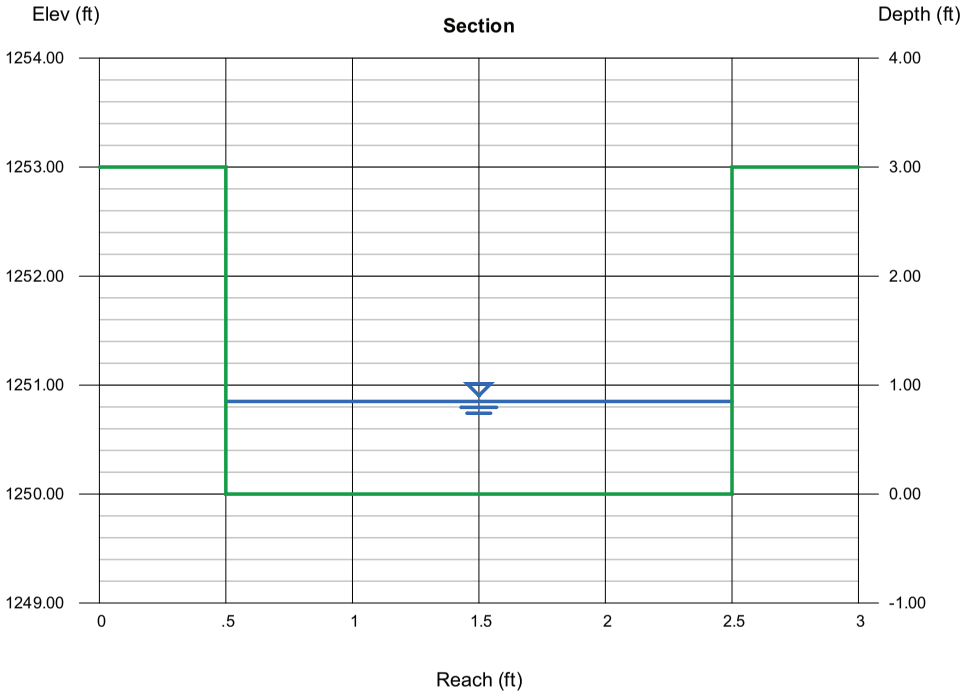
Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Monday, Nov 5 2018

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

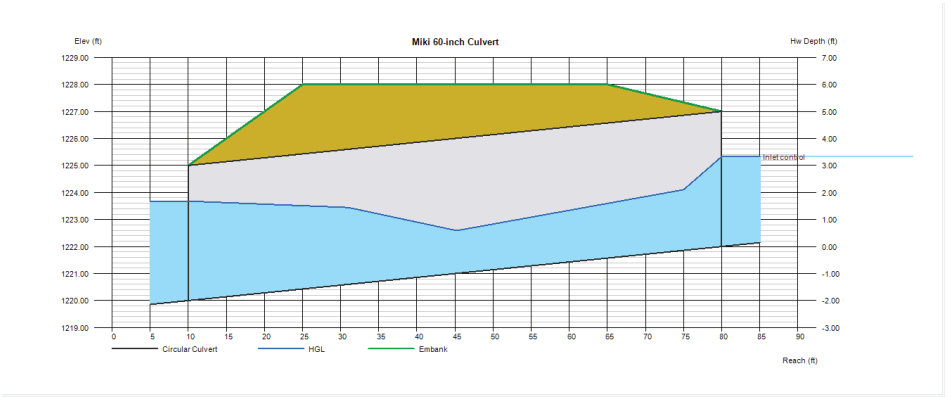
Miki 60-inch Culvert

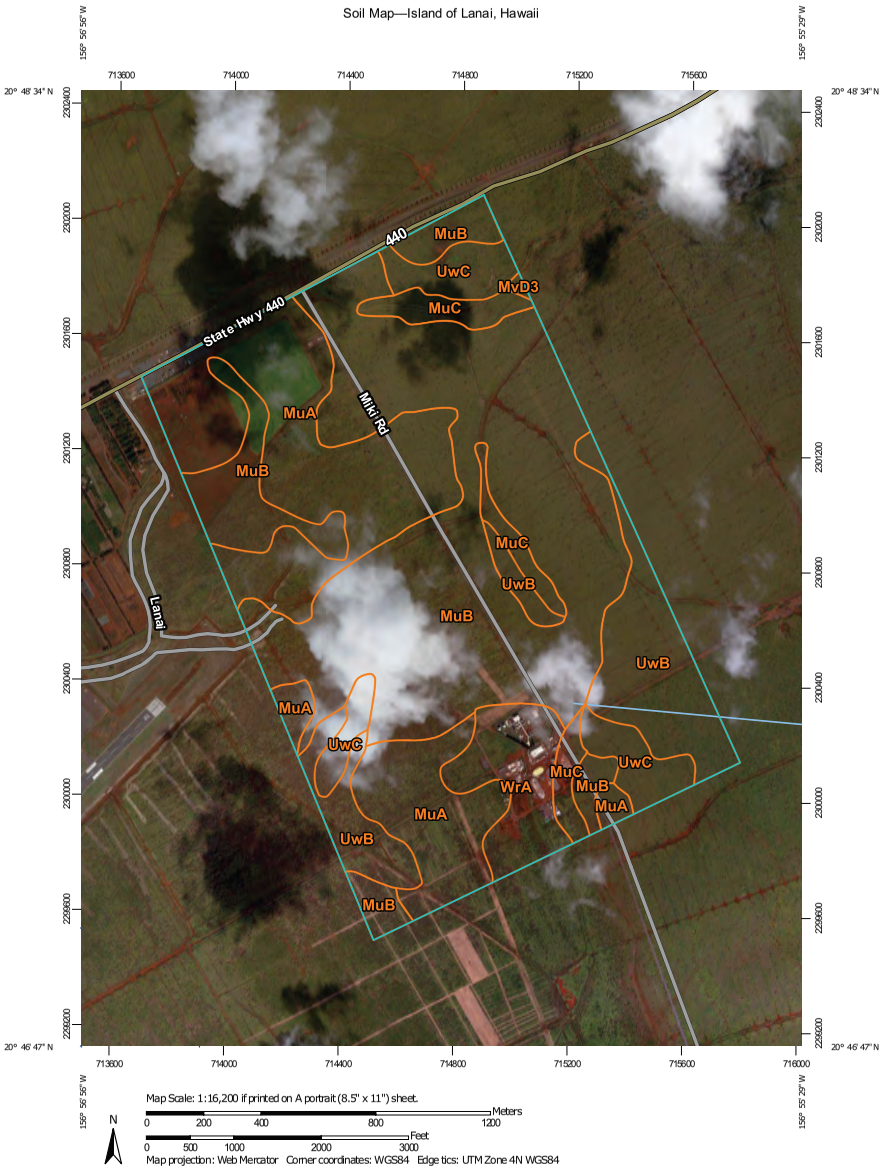
Invert Elev Dn (ft)	= 1220.00
Pipe Length (ft)	= 70.00
Slope (%)	= 2.86
Invert Elev Up (ft)	= 1222.00
Rise (in)	= 60.0
Shape	= Circular
Span (in)	= 60.0
No. Barrels	= 1
n-Value	= 0.012
Culvert Type	= Circular Concrete
Culvert Entrance	= Square edge w/headwall (C)
Coeff. K,M,c,Y,k	= 0.0098, 2, 0.0398,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





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.

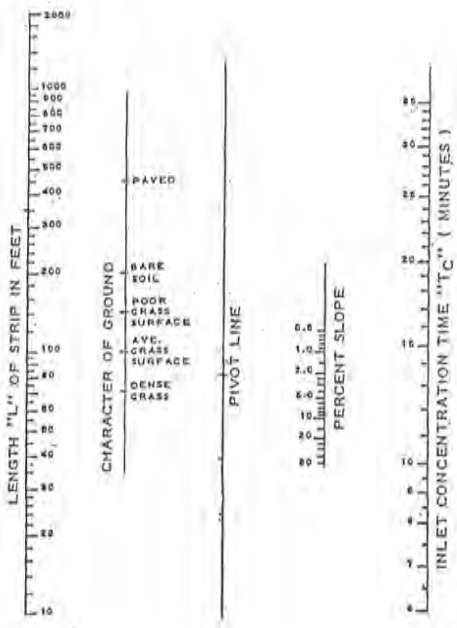
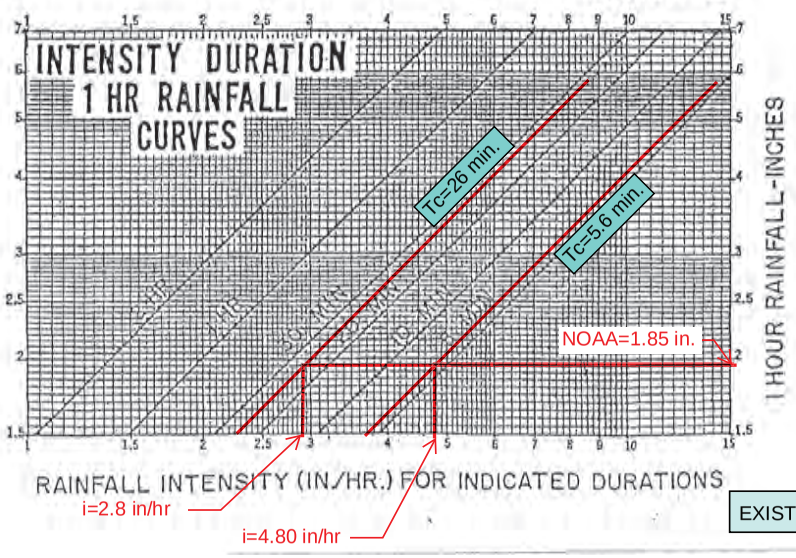


Plate 1

Overland Flow Chart

Plate 2



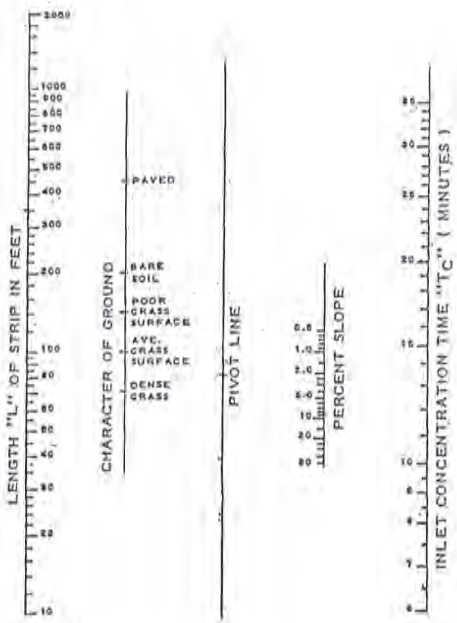
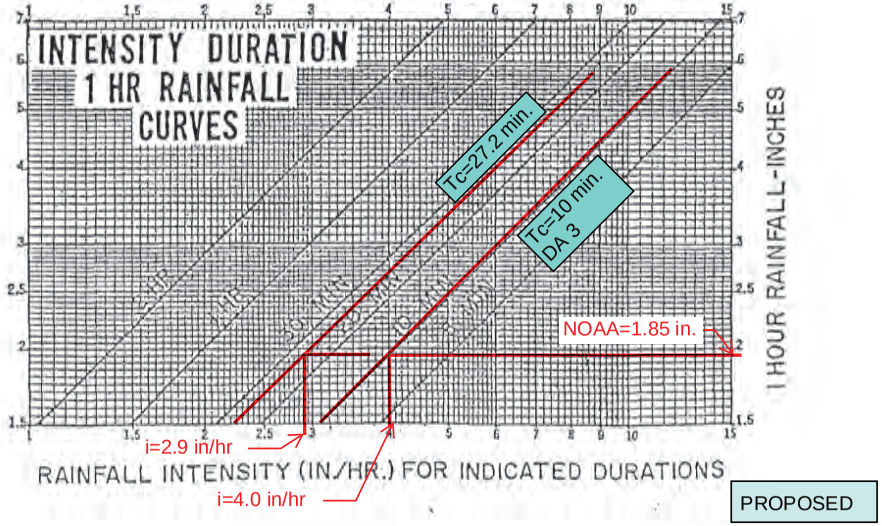


Plate 1

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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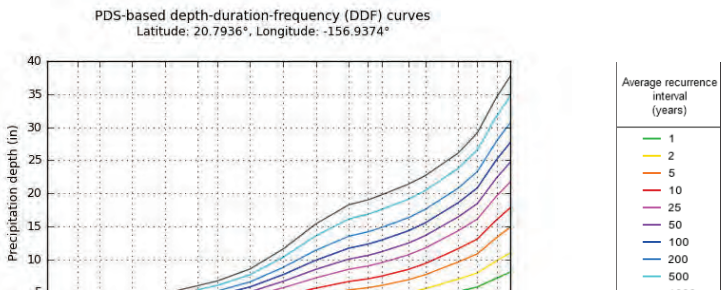
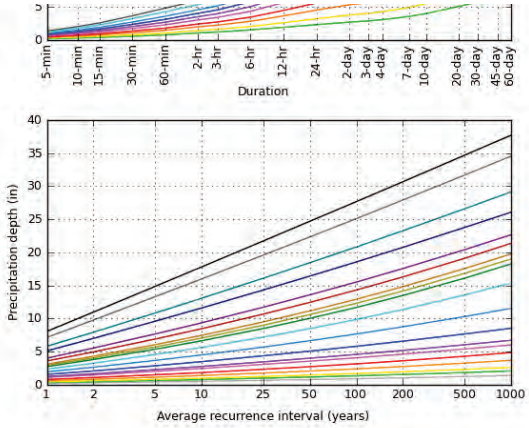
PF graphical





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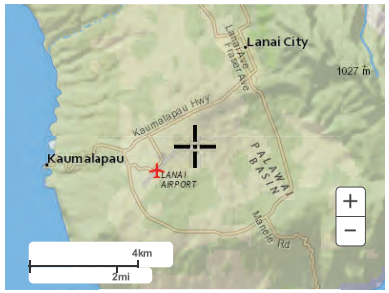
Maps & aerials

Small scale terrain



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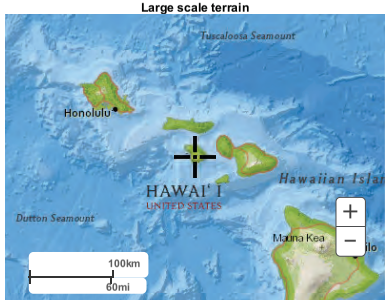

Large scale map

Large scale aerial

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

Disclaimer

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

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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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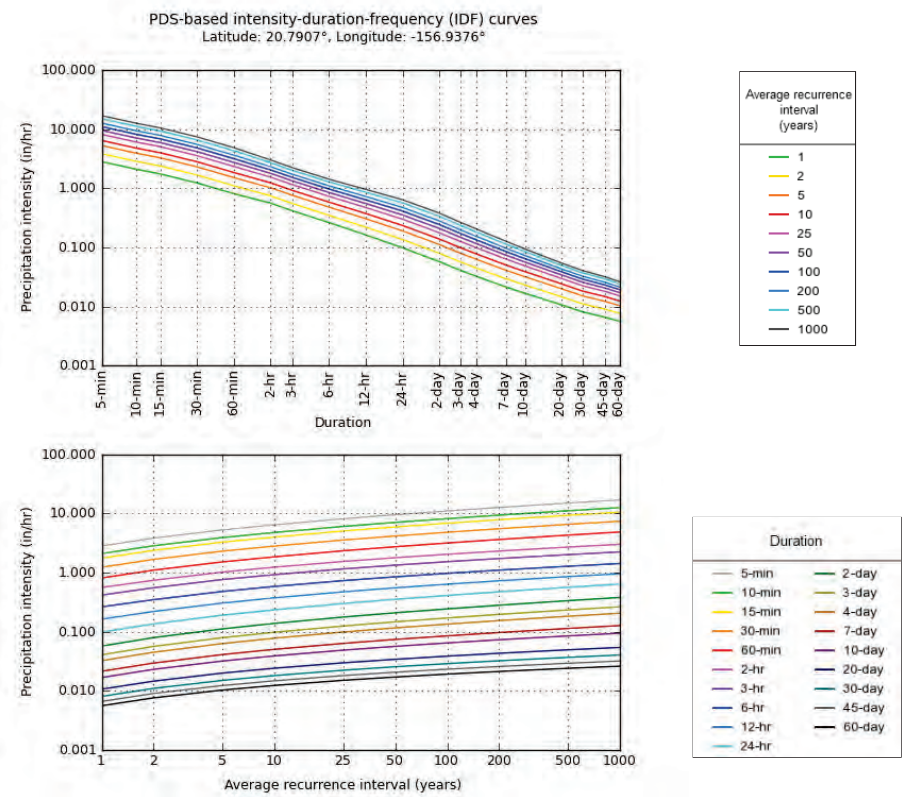
PF graphical



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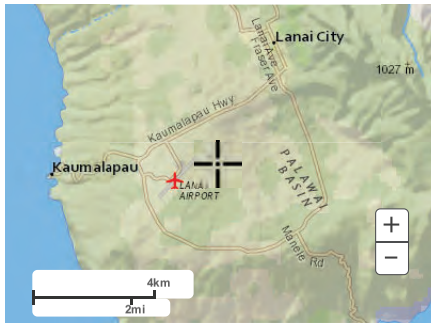
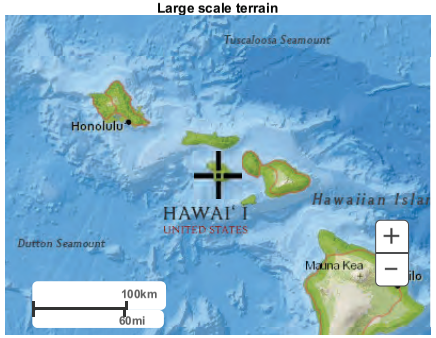
Maps & aerials

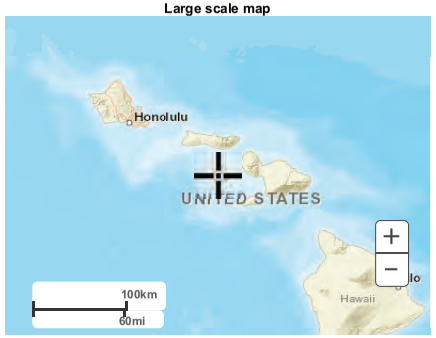
Small scale terrain



Large scale terrain



Large scale map



Large scale aerial

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Disclaimer

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

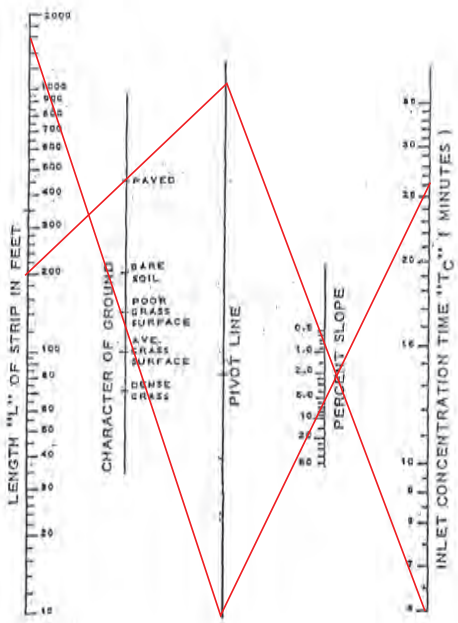

Plate 1

Overland Flow Chart

Plate 2