APPENDIX C

PRELIMINARY HYDROLOGY AND WATER QUALITY STUDY (BWE 2017)

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PRELIMINARY HYDROLOGY AND WATER QUALITY STUDY

Voigt Parking Structure – CEQA Submittal
UCSD Campus
Voigt Drive At Engineer Lane
La Jolla, California 92093

Prepared By:

BWE

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San Diego, CA 92123

Date: July 3, 2017

Table of Contents

Appendices

1. Purpose

The purpose of this hydrology and water quality study is to analyze the existing and proposed drainage patterns and peak flow rates associated with the proposed Voigt Parking Structure project. The 10 year, 6-hr storm is the design storm frequency used for this study. This design criteria satisfies the minimum requirements of UCSD's Drainage Design Guidelines. The basic design criteria and objectives used in this study are to;

- Analyze the peak flow rate of the 10 year, 6-hour storm frequency at each outlet location
- Design stormwater best management practices (BMPs) to maintain the 10 year, 6-hour frequency peak flow rate from this development.
- Analyze and ensure the proposed development is able to bypass the peak flow rate of the 100 year 6-hour frequency storm.

This hydrology study is prepared based on the UCSD Drainage Design Policy and utilizing the County of San Diego Hydrology Manual (2003 edition).

2. Project Description

The proposed Voigt Parking Structure is located within the limits of the City of San Diego on the University of California San Diego campus. The project site is located at the corner of Voigt Drive and Engineer Lane with associated circulation and public realm improvements extending outward from the site.

The project consists of the a proposed parking structure southwest of the intersection of Voigt Drive and Engineer Lane, bike and pedestrian paths from the Price Center to Warren Mall, and pedestrian and bike paths from the proposed parking structure to Hopkins Lane. The project's total disturbed area is approximately 6.6 acres.

3. Existing Conditions

Existing improvements at the site of the proposed parking structure include Parking Lot P503, Engineer Lane, and associated sidewalks and landscaping. An asphalt path currently extends from Warren Mall to Hopkins Lane. This area drains to an analysis point at the boundary in the unnamed canyon to the west of Parking Lot P503. The area between Warren Mall and the Price Center contains concrete, asphalt, and paver walkways which flow to a single analysis point in the unnamed canyon.

The runoff from the entire project site discharges to an unnamed canyon between Voigt Drive and the Geisel Library. The unnamed canyon ultimately discharges to

Los Penasquitos Lagoon. See the Existing Condition Hydrology Maps in Appendix B for basin delineations.

4. Proposed Improvements

Drainage basins and analysis points for the proposed condition match that in the existing condition to the maximum extent practical. The proposed development will mitigate the 10-year, 6-hour storm and will have the capacity to bypass the 100-year, 6-hour storm. The proposed development generally maintains existing flow patterns and peak flow rates of the existing conditions. Because the peak flow rate from the overall site is mitigated, the project will not create adverse impacts to the existing receiving storm drain system and downstream properties.

Proposed improvements include a 1.7 acre Parking Structure, adjacent and rooftop pedestrian paths, improvements along Engineer Lane, and pedestrian and bicycle paths extending from Warren Mall to Hopkins Lane. Approximately 70% of the Parking Structure’s roof level will be covered by landscaping and decomposed granite (DG). Proposed public realm improvements include bicycle and pedestrian paths from Warren Mall to the Price Center, as well as adjacent landscaping improvements.

Peak flow mitigation will be achieved by routing runoff from the parking structure to biofiltration planters on the structure’s western exterior face, and at the bottom of the two light-wells. These planters will detain runoff from the 10-year, 6-hour storm before flowing to planters below, and eventually the unnamed canyon.

The proposed site complies with water balance requirements through the use of site design measures. Approximately 2000 square-feet of amended soil areas are proposed between the parking structure and Engineer Lane to meet the requirements of the water balance calculator. The peak flow rate for the 10 year 6 hour storm frequency will be mitigated by biofiltration planters staggered along the western face of the parking structure.

See the Proposed Condition Hydrology Maps in Appendix B for basin delineations.

5. Soil Characteristics

The site is comprised of hydrologic soil group D based on the County of San Diego Soil Hydrologic Group Maps. Therefore, this hydrology analysis is performed by using design parameter for soil type D.

6. Calculations

6.a. Impervious and Pervious Areas:

The pervious and impervious areas are summarized for both the existing and proposed conditions in Table 6-1.

Table 6-1. Voigt Parking Structure Impervious area

	Area (Acres)			Percent Impervious Area	Percent Pervious Area
	Total	Impervious (Ai)	Pervious (Ap)		
Existing	6.73	1.80	4.93	26.8%	73.2%
Proposed	6.73	2.70	4.03	40.2%	59.8%
% Change	0.0%	50.1%	-18.3%		

Impervious area increases by approximately 39,200 SF in the proposed condition.

6.b. Runoff Coefficient:

The runoff coefficient for the site is calculated by using equation provided in Section 3.1.2 of the County of San Diego Hydrology Manual. The runoff coefficient C is calculated using the following formula;

C = 0.90 x (% Impervious) + Cp x (1 - % Impervious)

Where,

Cp = Pervious Coefficient Runoff Value for the soil type shown in Table 3-1 as Undisturbed Natural Terrain/Permanent Open Space.

Cp = 0.35 is used for Soil Type D

For this site, the existing and proposed runoff coefficients (C) are calculated to be 0.50 and 0.57 respectively. Calculations are provided in Appendix C.

6.c. Peak Flow Rates:

The rational method estimates the peak rate of runoff as a function of the Runoff Coefficient (C), tributary areas (A), and the Rainfall intensity (I) for a duration equal to the time of concentration (Tc) as follows;

Q = CIA

Where,
Q = Peak Runoff rate (cfs)
C = Runoff Coefficient
I = Rainfall Intensity (in/hr)
A = Tributary Area (acres)

The 2004 LRDP Environmental Impact Report requires that all developments that will increase impervious surfaces by 10,000 square feet or more shall maintain the peak flow rate for the 10-year, 6-hour storm event.

A peak flow rate analysis for the 10-year, 6-hour frequency storm is performed by utilizing the rational method formula. Time of concentrations (Tc) for are determined by utilizing the CivilD computer program. The peak flow rates at each drainage analysis/discharge point are tabulated below for the comparison purposes. See Appendices B, and C for details.

Table 6-2. Peak Flow Summary For Voigt Parking Structure

	Area (acres)		**10 yr, 6-hr Flow Rate (cfs)**		
	Existing Condition	**Proposed Condition**	**Existing Condition**	**Proposed Condition (Unmitigated)**	**Proposed Condition (Mitigated)**
Runoff Exit Point 1	6.24	6.10	7.05	9.78	6.58
Runoff Exit Point 2	0.50	0.64	0.72	0.99	0.99
Total	**6.74**	**6.74**	**7.77**	**10.77**	**7.57**

The peak flow rate of the 10 yr, 6-hr frequency storm at Runoff Exit Point 1 is reduced from 9.78 to 6.58 cfs. Peak flow rate mitigation is achieved by routing runoff through seven biofiltration planters on the western exterior and within the parking structure's light-wells. Runoff Exit Point 2 experiences an increase in the 10 year, 6 hour peak flow rate due to an increase in area between the existing and proposed conditions, but this increase is offset by reduced runoff at Runoff Exit Point 1. The overall site experiences a reduction of the 10 year, 6 hour peak flow rate from 10.77 cfs to 7.57 cfs. The peak flow rate mitigation though detention is summarized in Table 6-3, and the detention basin sizing is summarized in Table 6-4.

The routing of peak flow rates through the biofiltration planters is analyzed with *Hydraflow Hydrographs Express Extension* for AutoCad Civil 3D. Inflow hydrographs, basin geometries, and the hydraulic performances of the outlet structures are utilized as input for the model. Peak inflow hydrographs for the basins are developed utilizing the Rick Engineering Rational Hydrograph Generator. Civil-D results and other hydrologic information such as discharge rates, rainfall depths, runoff coefficients and time of concentrations are analyzed to develop a hydrograph. The inflow hydrograph is then manually entered into the Hydraflow Hydrographs software to determine the peak flow rate attenuation achieved by the biofiltration planter. The five planters proposed on the western exterior wall of the parking structure are designed with 1.9' of ponding depth, 0.5' of freeboard, 18" soil media, and 6" gravel. The two planters in the bottom of the two light-wells are designed with a 2.9' of ponding, 0.5' of freeboard, 18" soil media, and 6" gravel.

Table 6-3. Peak Flow Reduction Through Detention

Analysis/Runoff Exit Point	Detention Basin #	Peak Flow Rate (cfs)					
		Unmitigated		Mitigated		Reduction (CFS)	
		10 yr-6hr	100 yr-6hr	10 yr-6hr	100 yr-6hr	10 yr-6hr	100 yr-6hr
1	1	0.380	0.520	0.041	0.320	0.339	0.200
	2	0.700	1.080	0.000	0.689	0.700	0.391
	3	0.300	0.460	0.022	0.327	0.278	0.133
	4	0.180	0.290	0.000	0.218	0.180	0.072
	5	0.180	0.290	0.000	0.218	0.180	0.072
	6	0.250	0.390	0.000	0.289	0.250	0.101
	7	1.280	1.970	0.011	1.230	1.269	0.740
Total		3.270	5.000	0.074	3.291	**3.20**	**1.71**

Table 6-4. Detention Basin Sizing Summary

Detention Basin #	Bottom Area (SF)	Outlet Type	Weir Length (FT)	Detention Volume (cf)			Ponding Depth (FT)	Total Depth
				Media+Gravel Storage	Calculated	Net Required		
1	150	Weir	1.00	53	338	285	1.90	4.40
2	300	Riser	N/A	105	975	870	2.90	5.40
3	100	Weir	1.00	35	225	190	1.90	4.40
4	75	Weir	1.00	26	169	143	1.90	4.40
5	75	Weir	1.00	26	169	143	1.90	4.40
6	150	Weir	1.00	53	338	285	1.90	4.40
7	800	Riser	N/A	280	2,600	2,320	2.90	5.40
Total				**525**	**4,813**	**4,288**		

Note:
-Soil media and gravel are assumed to have porosities of 0.1 and 0.4 respectively.
-Total Depth includes ponding depth, 0.5' of freeboard, 1.5' of soil media, and 0.5' of gravel.
-Ponding Depth is measured from the top of the soil media to the weir or riser crest.

7. Stormwater Quality Control

UCSD has obtained water quality coverage under the U.S. Environmental Protection Agency's (EPA) Phase II Small Municipal Separate Storm Sewer System (MS4) rule. The EPA Storm Water Phase II Rule establishes a storm water management program for small and non-traditional municipal separate storm sewer systems (MS4s), such as Universities and State & federal Agencies.

NPDES Phase II regulations require operators of small MS4s to develop, implement, and enforce a storm water management program designed to:

- Reduce the discharge of pollutants to the "Maximum Extent Practicable" (MEP);
- Protect water quality; and
- Satisfy the appropriate water quality requirements of the CWA and Regional Water Quality Control Board (RWQCB) Basin Plans.

As a requirement of the Phase II Rule, UCSD has prepared a Storm Water Management Plan (SWMP) that outlines the "Minimum Control Measures" to be implemented within the campus facility. The term "Minimum Control Measures" is used by the EPA for the six MS4 program elements aimed at achieving improved water quality through NPDES Phase II requirements listed below:

1) Public Education and Outreach on Stormwater Impacts
2) Public Involvement/Participation
3) Illicit Discharge Detection and Elimination,
4) Pollution Prevention/ Good House Keeping
5) Construction Site Runoff Control,
6) Post Construction Storm Water Management in New Development and Redevelopment

This report will focus primarily on how Post Construction Storm Water Management is implemented into the project design using site design, source control, and structural pollutant control BMPs. The intent of this program is to develop, implement, and enforce a program to address discharges of post-construction storm water runoff from new development and redevelopment areas. The Post Construction Stormwater Management strategies implemented to this project is further discussed in Section 9.

8. Pollutants and Conditions of Concern

Watershed Contribution

The UCSD Campus is located within the Los Penasquitos Hydrologic Unit (HU 906.00) of the San Diego Region. The Penasquitos Hydrologic Unit is comprised of five hydrologic areas (HAs) and UCSD is located within three: the Miramar Reservoir HA (906.10), the Scripps HA (906.30), and the Miramar HA (906.40). The runoff originating from the site drains north into Los Penasquitos Lagoon via Soledad Canyon which is located within Miramar Reservoir HA (906.10). As a result of this, the receiving water risk for the site is high for sediment. The Los Penasquitos Lagoon is impaired by sediment.

The specific drainage basins that are relevant to the hydrology of the site are 1100 and 1300. According to the UCSD 2004 LRDP Hydrology Study, these drainage basins drain northerly toward Los Penasquitos Lagoon (see figure 4.7-2 in appendix D for details).

303(d) Status

Site storm runoff ultimately discharges into Los Penasquitos Lagoon. According to the California 2012 303(d) list, the following impairments have been found in the receiving water bodies for the site runoff.

- Soledad Canyon: Sediment Toxicity, Selenium
- Los Penasquitos Lagoon: Sedimentation/Siltation
- Pacific Ocean Shoreline, Miramar Reservoir HA, at Los Penasquitos River Mouth: Total Coliform

See Appendix E for details

Impact to Hydrologic Regime

The proposed hydrologic regime or drainage pattern for the site will change slightly due to the proposed improvements, but will maintain the existing discharge locations. Similarly, all drainage basins are required to maintain the same 10-year, 6-hour peak flow rate as in the existing condition, and therefore adverse impact to the hydrologic regime is not anticipated to result from this development.

Anticipated Pollutants

The following list of anticipated and potential pollutants of concern are developed from Table 2-1 (Table 8-1 of this report), of the County of San Diego SUSMP Manual (2011).

Project Category(ies)	**General Pollutants**	
	Anticipated Pollutants	**Potential Pollutants**
Commercial Development, Hillside Development, Parking Lot,	Sediment	
	Nutrients	Organic Compounds
	Heavy Metals	Bacteria & Viruses
	Trash & Debris	
	Oxygen Demanding Substances	
	Oil & Grease	

Anticipated pollutants likely to be generated from this site is evaluated with the known impairments of the receiving water bodies to determine the primary pollutants of concern for the site. Sediment is likely to be generated from the site and the receiving water body (Los Penasquitos Lagoon) is also impaired with sediment. Therefore, sediment is considered as primary pollutant of concern for this site.

Table 8-1: Anticipated and potential pollutants by project type (Reproduced from Table 2-1 of the County of San Diego SUSMP, 2011)

Priority Project Categories	**General Pollutant Categories**								
	Sediment	**Nutrients**	**Heavy Metals**	**Organic Compounds**	**Trash & Debris**	**Oxygen Demanding Substances**	**Oil & Grease**	**Bacteria & Viruses**	**Pesticides**
Detached Residential Development	X	X			X	X	X	X	X
Attached Residential Development	X	X			X	P(1)	P(2)	P	X
Commercial Development >one acre	**P(1)**	**P(1)**	**X**	**P(2)**	**X**	**P(5)**	**X**	**P(3)**	**P(5)**
Heavy Industry	X		X	X	X	X	X		
Automotive Repair Shops			X	X(4)(5)	X		X		
Restaurants					X	X	X	X	P(1)
Hillside Development >5,000 ft2	**X**	**X**			**X**	**X**	**X**		**X**
Parking Lots	**P(1)**	**P(1)**	**X**		**X**	**P(1)**	**X**		**P(1)**
Retail Gasoline Outlets			X	X	X	X	X		
Streets, Highways & Freeways	X	P(1)	X	X(4)	X	P(5)	X	X	P(1)

X = anticipated
P = potential
(1) A potential pollutant if landscaping exists on-site.
(2) A potential pollutant if the project includes uncovered parking areas.
(3) A potential pollutant if land use involves food or animal waste products.
(4) Including petroleum hydrocarbons.
(5) Including solvents.

9. Post-Construction Stormwater BMPs in New & Redevelopment Projects

The project creates more than 5,000 sf of impervious area. Therefore, a Post-Construction Storm Water Management Plan which includes Site Design, Source Control, and Treatment Control/baseline hydromodification BMPs is implemented. UCSD Post-Construction Management Checklists are also included in Appendix F of this report.

Site Design Measures (BMPs): Site design BMPs aim to treat and control runoff volume. These BMPs preserve natural areas and minimize development impact through improvements such as porous pavement, rooftop and impervious area disconnection, and vegetated swales. Table 9-1 lists the practices that will be implemented for the proposed development.

Table 9-1

☒ Stream Setbacks & Buffer	☒ Tree Planting and Preservation
☒ Soil Quality Improvement & Maintenance	☒ Rooftop & Impervious Area Disconnection
☐ Porous Pavement	☒ Green Roofs
☐ Vegetated Swales	☐ Rain Barrels & Cisterns

Native or drought tolerant plants will be utilized to the maximum extent feasible. Soil compaction will be minimized within the landscape areas. The runoff originating from impervious areas is discharged into adjacent landscaping prior to discharging to the storm drain system. The parking structure roof runoff is discharged into proposed smaller detention basins before being conveyed offsite. Green Roof credit and impervious area disconnection measures are utilized to the maximum extent feasible.

Source Control Measures

Source-control measures reduce the amount of runoff from the site and prevent pollutants from contaminating the site's runoff. Source-control BMPs are often the most effective to address non-storm (dry-weather) flows. Table 9-2 lists source-control BMPs and indicates the practices that will be implemented at the project site.

Table 9-2 Source-control BMP alternatives

- ☐ Housekeeping for outdoor work area
- ☒ Spill control and cleanup for outdoor spills or leaks
- ☐ Marine activities
- ☐ Loading dock management
- ☐ Outdoor washing/cleaning
- ☐ Fueling operations
- ☒ Maintenance on equipment containing water (e.g., eyewash showers, boiler drain lines, condensate drain lines, rooftop equipment, and drainage sumps
- ☐ Equipment, vehicle, and boat maintenance
- ☒ Trash management
- ☐ Hazardous materials management
- ☐ Hazardous waste management
- ☒ Potable water system flushing
- ☒ Fire sprinkler and hydrant testing/flushing
- ☒ Landscape management: irrigation runoff, erosion, gen waste
- ☐ Food service management
- ☐ Sanitary sewer overflows/line blockage
- ☐ Onsite transportation of materials/waste
- ☐ Surface cleaning/pressure washing
- ☒ Outdoor painting and sandblasting
- ☒ Storm water conveyance system management to prevent improper discharge into storm drains
- ☒ Non-storm water discharges
- ☒ Integrated pest management
- ☐ Building repairs and remodeling
- ☒ Parking lot and storage area management
- ☐ Pools, decorative fountains, and other water features

See Post Construction Stormwater Management Checklist in Appendix F for details.

Structural Treatment Control Measures are required only if the site design measures cannot fully meet the water balance requirement. This development is able to meet the water balance requirements by using source control measures, and therefore no post-construction treatment control measures are necessary. Seven biofiltration planters are proposed for peak flow rate attenuation, however, these planters are not required or designed to provide treatment control.

10. Conclusions

The proposed construction of the UCSD Parking Structure and its associated pedestrian circulation improvements will mitigate water quantity and quality impacts to the maximum extent practical through the use of Best Management Practices. The existing drainage system and flow pattern will not be significantly altered in the proposed condition. The existing receiving system will continue to receive runoff from the site through multiple discharge points. The peak flow rates resulting from the 10 year, 6 hour storm in the existing and proposed conditions are calculated and compared to determine the impact due to the redevelopment.

Seven new biofiltration planters are proposed to mitigate the drainage impacts due to the development. Peak flow rates due to 10 year 6-hour storm event are routed through the planters to determine the required mitigation. The cumulative peak flow rate mitigated by the planters is calculated to be 3.20 cfs for the 10 year, 6-hour storm event. As a result, the total peak flow rate from the site will be reduced from 10.77 to 7.57 cfs, which is 0.20 cfs less than existing conditions. No adverse impact to the receiving drainage system is anticipated because the proposed peak flow rate will be less than existing.

The site is designed to meet the water balance requirements by utilizing source control and site design BMPs. As a result, storm water treatment/baseline hydromodification measures are not required for this site. The proposed biofiltration planters are provided solely to control the peak flow rate of the 10 year, 6 hour storm event.

The downstream drainage system is assumed to have capacity to convey runoff from the peak 100 year storm event. Therefore, offsite drainage analysis is not performed. The site is also designed to bypass the peak flow rate due to 100 year storm event.

11. References

County of San Diego SUSMP: Standard Urban Stormwater Mitigation Plan Requirements for Development Application (2011)

UC San Diego Storm Water Management Plan (December, 2011).

County of San Diego Hydrology Manual (2003)

County of San Diego, 2007. Department of Planning and Land Use. (December 31, 2007) Low Impact Development Handbook. Stormwater Management Strategies.

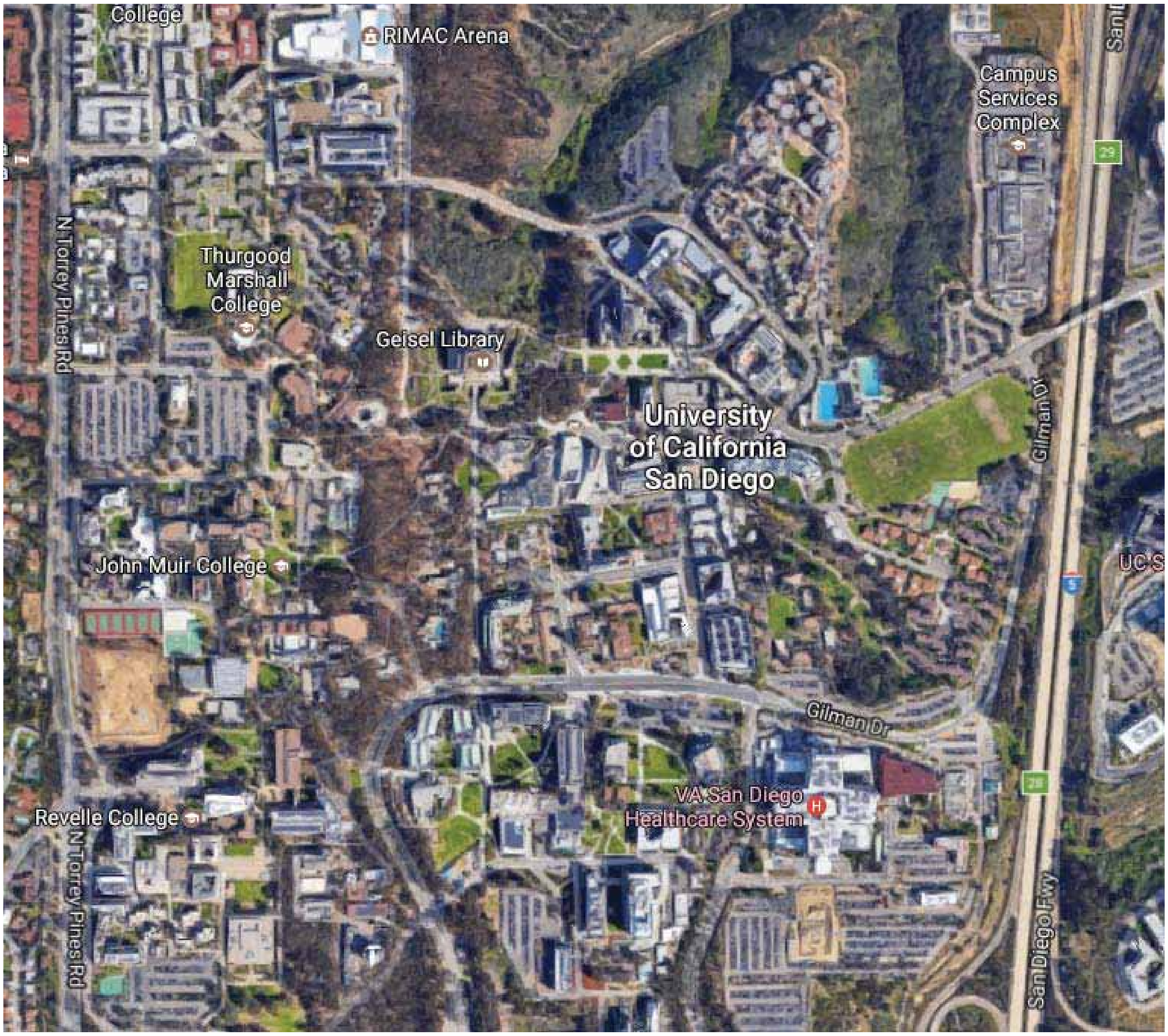
UCSD Design Guidelines (9/29/2009)

California Stormwater BMP Handbook New Development and Redevelopment (2003)

UCSD 2004 Long Range Development Plan (LRDP) Final EIR

APPENDIX A:

Site Vicinity Map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Geisel Library
University
of California
San Diego
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Healthcare System
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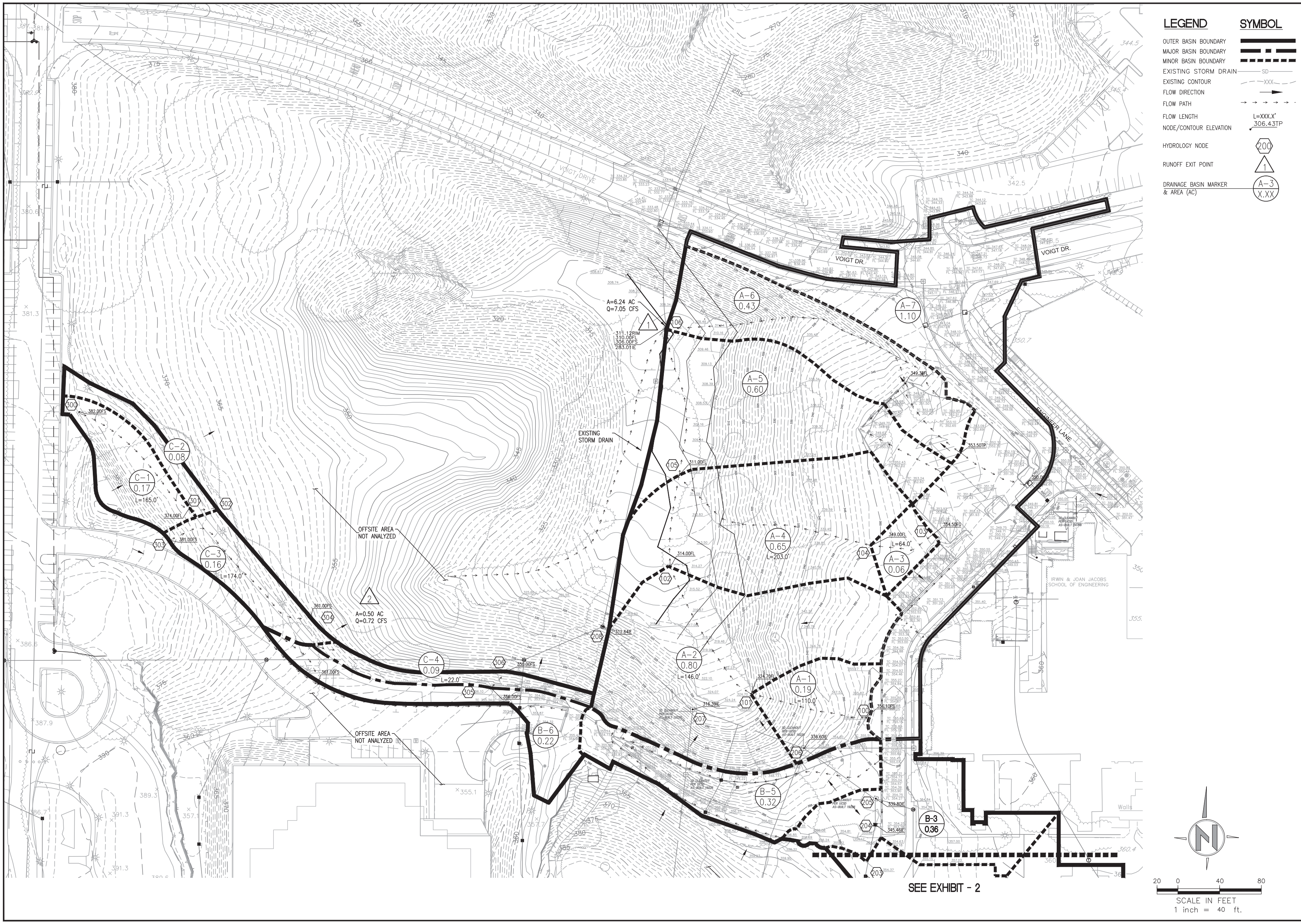
APPENDIX B:

Hydrology Exhibits



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MUNICIPALITY PROJECT NUMBER:	

SYM | DESCRIPTION | DATE | APPR

SHEET TITLE

EXISTING CONDITION
HYDROLOGY
EXHIBIT - 1

SHEET OF

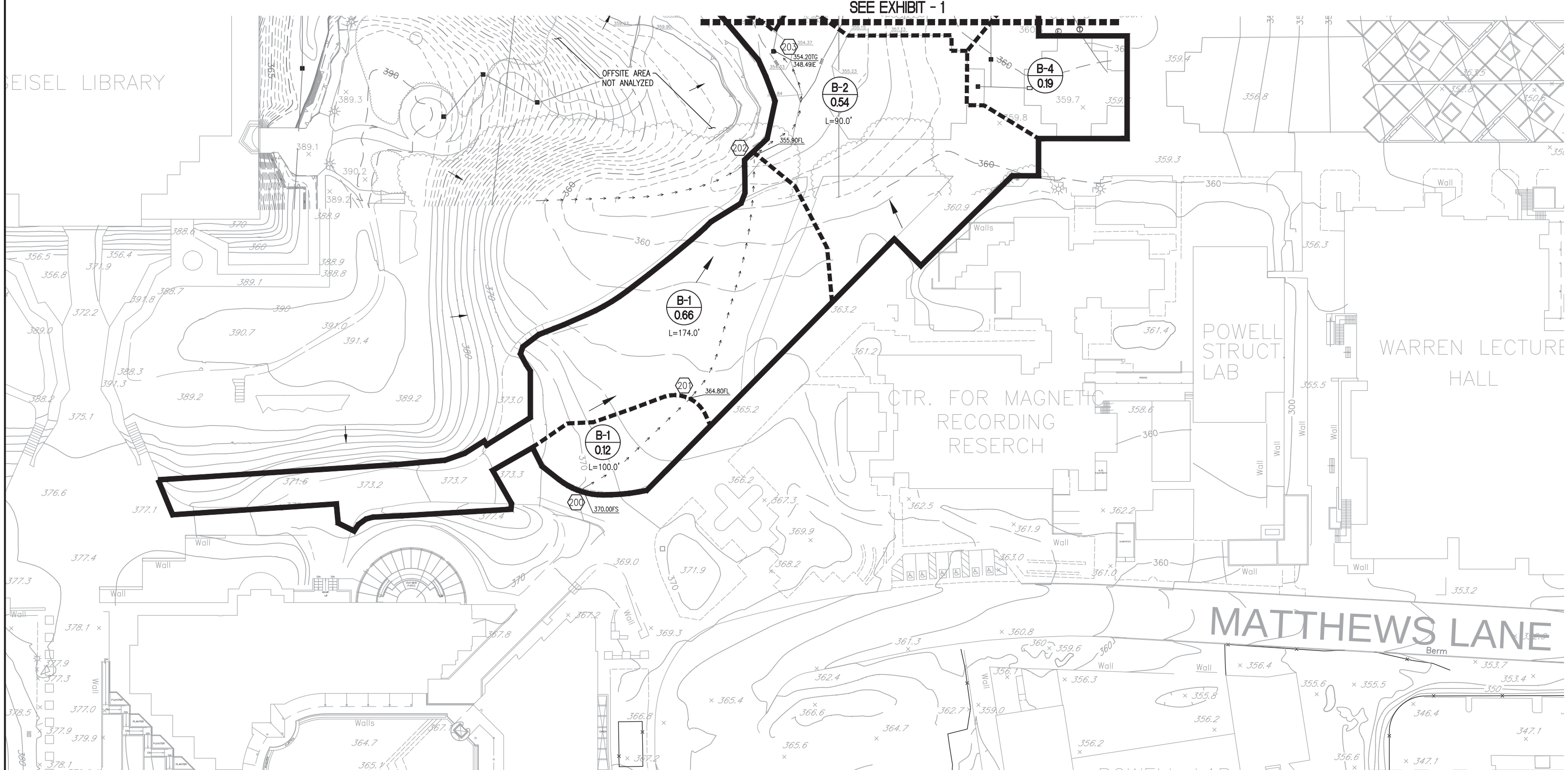
PROJECT

UCSD VOIGT PARKING STRUCTURE
SAN DIEGO, CA

SITE ADDRESS

VOIGT DRIVE AT ENGINEER LANE
LA JOLLA, CALIFORNIA 92093

PLOT: K:\SHARE\RFP SHARE (WILL NOT AUTO DELETE)\UCSD VOIGT PARKING STRUCTURE\DWGS\EXHIBITS\DRAINAGE\2016-06 EXHIBITS\UCSD CAMPUS-VOIGTPS-EXISTHYDRO.DWG MA GC 7/3/2017 4:36 PM



LEGEND

LEGEND	SYMBOL
OUTER BASIN BOUNDARY	
MAJOR BASIN BOUNDARY	
MINOR BASIN BOUNDARY	
EXISTING STORM DRAIN	SD
EXISTING CONTOUR	XXX
FLOW DIRECTION	
FLOW PATH	
FLOW LENGTH	L=XXX.X'
NODE/CONTOUR ELEVATION	306.43TP
HYDROLOGY NODE	200
RUNOFF EXIT POINT	1
DRAINAGE BASIN MARKER & AREA (AC)	A-3 / X.XX

SCALE IN FEET
1 inch = ## ft.

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SYM	DESCRIPTION	DATE	APPR

PROJECT
UCSD VOIGT PARKING STRUCTURE
SAN DIEGO, CA

SHEET TITLE
EXISTING CONDITION HYDROLOGY EXHIBIT - 2

SHEET OF

SITE ADDRESS
VOIGT DRIVE AT ENGINEER LANE
LA JOLLA, CALIFORNIA 92093

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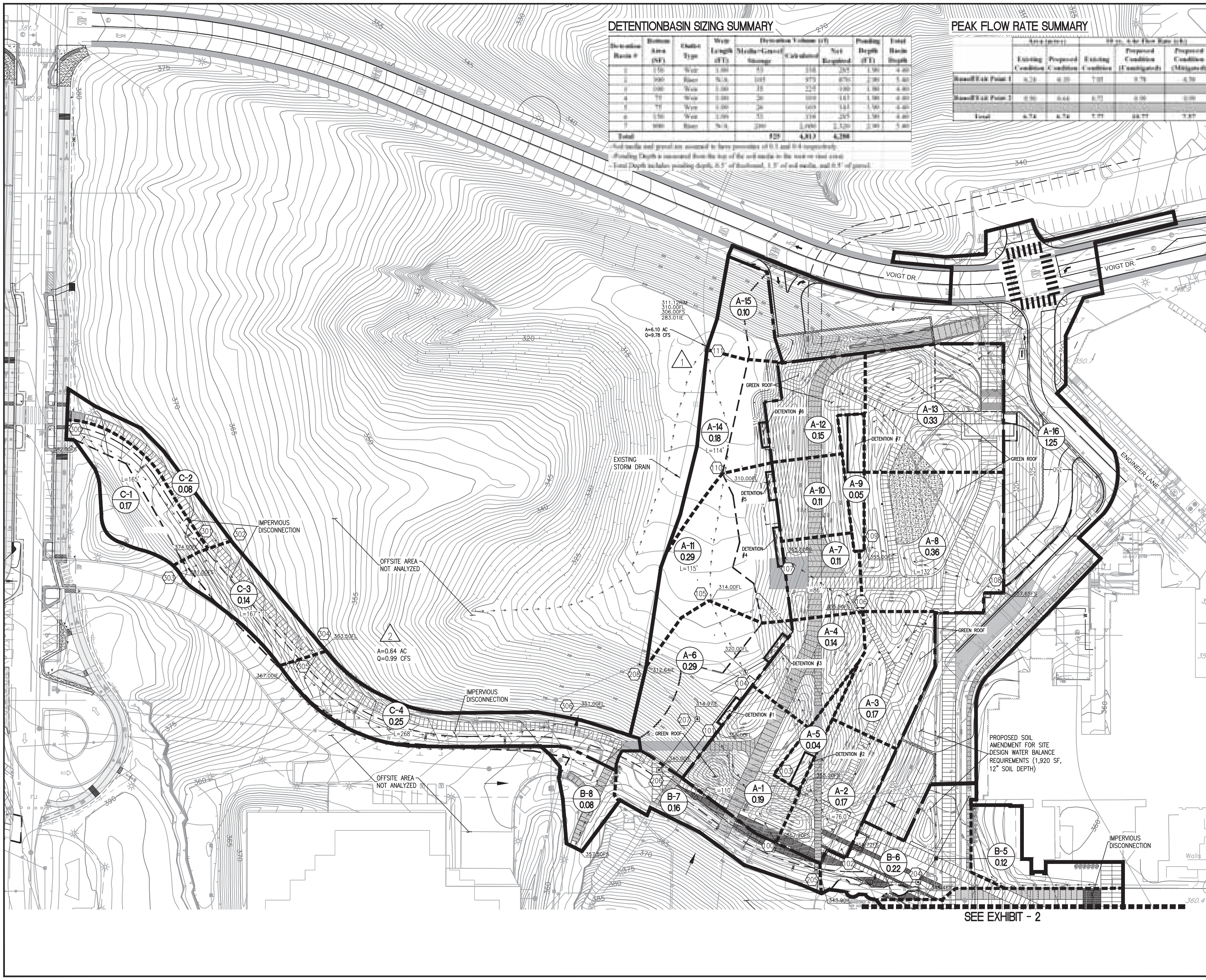

DETENTIONBASIN SIZING SUMMARY

Detention Basin #	Bottom Area (SF)	Outlet Type	Weir Length (FT)	Detention Volume (CF): Media+Gravel Storage	Detention Volume (CF): Calculated	Detention Volume (CF): Net Required	Ponding Depth (FT)	Total Basin Depth
1	[illegible]	Weir	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	Riser	N/A	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	Weir	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	Weir	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	Weir	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	[illegible]	Weir	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7	[illegible]	Riser	N/A	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total				[illegible]	[illegible]	[illegible]		

[illegible]

PEAK FLOW RATE SUMMARY

	Area (acres): Existing Condition	Area (acres): Proposed Condition	Peak Flow Rate (cfs): Existing Condition	Peak Flow Rate (cfs): Proposed Condition (Unmitigated)	Peak Flow Rate (cfs): Proposed Condition (Mitigated)
Runoff Exit Point 1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Runoff Exit Point 2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

LEGEND

	SYMBOL
OUTER BASIN BOUNDARY	
MAJOR BASIN BOUNDARY	
MINOR BASIN BOUNDARY	
LIMIT OF CONSTRUCTION	
EXISTING STORM DRAIN	SD
NEW STORM DRAIN	SD
EXISTING CONTOUR	XXX
NEW CONTOUR	XXX
FLOW DIRECTION	
FLOW PATH	
FLOW LENGTH	L=XXX.X'
NODE/CONTOUR ELEVATION	306.43TP
HYDROLOGY NODE	200
RUNOFF EXIT POINT	1
DRAINAGE BASIN MARKER & AREA (AC)	A-3 XXX

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SYM	DESCRIPTION	DATE	APPR

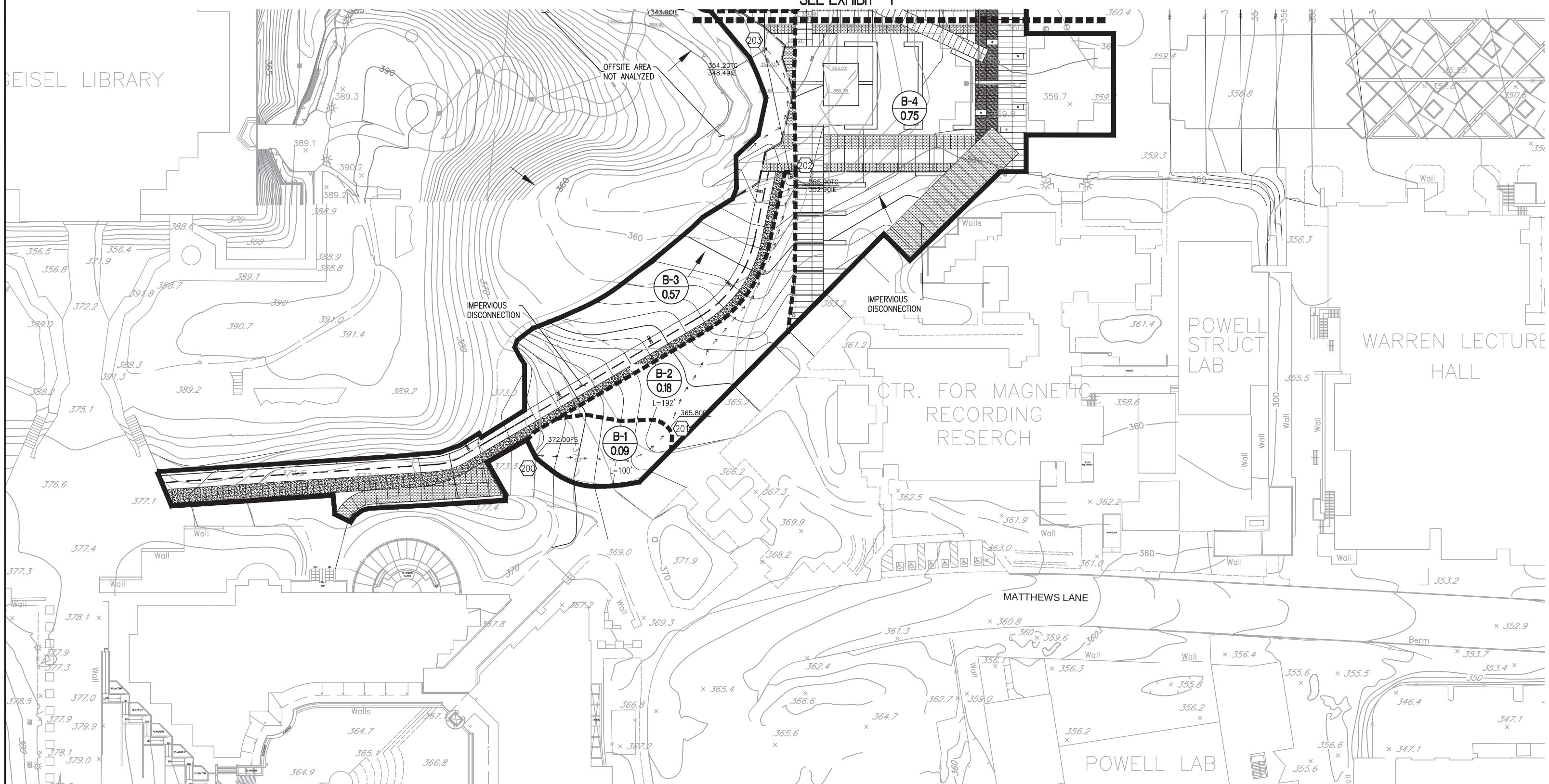
PROJECT: UCSD VOIGT PARKING STRUCTURE
SAN DIEGO, CA

SHEET TITLE: PROPOSED CONDITION HYDROLOGY EXHIBIT - 1

SHEET 1 OF 2

SITE ADDRESS: VOIGT DRIVE AT ENGINEER LANE
LA JOLLA, CALIFORNIA 92093

PLOT: K:\SHARE\RFP SHARE (WILL NOT AUTO DELETE)\UCSD VOIGT PARKING STRUCTURE\DWGS\EXHIBITS\DRAINAGE\2016-06 EXHIBITS\UCSD CAMPUS-VOIGTPS-PROPHYDRO.DWG MIn GC 7/3/2017 8:41 PM



LEGEND	SYMBOL
OUTER BASIN BOUNDARY	
MAJOR BASIN BOUNDARY	
MINOR BASIN BOUNDARY	
LIMIT OF CONSTRUCTION	
EXISTING STORM DRAIN	SD
NEW STORM DRAIN	SD
EXISTING CONTOUR	XXX
NEW CONTOUR	XXX
FLOW DIRECTION	
FLOW PATH	
FLOW LENGTH	L=XXX.X'
NODE/CONTOUR ELEVATION	306.43TP
HYDROLOGY NODE	200
RUNOFF EXIT POINT	1
DRAINAGE BASIN MARKER & AREA (AC)	A-3 XXX

BWE
WWW.BWESD.COM
619.299.5550

SYM	DESCRIPTION	DATE	APPR

ISSUE DATE: 07/03/2017
DRAWN BY: MDS
CHECKED BY: MGC
BWE JOB NUMBER:
CLIENT JOB NUMBER:
MUNICIPALITY
PROJECT NUMBER:

SHEET TITLE
PROPOSED CONDITION
HYDROLOGY
EXHIBIT - 2

SHEET 2 OF 2

PROJECT
UCSD VOIGT PARKING STRUCTURE
SAN DIEGO, CA

SITE ADDRESS
VOIGT DRIVE AT ENGINEER LANE
LA JOLLA, CALIFORNIA 92093

PLOT: K:\SHARE\RFP SHARE (WILL NOT AUTO DELETE)\UCSD VOIGT PARKING STRUCTURE\DWGS\EXHIBITS\DRAINAGE\2016-06 EXHIBITS\UCSD CAMPUS-VOIGTPS-PROPHYDRO.DWG Mn GC 7/3/2017 8:42 PM

APPENDIX C:

Hydrology Calculations

Runoff Coefficient Calculation (Existing Condition)

Project: UCSD Voigt Parking Structure

Soil Type: **D**

C = 0.90 × (% Impervious) + Cp × (1 - % Impervious)

Cp= 0.35 (per Table 3-1, County of San Diego Hydrology Manual, Soil Class D)

Basin #	Area (Acres) Total Area (ac)	Area (Acres) Imp. Area (Ai)	%imp	*Runoff Coef. (C)	C x A	Weighted C-Factor	**Equivalent Land Use (from Table 3-1)
A	3.93	0.94	24	0.48	1.890	-	-
B	2.17	0.80	37	0.55	1.203	-	-
C	0.63	0.06	9	0.40	0.255	-	-
Total	**6.74**	**1.80**	-	-	3.348	**0.50**	**Residential, Low Density 2.9 DU/A**

*The composite runoff coefficient (C) is calculated for entire site by using the following equation:

C = 0.90 × (% Impervious) + Cp × (1 - % Impervious);

Cp = 0.35 per Table 3-1 of the County Hydrology Manual = Pervious Coefficient Runoff Value for the soil type D (shown in Table 3-1 as Undisturbed Natural Terrain/Permanenet Open Space, 0% Impervious)

**Equivalent Land Use type is determined to be used as an input to the CivilD software for initial basin analysis only because the calculated C value cannot be entered as is.

San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2012 Version 7.9

Rational method hydrology program based on
San Diego County Flood Control Division 2003 hydrology manual
Rational Hydrology Study Date: 06/30/17

UCSD VOIGT PARKING STRUCTURE
EXISTING CONDITION HYDROLOGY ANALYSIS
EXIT POINT 1

********* Hydrology Study Control Information **********

Program License Serial Number 6116

Rational hydrology study storm event year is 10.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour, precipitation(inches) = 1.500
24 hour precipitation(inches) = 2.600
P6/P24 = 57.7%
San Diego hydrology manual 'C' values used

++
Process from Point/Station 100.000 to Point/Station 101.000
**** INITIAL AREA EVALUATION ****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[LOW DENSITY RESIDENTIAL]
(2.0 DU/A or Less)
Impervious value, Ai = 0.200
Sub-Area C Value = 0.460
Initial subarea total flow distance = 110.000(Ft.)
Highest elevation = 356.100(Ft.)
Lowest elevation = 324.700(Ft.)
Elevation difference = 31.400(Ft.) Slope = 28.545 %
Top of Initial Area Slope adjusted by User to 28.000 %
Bottom of Initial Area Slope adjusted by User to 28.000 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of 28.00 %, in a development type of
2.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration = 3.79 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.4600)*(100.000^.5)/(28.000^(1/3)]= 3.79
The initial area total distance of 110.00 (Ft.) entered leaves a
remaining distance of 10.00 (Ft.)
Using Figure 3-4, the travel time for this distance is 0.08 minutes
for a distance of 10.00 (Ft.) and a slope of 28.00 %

```
with an elevation difference of   2.80(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
 =    0.075 Minutes
Tt=[(11.9*0.0019^3)/(  2.80)]^.385=  0.08
Total initial area Ti =   3.79 minutes from Figure 3-3 formula plus
  0.08 minutes from the Figure 3-4 formula =   3.87 minutes
Calculated TC of    3.869 minutes is less than 5 minutes,
 resetting TC to 5.0 minutes for rainfall intensity calculations
Rainfall intensity (I) =      3.952(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.460
Subarea runoff =      0.345(CFS)
Total initial stream area =        0.190(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      101.000 to Point/Station      102.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
______________________________________________________________________
Estimated mean flow rate at midpoint of channel =      1.104(CFS)
Depth of flow =   0.112(Ft.), Average velocity =   2.941(Ft/s)
        ******* Irregular Channel Data ***********
-----------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
        1              0.00               0.50
        2             15.00               0.00
        3             30.00               0.50
Manning's 'N' friction factor =   0.020
-----------------------------------------------------------------
Sub-Channel flow  =      1.104(CFS)
  '     '        flow top width =      6.713(Ft.)
  '     '    velocity=    2.941(Ft/s)
  '     '        area =      0.375(Sq.Ft)
  '     '        Froude number =     2.191

Upstream point elevation =   324.700(Ft.)
Downstream point elevation =   314.000(Ft.)
Flow length =   146.000(Ft.)
Travel time  =    0.83 min.
Time of concentration =    4.70 min.
Depth of flow =   0.112(Ft.)
Average velocity =   2.941(Ft/s)
Total irregular channel flow =     1.104(CFS)
Irregular channel normal depth above invert elev. =   0.112(Ft.)
Average velocity of channel(s) =   2.941(Ft/s)
 Adding area flow to channel
Calculated TC of    4.696 minutes is less than 5 minutes,
 resetting TC to 5.0 minutes for rainfall intensity calculations
Rainfall intensity (I) =      3.952(In/Hr) for a    10.0 year storm
User specified 'C' value of 0.500 given for subarea
Rainfall intensity =      3.952(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.492  CA =      0.487
Subarea runoff =      1.581(CFS) for      0.800(Ac.)
Total runoff =      1.926(CFS)  Total area =       0.990(Ac.)
Depth of flow =   0.138(Ft.), Average velocity =   3.380(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      102.000 to Point/Station      105.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
______________________________________________________________________
Depth of flow =   0.159(Ft.), Average velocity =   2.536(Ft/s)
```

```
        ******* Irregular Channel Data ***********
-----------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
        1              0.00              0.50
        2             15.00              0.00
        3             30.00              0.50
Manning's 'N' friction factor =   0.020
-----------------------------------------------------------------
Sub-Channel flow  =      1.926(CFS)
  '     '        flow top width =      9.546(Ft.)
  '     '    velocity=    2.537(Ft/s)
  '     '        area =      0.759(Sq.Ft)
  '     '        Froude number =     1.585

Upstream point elevation =   314.000(Ft.)
Downstream point elevation =   311.000(Ft.)
Flow length =    88.000(Ft.)
Travel time  =    0.58 min.
Time of concentration =    5.27 min.
Depth of flow =   0.159(Ft.)
Average velocity =   2.536(Ft/s)
Total irregular channel flow =     1.926(CFS)
Irregular channel normal depth above invert elev. =   0.159(Ft.)
Average velocity of channel(s) =   2.536(Ft/s)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Process from Point/Station      105.000 to Point/Station      105.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =      0.990(Ac.)
Runoff from this stream =      1.926(CFS)
Time of concentration =    5.27 min.
Rainfall intensity =     3.818(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      103.000 to Point/Station      104.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[LOW DENSITY RESIDENTIAL                     ]
(2.0 DU/A or Less       )
Impervious value, Ai = 0.200
Sub-Area C Value = 0.460
Initial subarea total flow distance  =   64.000(Ft.)
Highest elevation =  354.500(Ft.)
Lowest elevation =  349.000(Ft.)
Elevation difference =    5.500(Ft.) Slope =  8.594 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of   8.59 %, in a development type of
 2.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   5.62 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.4600)*( 100.000^.5)/(   8.594^(1/3)]=   5.62
Rainfall intensity (I) =      3.663(In/Hr) for a    10.0 year storm
```

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Effective runoff coefficient used for area (Q=KCIA) is C = 0.460
Subarea runoff =      0.101(CFS)
Total initial stream area =        0.060(Ac.)


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Process from Point/Station      104.000 to Point/Station      105.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
______________________________________________________________________
Estimated mean flow rate at midpoint of channel =      0.649(CFS)
Depth of flow =   0.116(Ft.), Average velocity =   4.806(Ft/s)
        ******* Irregular Channel Data ***********
-----------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
        1             0.00              0.50
        2             5.00              0.00
        3            10.00              0.50
Manning's 'N' friction factor =   0.020
-----------------------------------------------------------------
Sub-Channel flow  =      0.649(CFS)
  '     '        flow top width =      2.324(Ft.)
  '     '    velocity=    4.806(Ft/s)
  '     '        area =      0.135(Sq.Ft)
  '     '        Froude number =     3.514

Upstream point elevation =   349.000(Ft.)
Downstream point elevation =   311.000(Ft.)
Flow length =   203.000(Ft.)
Travel time  =    0.70 min.
Time of concentration =    6.33 min.
Depth of flow =   0.116(Ft.)
Average velocity =   4.806(Ft/s)
Total irregular channel flow =     0.649(CFS)
Irregular channel normal depth above invert elev. =   0.116(Ft.)
Average velocity of channel(s) =   4.806(Ft/s)
 Adding area flow to channel
Rainfall intensity (I) =      3.395(In/Hr) for a    10.0 year storm
User specified 'C' value of 0.500 given for subarea
Rainfall intensity =      3.395(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.497  CA =      0.353
Subarea runoff =      1.096(CFS) for      0.650(Ac.)
Total runoff =      1.197(CFS)  Total area =       0.710(Ac.)
Depth of flow =   0.146(Ft.), Average velocity =   5.601(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      105.000 to Point/Station      106.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
______________________________________________________________________
Estimated mean flow rate at midpoint of channel =      1.657(CFS)
Depth of flow =   0.149(Ft.), Average velocity =   2.473(Ft/s)
        ******* Irregular Channel Data ***********
-----------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
        1             0.00              0.50
        2            15.00              0.00
        3            30.00              0.50
Manning's 'N' friction factor =   0.020
-----------------------------------------------------------------
Sub-Channel flow  =      1.657(CFS)
```

```
  '     '        flow top width =      8.967(Ft.)
  '     '    velocity=    2.473(Ft/s)
  '     '        area =      0.670(Sq.Ft)
  '     '        Froude number =     1.594

Upstream point elevation =   311.000(Ft.)
Downstream point elevation =   306.000(Ft.)
Flow length =   142.000(Ft.)
Travel time  =    0.96 min.
Time of concentration =    7.29 min.
Depth of flow =   0.149(Ft.)
Average velocity =   2.473(Ft/s)
Total irregular channel flow =     1.657(CFS)
Irregular channel normal depth above invert elev. =   0.149(Ft.)
Average velocity of channel(s) =   2.473(Ft/s)
 Adding area flow to channel
Rainfall intensity (I) =      3.100(In/Hr) for a    10.0 year storm
User specified 'C' value of 0.500 given for subarea
Rainfall intensity =      3.100(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.498  CA =      0.653
Subarea runoff =      0.826(CFS) for      0.600(Ac.)
Total runoff =      2.023(CFS)  Total area =       1.310(Ac.)
Depth of flow =   0.161(Ft.), Average velocity =   2.599(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      106.000 to Point/Station      106.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      3.100(In/Hr) for a    10.0 year storm
User specified 'C' value of 0.500 given for subarea
Time of concentration =     7.29 min.
Rainfall intensity =      3.100(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.499  CA =      0.868
Subarea runoff =      0.667(CFS) for      0.430(Ac.)
Total runoff =      2.690(CFS)  Total area =       1.740(Ac.)


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Process from Point/Station      106.000 to Point/Station      106.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      3.100(In/Hr) for a    10.0 year storm
User specified 'C' value of 0.500 given for subarea
Time of concentration =     7.29 min.
Rainfall intensity =      3.100(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.499  CA =      1.418
Subarea runoff =      1.705(CFS) for      1.100(Ac.)
Total runoff =      4.395(CFS)  Total area =       2.840(Ac.)


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Process from Point/Station      106.000 to Point/Station      106.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =      2.840(Ac.)
Runoff from this stream =      4.395(CFS)
Time of concentration =    7.29 min.
Rainfall intensity =     3.100(In/Hr)
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      200.000 to Point/Station      201.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[LOW DENSITY RESIDENTIAL                     ]
(2.0 DU/A or Less       )
Impervious value, Ai = 0.200
Sub-Area C Value = 0.460
Initial subarea total flow distance  =  100.000(Ft.)
Highest elevation =  370.000(Ft.)
Lowest elevation =  364.800(Ft.)
Elevation difference =    5.200(Ft.) Slope =  5.200 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of   5.20 %, in a development type of
 2.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   6.65 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.4600)*( 100.000^.5)/(   5.200^(1/3)]=   6.65
Rainfall intensity (I) =      3.288(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.460
Subarea runoff =      0.182(CFS)
Total initial stream area =       0.120(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      201.000 to Point/Station      202.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
______________________________________________________________________
Estimated mean flow rate at midpoint of channel =      0.681(CFS)
Depth of flow =   0.124(Ft.), Average velocity =   2.636(Ft/s)
        ******* Irregular Channel Data ***********
-----------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
        1              0.00             0.30
        2              5.00             0.00
        3             10.00             0.30
Manning's 'N' friction factor =   0.020
-----------------------------------------------------------------
Sub-Channel flow  =      0.681(CFS)
  '     '        flow top width =      4.149(Ft.)
  '     '    velocity=    2.636(Ft/s)
  '     '        area =      0.258(Sq.Ft)
  '     '        Froude number =     1.862

Upstream point elevation =   364.800(Ft.)
Downstream point elevation =   355.900(Ft.)
Flow length =   174.000(Ft.)
Travel time  =    1.10 min.
Time of concentration =    7.75 min.
Depth of flow =   0.124(Ft.)
Average velocity =   2.636(Ft/s)
Total irregular channel flow =     0.681(CFS)
Irregular channel normal depth above invert elev. =   0.124(Ft.)
Average velocity of channel(s) =   2.636(Ft/s)
```

```
 Adding area flow to channel
Rainfall intensity (I) =      2.979(In/Hr) for a    10.0 year storm
User specified 'C' value of 0.500 given for subarea
Rainfall intensity =      2.979(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.494  CA =      0.385
Subarea runoff =      0.966(CFS) for      0.660(Ac.)
Total runoff =      1.148(CFS)  Total area =       0.780(Ac.)
Depth of flow =   0.151(Ft.), Average velocity =   3.003(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      202.000 to Point/Station      203.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****

Estimated mean flow rate at midpoint of channel =      1.545(CFS)
Depth of flow =   0.351(Ft.), Average velocity =   3.136(Ft/s)
        ******* Irregular Channel Data ***********
-----------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
        1              0.00               0.50
        2              2.00               0.00
        3              4.00               0.50
Manning's 'N' friction factor =   0.020
-----------------------------------------------------------------
Sub-Channel flow  =      1.545(CFS)
  '     '        flow top width =      2.807(Ft.)
  '     '    velocity=    3.136(Ft/s)
  '     '        area =      0.493(Sq.Ft)
  '     '        Froude number =     1.320

Upstream point elevation =   355.900(Ft.)
Downstream point elevation =   354.200(Ft.)
Flow length =    90.000(Ft.)
Travel time  =    0.48 min.
Time of concentration =    8.23 min.
Depth of flow =   0.351(Ft.)
Average velocity =   3.136(Ft/s)
Total irregular channel flow =     1.545(CFS)
Irregular channel normal depth above invert elev. =   0.351(Ft.)
Average velocity of channel(s) =   3.136(Ft/s)
 Adding area flow to channel
Rainfall intensity (I) =      2.866(In/Hr) for a    10.0 year storm
User specified 'C' value of 0.500 given for subarea
Rainfall intensity =      2.866(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.496  CA =      0.655
Subarea runoff =      0.730(CFS) for      0.540(Ac.)
Total runoff =      1.878(CFS)  Total area =       1.320(Ac.)
Depth of flow =   0.378(Ft.), Average velocity =   3.293(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      203.000 to Point/Station      204.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation =   348.490(Ft.)
Downstream point/station elevation =   345.460(Ft.)
Pipe length  =    47.60(Ft.) Slope =   0.0637  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     1.878(CFS)
Nearest computed pipe diameter  =     9.00(In.)
Calculated individual pipe flow  =     1.878(CFS)
```

```
Normal flow depth in pipe =    4.23(In.)
Flow top width inside pipe =    8.98(In.)
Critical Depth =    7.51(In.)
Pipe flow velocity =      9.20(Ft/s)
Travel time through pipe =    0.09 min.
Time of concentration (TC) =     8.31 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      204.000 to Point/Station      204.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      2.847(In/Hr) for a    10.0 year storm
User specified 'C' value of 0.500 given for subarea
Time of concentration =     8.31 min.
Rainfall intensity =      2.847(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.497  CA =      0.835
Subarea runoff =      0.500(CFS) for      0.360(Ac.)
Total runoff =      2.378(CFS)  Total area =       1.680(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      204.000 to Point/Station      205.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________
Upstream point/station elevation =   345.460(Ft.)
Downstream point/station elevation =   339.800(Ft.)
Pipe length  =    22.00(Ft.) Slope =   0.2573  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     2.378(CFS)
Nearest computed pipe diameter  =      6.00(In.)
Calculated individual pipe flow  =     2.378(CFS)
Normal flow depth in pipe =    4.20(In.)
Flow top width inside pipe =    5.50(In.)
Critical depth could not be calculated.
Pipe flow velocity =     16.23(Ft/s)
Travel time through pipe =    0.02 min.
Time of concentration (TC) =     8.34 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      205.000 to Point/Station      206.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________
Upstream point/station elevation =   339.800(Ft.)
Downstream point/station elevation =   336.600(Ft.)
Pipe length  =    80.00(Ft.) Slope =   0.0400  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     2.378(CFS)
Nearest computed pipe diameter  =      9.00(In.)
Calculated individual pipe flow  =     2.378(CFS)
Normal flow depth in pipe =    5.65(In.)
Flow top width inside pipe =    8.70(In.)
Critical Depth =    8.19(In.)
Pipe flow velocity =      8.15(Ft/s)
Travel time through pipe =    0.16 min.
Time of concentration (TC) =     8.50 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      206.000 to Point/Station      206.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      2.807(In/Hr) for a    10.0 year storm
```

```
User specified 'C' value of 0.500 given for subarea
Time of concentration =     8.50 min.
Rainfall intensity =      2.807(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.497  CA =      0.930
Subarea runoff =      0.233(CFS) for      0.190(Ac.)
Total runoff =      2.611(CFS)  Total area =       1.870(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      206.000 to Point/Station      206.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      2.807(In/Hr) for a    10.0 year storm
User specified 'C' value of 0.500 given for subarea
Time of concentration =     8.50 min.
Rainfall intensity =      2.807(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.498  CA =      1.090
Subarea runoff =      0.449(CFS) for      0.320(Ac.)
Total runoff =      3.060(CFS)  Total area =       2.190(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      206.000 to Point/Station      207.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________
Upstream point/station elevation =   336.600(Ft.)
Downstream point/station elevation =   316.390(Ft.)
Pipe length  =   108.00(Ft.) Slope =   0.1871  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     3.060(CFS)
Nearest computed pipe diameter  =     9.00(In.)
Calculated individual pipe flow  =     3.060(CFS)
Normal flow depth in pipe =    4.11(In.)
Flow top width inside pipe =    8.97(In.)
Critical depth could not be calculated.
Pipe flow velocity =     15.56(Ft/s)
Travel time through pipe =    0.12 min.
Time of concentration (TC) =     8.62 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      207.000 to Point/Station      208.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________
Upstream point/station elevation =   316.390(Ft.)
Downstream point/station elevation =   312.640(Ft.)
Pipe length  =   114.00(Ft.) Slope =   0.0329  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     3.060(CFS)
Nearest computed pipe diameter  =    12.00(In.)
Calculated individual pipe flow  =     3.060(CFS)
Normal flow depth in pipe =    5.81(In.)
Flow top width inside pipe =   11.99(In.)
Critical Depth =    8.99(In.)
Pipe flow velocity =      8.12(Ft/s)
Travel time through pipe =    0.23 min.
Time of concentration (TC) =     8.85 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      208.000 to Point/Station      208.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
```

```
Rainfall intensity (I) =      2.735(In/Hr) for a    10.0 year storm
User specified 'C' value of 0.500 given for subarea
Time of concentration =     8.85 min.
Rainfall intensity =      2.735(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.498  CA =      1.200
Subarea runoff =      0.222(CFS) for      0.220(Ac.)
Total runoff =      3.282(CFS)  Total area =       2.410(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      208.000 to Point/Station      106.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________
Upstream point/station elevation =   312.640(Ft.)
Downstream point/station elevation =   283.010(Ft.)
Pipe length  =   290.00(Ft.) Slope =   0.1022  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     3.282(CFS)
Nearest computed pipe diameter  =      9.00(In.)
Calculated individual pipe flow  =     3.282(CFS)
Normal flow depth in pipe =    5.13(In.)
Flow top width inside pipe =    8.91(In.)
Critical depth could not be calculated.
Pipe flow velocity =     12.61(Ft/s)
Travel time through pipe =    0.38 min.
Time of concentration (TC) =     9.23 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      106.000 to Point/Station      106.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________
Along Main Stream number: 1 in normal stream number 2
Stream flow area =      2.410(Ac.)
Runoff from this stream =      3.282(CFS)
Time of concentration =    9.23 min.
Rainfall intensity =     2.661(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                 (In/Hr)


1        4.395      7.29                 3.100
2        3.282      9.23                 2.661
Qmax(1) =
           1.000 *    1.000 *     4.395) +
           1.000 *    0.789 *     3.282) + =       6.984
Qmax(2) =
           0.858 *    1.000 *     4.395) +
           1.000 *    1.000 *     3.282) + =       7.054

Total of 2 streams to confluence:
Flow rates before confluence point:
       4.395       3.282
Maximum flow rates at confluence using above data:
        6.984       7.054
Area of streams before confluence:
        2.840       2.410
Results of confluence:
Total flow rate =      7.054(CFS)
Time of concentration =     9.233 min.
Effective stream area after confluence =      5.250(Ac.)
```

End of computations, total study area = 6.240 (Ac.)

```
                San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2012 Version 7.9

Rational method hydrology  program based on
San Diego County Flood Control Division 2003 hydrology manual
        Rational Hydrology Study        Date: 06/30/17
------------------------------------------------------------------------
UCSD VOIGT PARKING STRUCTURE
EXISTING CONDITION HYDROLOGY ANALYSIS
RUNOFF EXIT POINT 2


------------------------------------------------------------------------
 *********   Hydrology Study Control Information **********

------------------------------------------------------------------------


Program License Serial Number 6116

------------------------------------------------------------------------
Rational hydrology study storm event year is    10.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour,  precipitation(inches) =  1.500
24 hour precipitation(inches) =  2.600
P6/P24 =    57.7%
San Diego hydrology manual 'C' values used


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      300.000 to Point/Station      301.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[LOW DENSITY RESIDENTIAL                     ]
(2.0 DU/A or Less       )
Impervious value, Ai = 0.200
Sub-Area C Value = 0.460
Initial subarea total flow distance  =  165.000(Ft.)
Highest elevation =  382.000(Ft.)
Lowest elevation =  374.000(Ft.)
Elevation difference =    8.000(Ft.) Slope =  4.848 %
Top of Initial Area Slope adjusted by User to  5.000 %
Bottom of Initial Area Slope adjusted by User to  5.000 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of   5.00 %, in a development type of
 2.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   6.74 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.4600)*( 100.000^.5)/(   5.000^(1/3)]=   6.74
The initial area total distance of  165.00 (Ft.) entered leaves a
remaining distance of   65.00 (Ft.)
Using Figure 3-4, the travel time for this distance is   0.62 minutes
for a distance of  65.00 (Ft.) and a slope of  5.00 %
```

```
with an elevation difference of   3.25(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
 =    0.616 Minutes
Tt=[(11.9*0.0123^3)/(  3.25)]^.385=  0.62
Total initial area Ti =   6.74 minutes from Figure 3-3 formula plus
  0.62 minutes from the Figure 3-4 formula =   7.35 minutes
Rainfall intensity (I) =      3.082(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.460
Subarea runoff =      0.241(CFS)
Total initial stream area =        0.170(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      301.000 to Point/Station      302.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      3.082(In/Hr) for a    10.0 year storm
User specified 'C' value of 0.500 given for subarea
Time of concentration =     7.35 min.
Rainfall intensity =      3.082(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.473  CA =      0.118
Subarea runoff =      0.123(CFS) for      0.080(Ac.)
Total runoff =      0.364(CFS)  Total area =       0.250(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      304.000 to Point/Station      304.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =      0.250(Ac.)
Runoff from this stream =      0.364(CFS)
Time of concentration =    7.35 min.
Rainfall intensity =     3.082(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      303.000 to Point/Station      304.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[LOW DENSITY RESIDENTIAL                     ]
(2.0 DU/A or Less       )
Impervious value, Ai = 0.200
Sub-Area C Value = 0.460
Initial subarea total flow distance  =  174.000(Ft.)
Highest elevation =  381.000(Ft.)
Lowest elevation =  361.000(Ft.)
Elevation difference =   20.000(Ft.) Slope = 11.494 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of  11.49 %, in a development type of
 2.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   5.10 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.4600)*( 100.000^.5)/(  11.494^(1/3)]=   5.10
The initial area total distance of  174.00 (Ft.) entered leaves a
remaining distance of   74.00 (Ft.)
```

```
Using Figure 3-4, the travel time for this distance is   0.49 minutes
for a distance of  74.00 (Ft.) and a slope of 11.49 %
with an elevation difference of   8.51(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
 =    0.494 Minutes
Tt=[(11.9*0.0140^3)/(  8.51)]^.385=  0.49
Total initial area Ti =   5.10 minutes from Figure 3-3 formula plus
  0.49 minutes from the Figure 3-4 formula =   5.60 minutes
Rainfall intensity (I) =      3.674(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.460
Subarea runoff =      0.270(CFS)
Total initial stream area =        0.160(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      304.000 to Point/Station      304.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________
Along Main Stream number: 1 in normal stream number 2
Stream flow area =      0.160(Ac.)
Runoff from this stream =      0.270(CFS)
Time of concentration =    5.60 min.
Rainfall intensity =     3.674(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                 (In/Hr)


1        0.364      7.35                 3.082
2        0.270      5.60                 3.674
Qmax(1) =
           1.000 *    1.000 *     0.364) +
           0.839 *    1.000 *     0.270) + =       0.591
Qmax(2) =
           1.000 *    0.761 *     0.364) +
           1.000 *    1.000 *     0.270) + =       0.548

Total of 2 streams to confluence:
Flow rates before confluence point:
       0.364       0.270
Maximum flow rates at confluence using above data:
        0.591       0.548
Area of streams before confluence:
        0.250       0.160
Results of confluence:
Total flow rate =      0.591(CFS)
Time of concentration =     7.353 min.
Effective stream area after confluence =      0.410(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      306.000 to Point/Station      306.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =      0.410(Ac.)
Runoff from this stream =      0.591(CFS)
Time of concentration =    7.35 min.
Rainfall intensity =     3.082(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
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```
Process from Point/Station      305.000 to Point/Station      306.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[LOW DENSITY RESIDENTIAL                     ]
(2.0 DU/A or Less       )
Impervious value, Ai = 0.200
Sub-Area C Value = 0.460
Initial subarea total flow distance  =   22.000(Ft.)
Highest elevation =  356.000(Ft.)
Lowest elevation =  350.000(Ft.)
Elevation difference =    6.000(Ft.) Slope = 27.273 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of  27.27 %, in a development type of
 2.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   3.83 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.4600)*( 100.000^.5)/(  27.273^(1/3)]=   3.83
Calculated TC of    3.827 minutes is less than 5 minutes,
 resetting TC to 5.0 minutes for rainfall intensity calculations
Rainfall intensity (I) =      3.952(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.460
Subarea runoff =      0.164(CFS)
Total initial stream area =        0.090(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      306.000 to Point/Station      306.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________
Along Main Stream number: 1 in normal stream number 2
Stream flow area =      0.090(Ac.)
Runoff from this stream =      0.164(CFS)
Time of concentration =    3.83 min.
Rainfall intensity =     3.952(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                 (In/Hr)


1        0.591      7.35                 3.082
2        0.164      3.83                 3.952
Qmax(1) =
           1.000 *    1.000 *     0.591) +
           0.780 *    1.000 *     0.164) + =       0.719
Qmax(2) =
           1.000 *    0.521 *     0.591) +
           1.000 *    1.000 *     0.164) + =       0.471

Total of 2 streams to confluence:
Flow rates before confluence point:
       0.591       0.164
Maximum flow rates at confluence using above data:
        0.719        0.471
Area of streams before confluence:
        0.410        0.090
Results of confluence:
```

```
Total flow rate =      0.719(CFS)
Time of concentration =     7.353 min.
Effective stream area after confluence =      0.500(Ac.)
End of computations, total study area =           0.500 (Ac.)
```

Runoff Coefficient Calculation (Proposed Condition)

Project: UCSD Voigt Parking Structure

Soil Type: D

C = 0.90 × (% Impervious) + Cp × (1 - % Impervious)

Cp= 0.35 (per Table 3-1, County of San Diego Hydrology Manual, Soil Class D)

Basin #	Area (Acres)		%imp	*Runoff Coef. (C)	C x A	Weighted C-Factor	**Equivalent Land Use (from Table 3-1)
	Total Area (ac)	Imp. Area (Ai)					
A	3.93	1.43	36	0.55	2.159	-	-
B	2.17	1.02	47	0.61	1.322	-	-
C	0.63	0.26	41	0.57	0.361	-	-
Total	**6.73**	**2.70**	-	-	3.843	**0.57**	**Residential, 7.3 DU/A or Less**

*The composite runoff coefficient (C) is calculated for entire site by using the following equation:

C = 0.90 × (% Impervious) + Cp × (1 - % Impervious);

Cp = 0.35 per Table 3-1 of the County Hydrology Manual = Pervious Coefficient Runoff Value for the soil type D (shown in Table 3-1 as Undisturbed Natural Terrain/Permanenet Open Space, 0% Impervious)

**Equivalent Land Use type is determined to be used as an input to the CivilD software for initial basin analysis only because the calculated C value cannot be entered as is.

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                    San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2012 Version 7.9

Rational method hydrology  program based on
San Diego County Flood Control Division 2003 hydrology manual
        Rational Hydrology Study        Date: 06/30/17
------------------------------------------------------------------------
UCSD VOIGT PARKING STRUCTURE
PROPOSED CONDITION HYDROLOGY ANALYSIS
EXIT POINT 1


------------------------------------------------------------------------
 *********   Hydrology Study Control Information **********

------------------------------------------------------------------------


Program License Serial Number 6116

------------------------------------------------------------------------
Rational hydrology study storm event year is    10.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour,  precipitation(inches) =  1.500
24 hour precipitation(inches) =  2.600
P6/P24 =    57.7%
San Diego hydrology manual 'C' values used


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      100.000 to Point/Station      101.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[MEDIUM DENSITY RESIDENTIAL                  ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.570
Initial subarea total flow distance  =  110.000(Ft.)
Highest elevation =  357.200(Ft.)
Lowest elevation =  355.000(Ft.)
Elevation difference =    2.200(Ft.) Slope =  2.000 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 80.00 (Ft)
for the top area slope value of   2.00 %, in a development type of
 7.3 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   6.77 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.5700)*(  80.000^.5)/(   2.000^(1/3)]=   6.77
The initial area total distance of  110.00 (Ft.) entered leaves a
remaining distance of   30.00 (Ft.)
Using Figure 3-4, the travel time for this distance is   0.48 minutes
for a distance of  30.00 (Ft.) and a slope of  2.00 %
with an elevation difference of   0.60(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
```

```
 =    0.483 Minutes
Tt=[(11.9*0.0057^3)/(  0.60)]^.385=  0.48
Total initial area Ti =   6.77 minutes from Figure 3-3 formula plus
  0.48 minutes from the Figure 3-4 formula =   7.26 minutes
Rainfall intensity (I) =      3.108(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.570
Subarea runoff =      0.337(CFS)
Total initial stream area =        0.190(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      101.000 to Point/Station      104.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =      0.190(Ac.)
Runoff from this stream =      0.337(CFS)
Time of concentration =    7.26 min.
Rainfall intensity =     3.108(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      102.000 to Point/Station      103.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[MEDIUM DENSITY RESIDENTIAL                  ]
(7.3 DU/A or Less        )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.570
Initial subarea total flow distance  =   76.000(Ft.)
Highest elevation =  358.720(Ft.)
Lowest elevation =  357.200(Ft.)
Elevation difference =    1.520(Ft.) Slope =  2.000 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 80.00 (Ft)
for the top area slope value of   2.00 %, in a development type of
 7.3 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   6.77 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.5700)*(  80.000^.5)/(   2.000^(1/3)]=   6.77
Rainfall intensity (I) =      3.250(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.570
Subarea runoff =      0.315(CFS)
Total initial stream area =        0.170(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      103.000 to Point/Station      103.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      3.250(In/Hr) for a    10.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =     6.77 min.
Rainfall intensity =      3.250(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      0.194
Subarea runoff =      0.315(CFS) for      0.170(Ac.)
Total runoff =      0.630(CFS)  Total area =       0.340(Ac.)
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      104.000 to Point/Station      104.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      3.250(In/Hr) for a    10.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =     6.77 min.
Rainfall intensity =      3.250(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      0.217
Subarea runoff =      0.074(CFS) for      0.040(Ac.)
Total runoff =      0.704(CFS)  Total area =       0.380(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      103.000 to Point/Station      104.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________
Along Main Stream number: 1 in normal stream number 2
Stream flow area =      0.380(Ac.)
Runoff from this stream =      0.704(CFS)
Time of concentration =    6.77 min.
Rainfall intensity =     3.250(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                 (In/Hr)


1        0.337      7.26                3.108
2        0.704      6.77                3.250
Qmax(1) =
           1.000 *    1.000 *     0.337) +
           0.957 *    1.000 *     0.704) + =       1.010
Qmax(2) =
           1.000 *    0.933 *     0.337) +
           1.000 *    1.000 *     0.704) + =       1.018

Total of 2 streams to confluence:
Flow rates before confluence point:
       0.337       0.704
Maximum flow rates at confluence using above data:
        1.010        1.018
Area of streams before confluence:
        0.190        0.380
Results of confluence:
Total flow rate =      1.018(CFS)
Time of concentration =     6.773 min.
Effective stream area after confluence =      0.570(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      104.000 to Point/Station      104.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      3.250(In/Hr) for a    10.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =     6.77 min.
Rainfall intensity =      3.250(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      0.405
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```
Subarea runoff =      0.297(CFS) for      0.140(Ac.)
Total runoff =      1.315(CFS)  Total area =       0.710(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      104.000 to Point/Station      105.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
______________________________________________________________________
Estimated mean flow rate at midpoint of channel =      1.584(CFS)
Depth of flow =   0.127(Ft.), Average velocity =   3.262(Ft/s)
        ******* Irregular Channel Data ***********
-----------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
        1              0.00              0.50
        2             15.00              0.00
        3             30.00              0.50
Manning's 'N' friction factor =   0.020
-----------------------------------------------------------------
Sub-Channel flow  =      1.584(CFS)
  '     '        flow top width =      7.633(Ft.)
  '     '    velocity=    3.262(Ft/s)
  '     '        area =      0.486(Sq.Ft)
  '     '        Froude number =     2.279

Upstream point elevation =   320.000(Ft.)
Downstream point elevation =   314.000(Ft.)
Flow length =    79.000(Ft.)
Travel time  =    0.40 min.
Time of concentration =    7.18 min.
Depth of flow =   0.127(Ft.)
Average velocity =   3.262(Ft/s)
Total irregular channel flow =     1.584(CFS)
Irregular channel normal depth above invert elev. =   0.127(Ft.)
Average velocity of channel(s) =   3.262(Ft/s)
 Adding area flow to channel
Rainfall intensity (I) =      3.130(In/Hr) for a    10.0 year storm
User specified 'C' value of 0.570 given for subarea
Rainfall intensity =      3.130(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      0.570
Subarea runoff =      0.469(CFS) for      0.290(Ac.)
Total runoff =      1.784(CFS)  Total area =       1.000(Ac.)
Depth of flow =   0.133(Ft.), Average velocity =   3.360(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      105.000 to Point/Station      110.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
______________________________________________________________________
Estimated mean flow rate at midpoint of channel =      2.008(CFS)
Depth of flow =   0.161(Ft.), Average velocity =   2.582(Ft/s)
        ******* Irregular Channel Data ***********
-----------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
        1              0.00              0.50
        2             15.00              0.00
        3             30.00              0.50
Manning's 'N' friction factor =   0.020
-----------------------------------------------------------------
Sub-Channel flow  =      2.008(CFS)
  '     '        flow top width =      9.659(Ft.)
```

```
  '     '    velocity=    2.582(Ft/s)
  '     '        area =      0.778(Sq.Ft)
  '     '        Froude number =     1.604

Upstream point elevation =   314.000(Ft.)
Downstream point elevation =   310.000(Ft.)
Flow length =   115.000(Ft.)
Travel time  =    0.74 min.
Time of concentration =    7.92 min.
Depth of flow =   0.161(Ft.)
Average velocity =   2.582(Ft/s)
Total irregular channel flow =     2.008(CFS)
Irregular channel normal depth above invert elev. =   0.161(Ft.)
Average velocity of channel(s) =   2.582(Ft/s)
 Adding area flow to channel
Rainfall intensity (I) =      2.938(In/Hr) for a    10.0 year storm
User specified 'C' value of 0.570 given for subarea
Rainfall intensity =      2.938(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      0.735
Subarea runoff =      0.376(CFS) for      0.290(Ac.)
Total runoff =      2.160(CFS)  Total area =       1.290(Ac.)
Depth of flow =   0.165(Ft.), Average velocity =   2.630(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      110.000 to Point/Station      110.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      2.938(In/Hr) for a    10.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =     7.92 min.
Rainfall intensity =      2.938(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      0.798
Subarea runoff =      0.184(CFS) for      0.110(Ac.)
Total runoff =      2.344(CFS)  Total area =       1.400(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      110.000 to Point/Station      110.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      2.938(In/Hr) for a    10.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =     7.92 min.
Rainfall intensity =      2.938(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      0.861
Subarea runoff =      0.184(CFS) for      0.110(Ac.)
Total runoff =      2.529(CFS)  Total area =       1.510(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      110.000 to Point/Station      110.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      2.938(In/Hr) for a    10.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =     7.92 min.
Rainfall intensity =      2.938(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      0.946
```

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Subarea runoff =      0.251(CFS) for      0.150(Ac.)
Total runoff =      2.780(CFS)  Total area =       1.660(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      110.000 to Point/Station      110.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =      1.660(Ac.)
Runoff from this stream =      2.780(CFS)
Time of concentration =    7.92 min.
Rainfall intensity =     2.938(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      108.000 to Point/Station      109.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[MEDIUM DENSITY RESIDENTIAL                  ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.570
Initial subarea total flow distance  =  132.000(Ft.)
Highest elevation =  357.650(Ft.)
Lowest elevation =  355.000(Ft.)
Elevation difference =    2.650(Ft.) Slope =  2.008 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 80.00 (Ft)
for the top area slope value of   2.00 %, in a development type of
 7.3 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   6.77 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.5700)*(  80.000^.5)/(   2.000^(1/3)]=   6.77
The initial area total distance of  132.00 (Ft.) entered leaves a
remaining distance of   52.00 (Ft.)
Using Figure 3-4, the travel time for this distance is   0.74 minutes
for a distance of  52.00 (Ft.) and a slope of  2.00 %
with an elevation difference of   1.04(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
 =    0.738 Minutes
Tt=[(11.9*0.0098^3)/(  1.04)]^.385=  0.74
Total initial area Ti =   6.77 minutes from Figure 3-3 formula plus
  0.74 minutes from the Figure 3-4 formula =   7.51 minutes
Rainfall intensity (I) =      3.040(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.570
Subarea runoff =      0.624(CFS)
Total initial stream area =        0.360(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      109.000 to Point/Station      109.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      3.040(In/Hr) for a    10.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =     7.51 min.
Rainfall intensity =      3.040(In/Hr) for a    10.0 year storm
```

Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570 CA =   0.393
Subarea runoff =   0.572(CFS) for   0.330(Ac.)
Total runoff =   1.196(CFS) Total area =   0.690(Ac.)

++
Process from Point/Station   109.000 to Point/Station   109.000
**** SUBAREA FLOW ADDITION ****

Rainfall intensity (I) =   3.040(In/Hr) for a   10.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =   7.51 min.
Rainfall intensity =   3.040(In/Hr) for a   10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570 CA =   0.422
Subarea runoff =   0.087(CFS) for   0.050(Ac.)
Total runoff =   1.282(CFS) Total area =   0.740(Ac.)

++
Process from Point/Station   109.000 to Point/Station   110.000
**** CONFLUENCE OF MINOR STREAMS ****

Along Main Stream number: 1 in normal stream number 2
Stream flow area =   0.740(Ac.)
Runoff from this stream =   1.282(CFS)
Time of concentration =   7.51 min.
Rainfall intensity =   3.040(In/Hr)
Summary of stream data:

Stream No.	Flow rate (CFS)	TC (min)	Rainfall Intensity (In/Hr)
1	2.780	7.92	2.938
2	1.282	7.51	3.040

Qmax(1) =
1.000 *   1.000 *   2.780) +
0.966 *   1.000 *   1.282) + =   4.019
Qmax(2) =
1.000 *   0.948 *   2.780) +
1.000 *   1.000 *   1.282) + =   3.919

Total of 2 streams to confluence:
Flow rates before confluence point:
2.780   1.282
Maximum flow rates at confluence using above data:
4.019   3.919
Area of streams before confluence:
1.660   0.740
Results of confluence:
Total flow rate =   4.019(CFS)
Time of concentration =   7.918 min.
Effective stream area after confluence =   2.400(Ac.)

++
Process from Point/Station   110.000 to Point/Station   111.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****

Estimated mean flow rate at midpoint of channel =   4.084(CFS)
Depth of flow =   0.224(Ft.), Average velocity =   2.707(Ft/s)

```
        ******* Irregular Channel Data ***********
-----------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
        1              0.00              0.50
        2             15.00              0.00
        3             30.00              0.50
Manning's 'N' friction factor =   0.020
-----------------------------------------------------------------
Sub-Channel flow  =      4.084(CFS)
  '     '        flow top width =     13.456(Ft.)
  '     '    velocity=    2.707(Ft/s)
  '     '        area =      1.509(Sq.Ft)
  '     '        Froude number =     1.424

Upstream point elevation =   310.000(Ft.)
Downstream point elevation =   307.200(Ft.)
Flow length =   114.000(Ft.)
Travel time  =    0.70 min.
Time of concentration =    8.62 min.
Depth of flow =   0.224(Ft.)
Average velocity =   2.707(Ft/s)
Total irregular channel flow =     4.084(CFS)
Irregular channel normal depth above invert elev. =   0.224(Ft.)
Average velocity of channel(s) =   2.707(Ft/s)
 Adding area flow to channel
Rainfall intensity (I) =      2.781(In/Hr) for a    10.0 year storm
User specified 'C' value of 0.570 given for subarea
Rainfall intensity =      2.781(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      1.471
Subarea runoff =      0.071(CFS) for      0.180(Ac.)
Total runoff =      4.090(CFS)  Total area =       2.580(Ac.)
Depth of flow =   0.224(Ft.), Average velocity =   2.708(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      111.000 to Point/Station      111.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      2.781(In/Hr) for a    10.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =     8.62 min.
Rainfall intensity =      2.781(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      1.528
Subarea runoff =      0.159(CFS) for      0.100(Ac.)
Total runoff =      4.249(CFS)  Total area =       2.680(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      111.000 to Point/Station      111.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      2.781(In/Hr) for a    10.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =     8.62 min.
Rainfall intensity =      2.781(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      2.240
Subarea runoff =      1.982(CFS) for      1.250(Ac.)
Total runoff =      6.230(CFS)  Total area =       3.930(Ac.)
```

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++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      111.000 to Point/Station      111.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =      3.930(Ac.)
Runoff from this stream =      6.230(CFS)
Time of concentration =    8.62 min.
Rainfall intensity =     2.781(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      200.000 to Point/Station      201.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[MEDIUM DENSITY RESIDENTIAL                  ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.570
Initial subarea total flow distance  =  100.000(Ft.)
Highest elevation =  372.000(Ft.)
Lowest elevation =  365.800(Ft.)
Elevation difference =    6.200(Ft.) Slope =  6.200 %
Top of Initial Area Slope adjusted by User to  6.000 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of   6.00 %, in a development type of
 7.3 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   5.25 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.5700)*( 100.000^.5)/(   6.000^(1/3)]=   5.25
Rainfall intensity (I) =      3.830(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.570
Subarea runoff =      0.196(CFS)
Total initial stream area =        0.090(Ac.)


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Process from Point/Station      201.000 to Point/Station      202.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
______________________________________________________________________
Estimated mean flow rate at midpoint of channel =      0.393(CFS)
Depth of flow =   0.160(Ft.), Average velocity =   3.086(Ft/s)
        ******* Irregular Channel Data ***********
-----------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
        1             0.00              0.30
        2             1.50              0.00
        3             3.00              0.30
Manning's 'N' friction factor =   0.020
-----------------------------------------------------------------
Sub-Channel flow  =      0.393(CFS)
  '     '        flow top width =      1.596(Ft.)
  '     '    velocity=    3.086(Ft/s)
  '     '        area =      0.127(Sq.Ft)
  '     '        Froude number =     1.925
```

```
Upstream point elevation =   365.800(Ft.)
Downstream point elevation =   355.900(Ft.)
Flow length =   192.000(Ft.)
Travel time  =    1.04 min.
Time of concentration =    6.29 min.
Depth of flow =   0.160(Ft.)
Average velocity =   3.086(Ft/s)
Total irregular channel flow =     0.393(CFS)
Irregular channel normal depth above invert elev. =   0.160(Ft.)
Average velocity of channel(s) =   3.086(Ft/s)
 Adding area flow to channel
Rainfall intensity (I) =      3.409(In/Hr) for a    10.0 year storm
User specified 'C' value of 0.570 given for subarea
Rainfall intensity =      3.409(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      0.154
Subarea runoff =      0.328(CFS) for      0.180(Ac.)
Total runoff =      0.525(CFS)  Total area =       0.270(Ac.)
Depth of flow =   0.178(Ft.), Average velocity =   3.318(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      202.000 to Point/Station      203.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________
Upstream point/station elevation =   352.900(Ft.)
Downstream point/station elevation =   348.490(Ft.)
Pipe length  =    89.50(Ft.) Slope =   0.0493  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     0.525(CFS)
Nearest computed pipe diameter  =     6.00(In.)
Calculated individual pipe flow  =     0.525(CFS)
Normal flow depth in pipe =    2.72(In.)
Flow top width inside pipe =    5.97(In.)
Critical Depth =    4.43(In.)
Pipe flow velocity =      6.07(Ft/s)
Travel time through pipe =    0.25 min.
Time of concentration (TC) =     6.53 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      203.000 to Point/Station      203.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      3.326(In/Hr) for a    10.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =     6.53 min.
Rainfall intensity =      3.326(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      0.479
Subarea runoff =      1.068(CFS) for      0.570(Ac.)
Total runoff =      1.593(CFS)  Total area =       0.840(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      203.000 to Point/Station      203.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      3.326(In/Hr) for a    10.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =     6.53 min.
Rainfall intensity =      3.326(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
```

```
(Q=KCIA) is C = 0.570  CA =      0.906
Subarea runoff =      1.422(CFS) for      0.750(Ac.)
Total runoff =      3.014(CFS)  Total area =       1.590(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      203.000 to Point/Station      204.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________
Upstream point/station elevation =   348.490(Ft.)
Downstream point/station elevation =   345.460(Ft.)
Pipe length  =    39.00(Ft.) Slope =   0.0777  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     3.014(CFS)
Nearest computed pipe diameter  =      9.00(In.)
Calculated individual pipe flow  =     3.014(CFS)
Normal flow depth in pipe =    5.30(In.)
Flow top width inside pipe =    8.86(In.)
Critical depth could not be calculated.
Pipe flow velocity =     11.12(Ft/s)
Travel time through pipe =    0.06 min.
Time of concentration (TC) =     6.59 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      204.000 to Point/Station      204.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      3.307(In/Hr) for a    10.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =     6.59 min.
Rainfall intensity =      3.307(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      0.975
Subarea runoff =      0.209(CFS) for      0.120(Ac.)
Total runoff =      3.223(CFS)  Total area =       1.710(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      204.000 to Point/Station      204.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      3.307(In/Hr) for a    10.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =     6.59 min.
Rainfall intensity =      3.307(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      1.100
Subarea runoff =      0.415(CFS) for      0.220(Ac.)
Total runoff =      3.638(CFS)  Total area =       1.930(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      204.000 to Point/Station      205.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________
Upstream point/station elevation =   345.460(Ft.)
Downstream point/station elevation =   343.900(Ft.)
Pipe length  =    86.00(Ft.) Slope =   0.0181  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     3.638(CFS)
Nearest computed pipe diameter  =     12.00(In.)
Calculated individual pipe flow  =     3.638(CFS)
Normal flow depth in pipe =    7.82(In.)
Flow top width inside pipe =   11.44(In.)
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Critical Depth =    9.76(In.)
Pipe flow velocity =      6.72(Ft/s)
Travel time through pipe =    0.21 min.
Time of concentration (TC) =     6.80 min.


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Process from Point/Station      205.000 to Point/Station      206.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________
Upstream point/station elevation =   343.900(Ft.)
Downstream point/station elevation =   340.000(Ft.)
Pipe length  =   167.00(Ft.) Slope =   0.0234  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     3.638(CFS)
Nearest computed pipe diameter  =     12.00(In.)
Calculated individual pipe flow  =     3.638(CFS)
Normal flow depth in pipe =    7.17(In.)
Flow top width inside pipe =   11.77(In.)
Critical Depth =    9.76(In.)
Pipe flow velocity =      7.42(Ft/s)
Travel time through pipe =    0.37 min.
Time of concentration (TC) =     7.18 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      206.000 to Point/Station      206.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      3.130(In/Hr) for a    10.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =     7.18 min.
Rainfall intensity =      3.130(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      1.191
Subarea runoff =      0.090(CFS) for      0.160(Ac.)
Total runoff =      3.728(CFS)  Total area =       2.090(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      206.000 to Point/Station      207.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________
Upstream point/station elevation =   340.000(Ft.)
Downstream point/station elevation =   314.190(Ft.)
Pipe length  =    52.00(Ft.) Slope =   0.4963  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     3.728(CFS)
Nearest computed pipe diameter  =      6.00(In.)
Calculated individual pipe flow  =     3.728(CFS)
Normal flow depth in pipe =    4.64(In.)
Flow top width inside pipe =    5.02(In.)
Critical depth could not be calculated.
Pipe flow velocity =     22.90(Ft/s)
Travel time through pipe =    0.04 min.
Time of concentration (TC) =     7.22 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      207.000 to Point/Station      208.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________
Upstream point/station elevation =   314.190(Ft.)
Downstream point/station elevation =   312.640(Ft.)
Pipe length  =    67.00(Ft.) Slope =   0.0231  Manning's N = 0.013
```

```
No. of pipes = 1  Required pipe flow  =     3.728(CFS)
Nearest computed pipe diameter  =     12.00(In.)
Calculated individual pipe flow  =     3.728(CFS)
Normal flow depth in pipe =    7.31(In.)
Flow top width inside pipe =   11.71(In.)
Critical Depth =    9.87(In.)
Pipe flow velocity =      7.44(Ft/s)
Travel time through pipe =    0.15 min.
Time of concentration (TC) =     7.37 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      208.000 to Point/Station      208.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      3.078(In/Hr) for a    10.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =     7.37 min.
Rainfall intensity =      3.078(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      1.237
Subarea runoff =      0.079(CFS) for      0.080(Ac.)
Total runoff =      3.807(CFS)  Total area =       2.170(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      208.000 to Point/Station      111.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________
Upstream point/station elevation =   312.640(Ft.)
Downstream point/station elevation =   283.010(Ft.)
Pipe length  =   290.00(Ft.) Slope =   0.1022  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     3.807(CFS)
Nearest computed pipe diameter  =      9.00(In.)
Calculated individual pipe flow  =     3.807(CFS)
Normal flow depth in pipe =    5.65(In.)
Flow top width inside pipe =    8.70(In.)
Critical depth could not be calculated.
Pipe flow velocity =     13.03(Ft/s)
Travel time through pipe =    0.37 min.
Time of concentration (TC) =     7.74 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      111.000 to Point/Station      111.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________
Along Main Stream number: 1 in normal stream number 2
Stream flow area =      2.170(Ac.)
Runoff from this stream =      3.807(CFS)
Time of concentration =    7.74 min.
Rainfall intensity =     2.982(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                 (In/Hr)


1        6.230      8.62                 2.781
2        3.807      7.74                 2.982
Qmax(1) =
           1.000 *    1.000 *     6.230) +
           0.933 *    1.000 *     3.807) + =       9.781
```

```
Qmax(2) =
           1.000 *    0.898 *     6.230) +
           1.000 *    1.000 *     3.807) + =       9.400

Total of 2 streams to confluence:
Flow rates before confluence point:
       6.230       3.807
Maximum flow rates at confluence using above data:
        9.781        9.400
Area of streams before confluence:
        3.930        2.170
Results of confluence:
Total flow rate =      9.781(CFS)
Time of concentration =     8.620 min.
Effective stream area after confluence =      6.100(Ac.)
End of computations, total study area =           6.100 (Ac.)
```

```
                San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2012 Version 7.9

Rational method hydrology  program based on
San Diego County Flood Control Division 2003 hydrology manual
        Rational Hydrology Study        Date: 07/03/17
------------------------------------------------------------------------
UCSD VOIGT PARKING STRUCTURE
PROPOSED CONDITION HYDROLOGY ANALYSIS
RUNOFF EXIT POINT 2


------------------------------------------------------------------------
 *********   Hydrology Study Control Information **********

------------------------------------------------------------------------


Program License Serial Number 6116

------------------------------------------------------------------------
Rational hydrology study storm event year is    10.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour,  precipitation(inches) =  1.500
24 hour precipitation(inches) =  2.600
P6/P24 =    57.7%
San Diego hydrology manual 'C' values used


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      300.000 to Point/Station      301.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[MEDIUM DENSITY RESIDENTIAL                  ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.570
Initial subarea total flow distance  =  165.000(Ft.)
Highest elevation =  382.000(Ft.)
Lowest elevation =  374.000(Ft.)
Elevation difference =    8.000(Ft.) Slope =  4.848 %
Top of Initial Area Slope adjusted by User to  5.000 %
Bottom of Initial Area Slope adjusted by User to  5.000 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of   5.00 %, in a development type of
 7.3 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   5.58 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.5700)*( 100.000^.5)/(   5.000^(1/3)]=   5.58
The initial area total distance of  165.00 (Ft.) entered leaves a
remaining distance of   65.00 (Ft.)
Using Figure 3-4, the travel time for this distance is   0.62 minutes
for a distance of  65.00 (Ft.) and a slope of  5.00 %
```

```
with an elevation difference of   3.25(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
 =    0.616 Minutes
Tt=[(11.9*0.0123^3)/(  3.25)]^.385=  0.62
Total initial area Ti =   5.58 minutes from Figure 3-3 formula plus
  0.62 minutes from the Figure 3-4 formula =   6.19 minutes
Rainfall intensity (I) =      3.442(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.570
Subarea runoff =      0.334(CFS)
Total initial stream area =        0.170(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      301.000 to Point/Station      302.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      3.442(In/Hr) for a    10.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =     6.19 min.
Rainfall intensity =      3.442(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      0.142
Subarea runoff =      0.157(CFS) for      0.080(Ac.)
Total runoff =      0.490(CFS)  Total area =       0.250(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      304.000 to Point/Station      304.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =      0.250(Ac.)
Runoff from this stream =      0.490(CFS)
Time of concentration =    6.19 min.
Rainfall intensity =     3.442(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      303.000 to Point/Station      304.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[LOW DENSITY RESIDENTIAL                     ]
(2.0 DU/A or Less       )
Impervious value, Ai = 0.200
Sub-Area C Value = 0.460
Initial subarea total flow distance  =  167.000(Ft.)
Highest elevation =  381.000(Ft.)
Lowest elevation =  363.500(Ft.)
Elevation difference =   17.500(Ft.) Slope = 10.479 %
Top of Initial Area Slope adjusted by User to 10.000 %
Bottom of Initial Area Slope adjusted by User to 10.000 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of  10.00 %, in a development type of
 2.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   5.35 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.4600)*( 100.000^.5)/(  10.000^(1/3)]=   5.35
```

The initial area total distance of 167.00 (Ft.) entered leaves a
remaining distance of 67.00 (Ft.)
Using Figure 3-4, the travel time for this distance is 0.48 minutes
for a distance of 67.00 (Ft.) and a slope of 10.00 %
with an elevation difference of 6.70(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
= 0.483 Minutes
Tt=[(11.9*0.0127^3)/(6.70)]^.385= 0.48
Total initial area Ti = 5.35 minutes from Figure 3-3 formula plus
0.48 minutes from the Figure 3-4 formula = 5.83 minutes
Rainfall intensity (I) = 3.579(In/Hr) for a 10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.460
Subarea runoff = 0.231(CFS)
Total initial stream area = 0.140(Ac.)

++
Process from Point/Station 304.000 to Point/Station 304.000
**** CONFLUENCE OF MINOR STREAMS ****

Along Main Stream number: 1 in normal stream number 2
Stream flow area = 0.140(Ac.)
Runoff from this stream = 0.231(CFS)
Time of concentration = 5.83 min.
Rainfall intensity = 3.579(In/Hr)
Summary of stream data:

Stream No.	Flow rate (CFS)	TC (min)	Rainfall Intensity (In/Hr)
1	0.490	6.19	3.442
2	0.231	5.83	3.579

Qmax(1) =
1.000 * 1.000 * 0.490) +
0.962 * 1.000 * 0.231) + = 0.712
Qmax(2) =
1.000 * 0.941 * 0.490) +
1.000 * 1.000 * 0.231) + = 0.692

Total of 2 streams to confluence:
Flow rates before confluence point:
0.490 0.231
Maximum flow rates at confluence using above data:
0.712 0.692
Area of streams before confluence:
0.250 0.140
Results of confluence:
Total flow rate = 0.712(CFS)
Time of concentration = 6.195 min.
Effective stream area after confluence = 0.390(Ac.)

++
Process from Point/Station 306.000 to Point/Station 306.000
**** CONFLUENCE OF MINOR STREAMS ****

Along Main Stream number: 1 in normal stream number 1
Stream flow area = 0.390(Ac.)
Runoff from this stream = 0.712(CFS)
Time of concentration = 6.19 min.
Rainfall intensity = 3.442(In/Hr)

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      305.000 to Point/Station      306.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[LOW DENSITY RESIDENTIAL                     ]
(2.0 DU/A or Less       )
Impervious value, Ai = 0.200
Sub-Area C Value = 0.460
Initial subarea total flow distance  =  268.000(Ft.)
Highest elevation =  367.000(Ft.)
Lowest elevation =  351.000(Ft.)
Elevation difference =   16.000(Ft.) Slope =  5.970 %
Top of Initial Area Slope adjusted by User to  6.000 %
Bottom of Initial Area Slope adjusted by User to  6.000 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of   6.00 %, in a development type of
 2.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   6.34 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.4600)*( 100.000^.5)/(   6.000^(1/3)]=   6.34
The initial area total distance of  268.00 (Ft.) entered leaves a
remaining distance of  168.00 (Ft.)
Using Figure 3-4, the travel time for this distance is   1.19 minutes
for a distance of 168.00 (Ft.) and a slope of  6.00 %
with an elevation difference of  10.08(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
 =    1.193 Minutes
Tt=[(11.9*0.0318^3)/( 10.08)]^.385=  1.19
Total initial area Ti =   6.34 minutes from Figure 3-3 formula plus
  1.19 minutes from the Figure 3-4 formula =   7.53 minutes
Rainfall intensity (I) =      3.034(In/Hr) for a    10.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.460
Subarea runoff =      0.349(CFS)
Total initial stream area =        0.250(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      306.000 to Point/Station      306.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________
Along Main Stream number: 1 in normal stream number 2
Stream flow area =      0.250(Ac.)
Runoff from this stream =      0.349(CFS)
Time of concentration =    7.53 min.
Rainfall intensity =     3.034(In/Hr)
Summary of stream data:

Stream   Flow rate      TC           Rainfall Intensity
 No.       (CFS)       (min)                (In/Hr)


1        0.712      6.19                 3.442
2        0.349      7.53                 3.034
Qmax(1) =
           1.000 *    1.000 *     0.712) +
           1.000 *    0.822 *     0.349) + =       0.999
```

```
Qmax(2) =
           0.882 *    1.000 *     0.712) +
           1.000 *    1.000 *     0.349) + =       0.977

Total of 2 streams to confluence:
Flow rates before confluence point:
       0.712       0.349
Maximum flow rates at confluence using above data:
        0.999        0.977
Area of streams before confluence:
        0.390        0.250
Results of confluence:
Total flow rate =      0.999(CFS)
Time of concentration =     6.195 min.
Effective stream area after confluence =      0.640(Ac.)
End of computations, total study area =           0.640 (Ac.)
```

```
                San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2012 Version 7.9

Rational method hydrology  program based on
San Diego County Flood Control Division 2003 hydrology manual
        Rational Hydrology Study        Date: 07/03/17
------------------------------------------------------------------------
UCSD VOIGT PARKING STRUCTURE
PROPOSED CONDITION HYDROLOGY ANALYSIS
RUNOFF EXIT POINT 1


------------------------------------------------------------------------
 *********   Hydrology Study Control Information **********

------------------------------------------------------------------------


Program License Serial Number 6116

------------------------------------------------------------------------
Rational hydrology study storm event year is   100.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour,  precipitation(inches) =  2.300
24 hour precipitation(inches) =  3.900
P6/P24 =    59.0%
San Diego hydrology manual 'C' values used


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      100.000 to Point/Station      101.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[MEDIUM DENSITY RESIDENTIAL                  ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.570
Initial subarea total flow distance  =  110.000(Ft.)
Highest elevation =  357.200(Ft.)
Lowest elevation =  355.000(Ft.)
Elevation difference =    2.200(Ft.) Slope =  2.000 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 80.00 (Ft)
for the top area slope value of   2.00 %, in a development type of
 7.3 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   6.77 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.5700)*(  80.000^.5)/(   2.000^(1/3)]=   6.77
The initial area total distance of  110.00 (Ft.) entered leaves a
remaining distance of   30.00 (Ft.)
Using Figure 3-4, the travel time for this distance is   0.48 minutes
for a distance of  30.00 (Ft.) and a slope of  2.00 %
with an elevation difference of   0.60(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
```

```
 =    0.483 Minutes
Tt=[(11.9*0.0057^3)/(  0.60)]^.385=  0.48
Total initial area Ti =   6.77 minutes from Figure 3-3 formula plus
  0.48 minutes from the Figure 3-4 formula =   7.26 minutes
Rainfall intensity (I) =      4.766(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.570
Subarea runoff =      0.516(CFS)
Total initial stream area =        0.190(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      101.000 to Point/Station      104.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =      0.190(Ac.)
Runoff from this stream =      0.516(CFS)
Time of concentration =    7.26 min.
Rainfall intensity =     4.766(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      102.000 to Point/Station      103.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[MEDIUM DENSITY RESIDENTIAL                  ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.570
Initial subarea total flow distance  =   76.000(Ft.)
Highest elevation =  358.720(Ft.)
Lowest elevation =  357.200(Ft.)
Elevation difference =    1.520(Ft.) Slope =  2.000 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 80.00 (Ft)
for the top area slope value of   2.00 %, in a development type of
 7.3 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   6.77 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.5700)*(  80.000^.5)/(   2.000^(1/3)]=   6.77
Rainfall intensity (I) =      4.983(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.570
Subarea runoff =      0.483(CFS)
Total initial stream area =        0.170(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      103.000 to Point/Station      103.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      4.983(In/Hr) for a   100.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =     6.77 min.
Rainfall intensity =      4.983(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      0.194
Subarea runoff =      0.483(CFS) for      0.170(Ac.)
Total runoff =      0.966(CFS)  Total area =       0.340(Ac.)
```

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++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      104.000 to Point/Station      104.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      4.983(In/Hr) for a   100.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =     6.77 min.
Rainfall intensity =      4.983(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      0.217
Subarea runoff =      0.114(CFS) for      0.040(Ac.)
Total runoff =      1.079(CFS)  Total area =       0.380(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      103.000 to Point/Station      104.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________
Along Main Stream number: 1 in normal stream number 2
Stream flow area =      0.380(Ac.)
Runoff from this stream =      1.079(CFS)
Time of concentration =    6.77 min.
Rainfall intensity =     4.983(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                 (In/Hr)


1        0.516      7.26                4.766
2        1.079      6.77                4.983
Qmax(1) =
           1.000 *    1.000 *     0.516) +
           0.957 *    1.000 *     1.079) + =       1.549
Qmax(2) =
           1.000 *    0.933 *     0.516) +
           1.000 *    1.000 *     1.079) + =       1.561

Total of 2 streams to confluence:
Flow rates before confluence point:
       0.516       1.079
Maximum flow rates at confluence using above data:
        1.549        1.561
Area of streams before confluence:
        0.190        0.380
Results of confluence:
Total flow rate =      1.561(CFS)
Time of concentration =     6.773 min.
Effective stream area after confluence =      0.570(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      104.000 to Point/Station      104.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      4.983(In/Hr) for a   100.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =     6.77 min.
Rainfall intensity =      4.983(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      0.405
```

```
Subarea runoff =      0.455(CFS) for      0.140(Ac.)
Total runoff =      2.017(CFS)  Total area =       0.710(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      104.000 to Point/Station      105.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
______________________________________________________________________
Estimated mean flow rate at midpoint of channel =      2.428(CFS)
Depth of flow =   0.149(Ft.), Average velocity =   3.630(Ft/s)
        ******* Irregular Channel Data ***********
-----------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
        1              0.00              0.50
        2             15.00              0.00
        3             30.00              0.50
Manning's 'N' friction factor =   0.020
-----------------------------------------------------------------
Sub-Channel flow  =      2.428(CFS)
  '     '        flow top width =      8.960(Ft.)
  '     '    velocity=    3.630(Ft/s)
  '     '        area =      0.669(Sq.Ft)
  '     '        Froude number =     2.341

Upstream point elevation =   320.000(Ft.)
Downstream point elevation =   314.000(Ft.)
Flow length =    79.000(Ft.)
Travel time  =    0.36 min.
Time of concentration =    7.14 min.
Depth of flow =   0.149(Ft.)
Average velocity =   3.630(Ft/s)
Total irregular channel flow =     2.428(CFS)
Irregular channel normal depth above invert elev. =   0.149(Ft.)
Average velocity of channel(s) =   3.630(Ft/s)
 Adding area flow to channel
Rainfall intensity (I) =      4.818(In/Hr) for a   100.0 year storm
User specified 'C' value of 0.570 given for subarea
Rainfall intensity =      4.818(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      0.570
Subarea runoff =      0.730(CFS) for      0.290(Ac.)
Total runoff =      2.746(CFS)  Total area =       1.000(Ac.)
Depth of flow =   0.156(Ft.), Average velocity =   3.743(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      105.000 to Point/Station      110.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
______________________________________________________________________
Estimated mean flow rate at midpoint of channel =      3.095(CFS)
Depth of flow =   0.189(Ft.), Average velocity =   2.877(Ft/s)
        ******* Irregular Channel Data ***********
-----------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
        1              0.00              0.50
        2             15.00              0.00
        3             30.00              0.50
Manning's 'N' friction factor =   0.020
-----------------------------------------------------------------
Sub-Channel flow  =      3.095(CFS)
  '     '        flow top width =     11.361(Ft.)
```

```
  '     '    velocity=    2.877(Ft/s)
  '     '        area =      1.076(Sq.Ft)
  '     '        Froude number =     1.648

Upstream point elevation =   314.000(Ft.)
Downstream point elevation =   310.000(Ft.)
Flow length =   115.000(Ft.)
Travel time  =    0.67 min.
Time of concentration =    7.80 min.
Depth of flow =   0.189(Ft.)
Average velocity =   2.877(Ft/s)
Total irregular channel flow =     3.095(CFS)
Irregular channel normal depth above invert elev. =   0.189(Ft.)
Average velocity of channel(s) =   2.877(Ft/s)
 Adding area flow to channel
Rainfall intensity (I) =      4.548(In/Hr) for a   100.0 year storm
User specified 'C' value of 0.570 given for subarea
Rainfall intensity =      4.548(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      0.735
Subarea runoff =      0.598(CFS) for      0.290(Ac.)
Total runoff =      3.344(CFS)  Total area =       1.290(Ac.)
Depth of flow =   0.195(Ft.), Average velocity =   2.934(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      110.000 to Point/Station      110.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      4.548(In/Hr) for a   100.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =     7.80 min.
Rainfall intensity =      4.548(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      0.798
Subarea runoff =      0.285(CFS) for      0.110(Ac.)
Total runoff =      3.630(CFS)  Total area =       1.400(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      110.000 to Point/Station      110.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      4.548(In/Hr) for a   100.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =     7.80 min.
Rainfall intensity =      4.548(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      0.861
Subarea runoff =      0.285(CFS) for      0.110(Ac.)
Total runoff =      3.915(CFS)  Total area =       1.510(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      110.000 to Point/Station      110.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      4.548(In/Hr) for a   100.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =     7.80 min.
Rainfall intensity =      4.548(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      0.946
```

```
Subarea runoff =      0.389(CFS) for      0.150(Ac.)
Total runoff =      4.304(CFS)  Total area =       1.660(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      110.000 to Point/Station      110.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =      1.660(Ac.)
Runoff from this stream =      4.304(CFS)
Time of concentration =    7.80 min.
Rainfall intensity =     4.548(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      108.000 to Point/Station      109.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[MEDIUM DENSITY RESIDENTIAL                  ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.570
Initial subarea total flow distance  =  132.000(Ft.)
Highest elevation =  357.650(Ft.)
Lowest elevation =  355.000(Ft.)
Elevation difference =    2.650(Ft.) Slope =  2.008 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 80.00 (Ft)
for the top area slope value of   2.00 %, in a development type of
 7.3 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   6.77 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.5700)*(  80.000^.5)/(   2.000^(1/3)]=   6.77
The initial area total distance of  132.00 (Ft.) entered leaves a
remaining distance of   52.00 (Ft.)
Using Figure 3-4, the travel time for this distance is   0.74 minutes
for a distance of  52.00 (Ft.) and a slope of  2.00 %
with an elevation difference of   1.04(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
 =    0.738 Minutes
Tt=[(11.9*0.0098^3)/(  1.04)]^.385=  0.74
Total initial area Ti =   6.77 minutes from Figure 3-3 formula plus
  0.74 minutes from the Figure 3-4 formula =   7.51 minutes
Rainfall intensity (I) =      4.661(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.570
Subarea runoff =      0.956(CFS)
Total initial stream area =        0.360(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      109.000 to Point/Station      109.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      4.661(In/Hr) for a   100.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =     7.51 min.
Rainfall intensity =      4.661(In/Hr) for a   100.0 year storm
```

Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570 CA =   0.393
Subarea runoff =   0.877(CFS) for   0.330(Ac.)
Total runoff =   1.833(CFS) Total area =   0.690(Ac.)

++
Process from Point/Station   109.000 to Point/Station   109.000
**** SUBAREA FLOW ADDITION ****

Rainfall intensity (I) =   4.661(In/Hr) for a   100.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =   7.51 min.
Rainfall intensity =   4.661(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570 CA =   0.422
Subarea runoff =   0.133(CFS) for   0.050(Ac.)
Total runoff =   1.966(CFS) Total area =   0.740(Ac.)

++
Process from Point/Station   109.000 to Point/Station   110.000
**** CONFLUENCE OF MINOR STREAMS ****

Along Main Stream number: 1 in normal stream number 2
Stream flow area =   0.740(Ac.)
Runoff from this stream =   1.966(CFS)
Time of concentration =   7.51 min.
Rainfall intensity =   4.661(In/Hr)
Summary of stream data:

Stream No.	Flow rate (CFS)	TC (min)	Rainfall Intensity (In/Hr)
1	4.304	7.80	4.548
2	1.966	7.51	4.661

Qmax(1) =
1.000 *   1.000 *   4.304) +
0.976 *   1.000 *   1.966) + =   6.222
Qmax(2) =
1.000 *   0.963 *   4.304) +
1.000 *   1.000 *   1.966) + =   6.109

Total of 2 streams to confluence:
Flow rates before confluence point:
4.304   1.966
Maximum flow rates at confluence using above data:
6.222   6.109
Area of streams before confluence:
1.660   0.740
Results of confluence:
Total flow rate =   6.222(CFS)
Time of concentration =   7.801 min.
Effective stream area after confluence =   2.400(Ac.)

++
Process from Point/Station   110.000 to Point/Station   111.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****

Estimated mean flow rate at midpoint of channel =   6.333(CFS)
Depth of flow =   0.264(Ft.), Average velocity =   3.020(Ft/s)

```
        ******* Irregular Channel Data ***********
-----------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
        1              0.00              0.50
        2             15.00              0.00
        3             30.00              0.50
Manning's 'N' friction factor =   0.020
-----------------------------------------------------------------
Sub-Channel flow  =      6.333(CFS)
  '     '        flow top width =     15.862(Ft.)
  '     '    velocity=    3.021(Ft/s)
  '     '        area =      2.097(Sq.Ft)
  '     '        Froude number =     1.464

Upstream point elevation =   310.000(Ft.)
Downstream point elevation =   307.200(Ft.)
Flow length =   114.000(Ft.)
Travel time  =    0.63 min.
Time of concentration =    8.43 min.
Depth of flow =   0.264(Ft.)
Average velocity =   3.020(Ft/s)
Total irregular channel flow =     6.333(CFS)
Irregular channel normal depth above invert elev. =   0.264(Ft.)
Average velocity of channel(s) =   3.020(Ft/s)
 Adding area flow to channel
Rainfall intensity (I) =      4.326(In/Hr) for a   100.0 year storm
User specified 'C' value of 0.570 given for subarea
Rainfall intensity =      4.326(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      1.471
Subarea runoff =      0.140(CFS) for      0.180(Ac.)
Total runoff =      6.362(CFS)  Total area =       2.580(Ac.)
Depth of flow =   0.265(Ft.), Average velocity =   3.024(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      111.000 to Point/Station      111.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      4.326(In/Hr) for a   100.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =     8.43 min.
Rainfall intensity =      4.326(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      1.528
Subarea runoff =      0.247(CFS) for      0.100(Ac.)
Total runoff =      6.609(CFS)  Total area =       2.680(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      111.000 to Point/Station      111.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      4.326(In/Hr) for a   100.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =     8.43 min.
Rainfall intensity =      4.326(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      2.240
Subarea runoff =      3.083(CFS) for      1.250(Ac.)
Total runoff =      9.692(CFS)  Total area =       3.930(Ac.)
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      111.000 to Point/Station      111.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =      3.930(Ac.)
Runoff from this stream =      9.692(CFS)
Time of concentration =    8.43 min.
Rainfall intensity =     4.326(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      200.000 to Point/Station      201.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[MEDIUM DENSITY RESIDENTIAL                  ]
(7.3 DU/A or Less       )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.570
Initial subarea total flow distance  =  100.000(Ft.)
Highest elevation =  372.000(Ft.)
Lowest elevation =  365.800(Ft.)
Elevation difference =    6.200(Ft.) Slope =  6.200 %
Top of Initial Area Slope adjusted by User to  6.000 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of   6.00 %, in a development type of
 7.3 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   5.25 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.5700)*( 100.000^.5)/(   6.000^(1/3)]=   5.25
Rainfall intensity (I) =      5.872(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.570
Subarea runoff =      0.301(CFS)
Total initial stream area =        0.090(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      201.000 to Point/Station      202.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
______________________________________________________________________
Estimated mean flow rate at midpoint of channel =      0.602(CFS)
Depth of flow =   0.187(Ft.), Average velocity =   3.434(Ft/s)
        ******* Irregular Channel Data ***********
-----------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
        1             0.00               0.30
        2             1.50               0.00
        3             3.00               0.30
Manning's 'N' friction factor =   0.020
-----------------------------------------------------------------
Sub-Channel flow  =      0.602(CFS)
  '     '        flow top width =      1.873(Ft.)
  '     '    velocity=    3.434(Ft/s)
  '     '        area =      0.175(Sq.Ft)
  '     '        Froude number =     1.978
```

```
Upstream point elevation =   365.800(Ft.)
Downstream point elevation =   355.900(Ft.)
Flow length =   192.000(Ft.)
Travel time  =    0.93 min.
Time of concentration =    6.18 min.
Depth of flow =   0.187(Ft.)
Average velocity =   3.434(Ft/s)
Total irregular channel flow =     0.602(CFS)
Irregular channel normal depth above invert elev. =   0.187(Ft.)
Average velocity of channel(s) =   3.434(Ft/s)
 Adding area flow to channel
Rainfall intensity (I) =      5.285(In/Hr) for a   100.0 year storm
User specified 'C' value of 0.570 given for subarea
Rainfall intensity =      5.285(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      0.154
Subarea runoff =      0.512(CFS) for      0.180(Ac.)
Total runoff =      0.813(CFS)  Total area =       0.270(Ac.)
Depth of flow =   0.210(Ft.), Average velocity =   3.702(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      202.000 to Point/Station      203.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________
Upstream point/station elevation =   352.900(Ft.)
Downstream point/station elevation =   348.490(Ft.)
Pipe length  =    89.50(Ft.) Slope =   0.0493  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     0.813(CFS)
Nearest computed pipe diameter  =      6.00(In.)
Calculated individual pipe flow  =     0.813(CFS)
Normal flow depth in pipe =    3.53(In.)
Flow top width inside pipe =    5.90(In.)
Critical Depth =    5.36(In.)
Pipe flow velocity =      6.76(Ft/s)
Travel time through pipe =    0.22 min.
Time of concentration (TC) =     6.40 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      203.000 to Point/Station      203.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      5.167(In/Hr) for a   100.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =     6.40 min.
Rainfall intensity =      5.167(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      0.479
Subarea runoff =      1.660(CFS) for      0.570(Ac.)
Total runoff =      2.474(CFS)  Total area =       0.840(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      203.000 to Point/Station      203.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      5.167(In/Hr) for a   100.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =     6.40 min.
Rainfall intensity =      5.167(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
```

(Q=KCIA) is C = 0.570 CA =   0.906
Subarea runoff =   2.209(CFS) for   0.750(Ac.)
Total runoff =   4.682(CFS) Total area =   1.590(Ac.)

++
Process from Point/Station   203.000 to Point/Station   204.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation =   348.490(Ft.)
Downstream point/station elevation =   345.460(Ft.)
Pipe length =   39.00(Ft.) Slope =   0.0777 Manning's N = 0.013
No. of pipes = 1 Required pipe flow =   4.682(CFS)
Nearest computed pipe diameter =   12.00(In.)
Calculated individual pipe flow =   4.682(CFS)
Normal flow depth in pipe =   5.80(In.)
Flow top width inside pipe =   11.99(In.)
Critical Depth =   10.78(In.)
Pipe flow velocity =   12.46(Ft/s)
Travel time through pipe =   0.05 min.
Time of concentration (TC) =   6.45 min.

++
Process from Point/Station   204.000 to Point/Station   204.000
**** SUBAREA FLOW ADDITION ****

Rainfall intensity (I) =   5.140(In/Hr) for a   100.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =   6.45 min.
Rainfall intensity =   5.140(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570 CA =   0.975
Subarea runoff =   0.327(CFS) for   0.120(Ac.)
Total runoff =   5.010(CFS) Total area =   1.710(Ac.)

++
Process from Point/Station   204.000 to Point/Station   204.000
**** SUBAREA FLOW ADDITION ****

Rainfall intensity (I) =   5.140(In/Hr) for a   100.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =   6.45 min.
Rainfall intensity =   5.140(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570 CA =   1.100
Subarea runoff =   0.645(CFS) for   0.220(Ac.)
Total runoff =   5.654(CFS) Total area =   1.930(Ac.)

++
Process from Point/Station   204.000 to Point/Station   205.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****

Upstream point/station elevation =   345.460(Ft.)
Downstream point/station elevation =   343.900(Ft.)
Pipe length =   86.00(Ft.) Slope =   0.0181 Manning's N = 0.013
No. of pipes = 1 Required pipe flow =   5.654(CFS)
Nearest computed pipe diameter =   15.00(In.)
Calculated individual pipe flow =   5.654(CFS)
Normal flow depth in pipe =   8.81(In.)
Flow top width inside pipe =   14.77(In.)

```
Critical Depth =   11.55(In.)
Pipe flow velocity =      7.55(Ft/s)
Travel time through pipe =    0.19 min.
Time of concentration (TC) =     6.64 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      205.000 to Point/Station      206.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________
Upstream point/station elevation =   343.900(Ft.)
Downstream point/station elevation =   340.000(Ft.)
Pipe length  =   167.00(Ft.) Slope =   0.0234  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     5.654(CFS)
Nearest computed pipe diameter  =     15.00(In.)
Calculated individual pipe flow  =     5.654(CFS)
Normal flow depth in pipe =    8.13(In.)
Flow top width inside pipe =   14.95(In.)
Critical Depth =   11.55(In.)
Pipe flow velocity =      8.31(Ft/s)
Travel time through pipe =    0.33 min.
Time of concentration (TC) =     6.98 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      206.000 to Point/Station      206.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      4.887(In/Hr) for a   100.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =     6.98 min.
Rainfall intensity =      4.887(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      1.191
Subarea runoff =      0.168(CFS) for      0.160(Ac.)
Total runoff =      5.822(CFS)  Total area =       2.090(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      206.000 to Point/Station      207.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________
Upstream point/station elevation =   340.000(Ft.)
Downstream point/station elevation =   314.190(Ft.)
Pipe length  =    52.00(Ft.) Slope =   0.4963  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     5.822(CFS)
Nearest computed pipe diameter  =      9.00(In.)
Calculated individual pipe flow  =     5.822(CFS)
Normal flow depth in pipe =    4.50(In.)
Flow top width inside pipe =    9.00(In.)
Critical depth could not be calculated.
Pipe flow velocity =     26.38(Ft/s)
Travel time through pipe =    0.03 min.
Time of concentration (TC) =     7.01 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      207.000 to Point/Station      208.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________
Upstream point/station elevation =   314.190(Ft.)
Downstream point/station elevation =   312.640(Ft.)
Pipe length  =    67.00(Ft.) Slope =   0.0231  Manning's N = 0.013
```

```
No. of pipes = 1  Required pipe flow  =     5.822(CFS)
Nearest computed pipe diameter  =     15.00(In.)
Calculated individual pipe flow  =     5.822(CFS)
Normal flow depth in pipe =    8.31(In.)
Flow top width inside pipe =   14.91(In.)
Critical Depth =   11.72(In.)
Pipe flow velocity =      8.34(Ft/s)
Travel time through pipe =    0.13 min.
Time of concentration (TC) =     7.15 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      208.000 to Point/Station      208.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      4.813(In/Hr) for a   100.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =     7.15 min.
Rainfall intensity =      4.813(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      1.237
Subarea runoff =      0.132(CFS) for      0.080(Ac.)
Total runoff =      5.953(CFS)  Total area =       2.170(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      208.000 to Point/Station      111.000
**** PIPEFLOW TRAVEL TIME (Program estimated size) ****
______________________________________________________________________
Upstream point/station elevation =   312.640(Ft.)
Downstream point/station elevation =   283.010(Ft.)
Pipe length  =   290.00(Ft.) Slope =   0.1022  Manning's N = 0.013
No. of pipes = 1  Required pipe flow  =     5.953(CFS)
Nearest computed pipe diameter  =     12.00(In.)
Calculated individual pipe flow  =     5.953(CFS)
Normal flow depth in pipe =    6.16(In.)
Flow top width inside pipe =   12.00(In.)
Critical depth could not be calculated.
Pipe flow velocity =     14.66(Ft/s)
Travel time through pipe =    0.33 min.
Time of concentration (TC) =     7.48 min.


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      111.000 to Point/Station      111.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________
Along Main Stream number: 1 in normal stream number 2
Stream flow area =      2.170(Ac.)
Runoff from this stream =      5.953(CFS)
Time of concentration =    7.48 min.
Rainfall intensity =     4.675(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                 (In/Hr)


1        9.692      8.43                 4.326
2        5.953      7.48                 4.675
Qmax(1) =
           1.000 *    1.000 *     9.692) +
           0.925 *    1.000 *     5.953) + =      15.201
```

```
Qmax(2) =
           1.000 *    0.887 *     9.692) +
           1.000 *    1.000 *     5.953) + =      14.547

Total of 2 streams to confluence:
Flow rates before confluence point:
       9.692       5.953
Maximum flow rates at confluence using above data:
       15.201       14.547
Area of streams before confluence:
        3.930        2.170
Results of confluence:
Total flow rate =     15.201(CFS)
Time of concentration =     8.430 min.
Effective stream area after confluence =      6.100(Ac.)
End of computations, total study area =           6.100 (Ac.)
```

San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2012 Version 7.9

Rational method hydrology program based on
San Diego County Flood Control Division 2003 hydrology manual
Rational Hydrology Study   Date: 07/03/17

UCSD VOIGT PARKING STRUCTURE
PROPOSED CONDITION HYDROLOGY ANALYSIS
RUNOFF EXIT POINT 2

*********   Hydrology Study Control Information **********

Program License Serial Number 6116

Rational hydrology study storm event year is   100.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour, precipitation(inches) = 2.300
24 hour precipitation(inches) = 3.900
P6/P24 =   59.0%
San Diego hydrology manual 'C' values used

++
Process from Point/Station   300.000 to Point/Station   301.000
**** INITIAL AREA EVALUATION ****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[MEDIUM DENSITY RESIDENTIAL   ]
(7.3 DU/A or Less   )
Impervious value, Ai = 0.400
Sub-Area C Value = 0.570
Initial subarea total flow distance = 165.000(Ft.)
Highest elevation = 382.000(Ft.)
Lowest elevation = 374.000(Ft.)
Elevation difference =   8.000(Ft.) Slope = 4.848 %
Top of Initial Area Slope adjusted by User to 5.000 %
Bottom of Initial Area Slope adjusted by User to 5.000 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of   5.00 %, in a development type of
7.3 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   5.58 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.5700)*(100.000^.5)/(5.000^(1/3)]=   5.58
The initial area total distance of 165.00 (Ft.) entered leaves a
remaining distance of   65.00 (Ft.)
Using Figure 3-4, the travel time for this distance is   0.62 minutes
for a distance of 65.00 (Ft.) and a slope of 5.00 %

```
with an elevation difference of   3.25(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
 =    0.616 Minutes
Tt=[(11.9*0.0123^3)/(  3.25)]^.385=  0.62
Total initial area Ti =   5.58 minutes from Figure 3-3 formula plus
  0.62 minutes from the Figure 3-4 formula =   6.19 minutes
Rainfall intensity (I) =      5.278(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.570
Subarea runoff =      0.511(CFS)
Total initial stream area =        0.170(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      301.000 to Point/Station      302.000
**** SUBAREA FLOW ADDITION ****
______________________________________________________________________
Rainfall intensity (I) =      5.278(In/Hr) for a   100.0 year storm
User specified 'C' value of 0.570 given for subarea
Time of concentration =     6.19 min.
Rainfall intensity =      5.278(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.570  CA =      0.142
Subarea runoff =      0.241(CFS) for      0.080(Ac.)
Total runoff =      0.752(CFS)  Total area =       0.250(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      304.000 to Point/Station      304.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =      0.250(Ac.)
Runoff from this stream =      0.752(CFS)
Time of concentration =    6.19 min.
Rainfall intensity =     5.278(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      303.000 to Point/Station      304.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[LOW DENSITY RESIDENTIAL                     ]
(2.0 DU/A or Less       )
Impervious value, Ai = 0.200
Sub-Area C Value = 0.460
Initial subarea total flow distance  =  167.000(Ft.)
Highest elevation =  381.000(Ft.)
Lowest elevation =  363.500(Ft.)
Elevation difference =   17.500(Ft.) Slope = 10.479 %
Top of Initial Area Slope adjusted by User to 10.000 %
Bottom of Initial Area Slope adjusted by User to 10.000 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of  10.00 %, in a development type of
 2.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   5.35 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.4600)*( 100.000^.5)/(  10.000^(1/3)]=   5.35
```

The initial area total distance of 167.00 (Ft.) entered leaves a remaining distance of 67.00 (Ft.)
Using Figure 3-4, the travel time for this distance is 0.48 minutes for a distance of 67.00 (Ft.) and a slope of 10.00 %
with an elevation difference of 6.70(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
= 0.483 Minutes
Tt=[(11.9*0.0127^3)/(6.70)]^.385= 0.48
Total initial area Ti = 5.35 minutes from Figure 3-3 formula plus
0.48 minutes from the Figure 3-4 formula = 5.83 minutes
Rainfall intensity (I) = 5.489(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.460
Subarea runoff = 0.353(CFS)
Total initial stream area = 0.140(Ac.)

++
Process from Point/Station 304.000 to Point/Station 304.000
**** CONFLUENCE OF MINOR STREAMS ****

Along Main Stream number: 1 in normal stream number 2
Stream flow area = 0.140(Ac.)
Runoff from this stream = 0.353(CFS)
Time of concentration = 5.83 min.
Rainfall intensity = 5.489(In/Hr)
Summary of stream data:

Stream No.	Flow rate (CFS)	TC (min)	Rainfall Intensity (In/Hr)
1	0.752	6.19	5.278
2	0.353	5.83	5.489

Qmax(1) =
1.000 * 1.000 * 0.752) +
0.962 * 1.000 * 0.353) + = 1.092
Qmax(2) =
1.000 * 0.941 * 0.752) +
1.000 * 1.000 * 0.353) + = 1.061

Total of 2 streams to confluence:
Flow rates before confluence point:
0.752 0.353
Maximum flow rates at confluence using above data:
1.092 1.061
Area of streams before confluence:
0.250 0.140
Results of confluence:
Total flow rate = 1.092(CFS)
Time of concentration = 6.195 min.
Effective stream area after confluence = 0.390(Ac.)

++
Process from Point/Station 306.000 to Point/Station 306.000
**** CONFLUENCE OF MINOR STREAMS ****

Along Main Stream number: 1 in normal stream number 1
Stream flow area = 0.390(Ac.)
Runoff from this stream = 1.092(CFS)
Time of concentration = 6.19 min.
Rainfall intensity = 5.278(In/Hr)

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      305.000 to Point/Station      306.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 1.000
[LOW DENSITY RESIDENTIAL                     ]
(2.0 DU/A or Less       )
Impervious value, Ai = 0.200
Sub-Area C Value = 0.460
Initial subarea total flow distance  =  268.000(Ft.)
Highest elevation =  367.000(Ft.)
Lowest elevation =  351.000(Ft.)
Elevation difference =   16.000(Ft.) Slope =  5.970 %
Top of Initial Area Slope adjusted by User to  6.000 %
Bottom of Initial Area Slope adjusted by User to  6.000 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of   6.00 %, in a development type of
 2.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   6.34 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.4600)*( 100.000^.5)/(   6.000^(1/3)]=   6.34
The initial area total distance of  268.00 (Ft.) entered leaves a
remaining distance of  168.00 (Ft.)
Using Figure 3-4, the travel time for this distance is   1.19 minutes
for a distance of 168.00 (Ft.) and a slope of  6.00 %
with an elevation difference of  10.08(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
 =    1.193 Minutes
Tt=[(11.9*0.0318^3)/( 10.08)]^.385=  1.19
Total initial area Ti =   6.34 minutes from Figure 3-3 formula plus
  1.19 minutes from the Figure 3-4 formula =   7.53 minutes
Rainfall intensity (I) =      4.652(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.460
Subarea runoff =      0.535(CFS)
Total initial stream area =        0.250(Ac.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      306.000 to Point/Station      306.000
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________
Along Main Stream number: 1 in normal stream number 2
Stream flow area =      0.250(Ac.)
Runoff from this stream =      0.535(CFS)
Time of concentration =    7.53 min.
Rainfall intensity =     4.652(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                 (In/Hr)


1        1.092      6.19                 5.278
2        0.535      7.53                 4.652
Qmax(1) =
           1.000 *    1.000 *     1.092) +
           1.000 *    0.822 *     0.535) + =       1.532
```

```
Qmax(2) =
           0.882 *    1.000 *     1.092) +
           1.000 *    1.000 *     0.535) + =       1.498

Total of 2 streams to confluence:
Flow rates before confluence point:
       1.092       0.535
Maximum flow rates at confluence using above data:
        1.532        1.498
Area of streams before confluence:
        0.390        0.250
Results of confluence:
Total flow rate =      1.532(CFS)
Time of concentration =     6.195 min.
Effective stream area after confluence =      0.640(Ac.)
End of computations, total study area =           0.640 (Ac.)
```

DETENTION BASINS

Project: UCSD Voigt Parking Structure

Porosity of Gravel = 0.4

Porosity of Soil Media = 0.1

Detention Basin #	Bottom Area (SF)	Outlet Type	Weir Length (FT)	Detention Volume (cf)			Ponding Depth (FT)	Total Basin Depth
				Media+Gravel Storage	Calculated	Net Required		
1	150	Weir	1.00	53	338	285	1.90	4.40
2	300	Riser	N/A	105	975	870	2.90	5.40
3	100	Weir	1.00	35	225	190	1.90	4.40
4	75	Weir	1.00	26	169	143	1.90	4.40
5	75	Weir	1.00	26	169	143	1.90	4.40
6	150	Weir	1.00	53	338	285	1.90	4.40
7	800	Riser	N/A	280	2,600	2,320	2.90	5.40
Total				**525**	**4,813**	**4,288**		

-Soil media and gravel are assumed to have porosities of 0.1 and 0.4 respectively.

-Ponding Depth is measured from the top of the soil media to the weir or riser crest.

-Total Depth includes ponding depth, 0.5’ of freeboard, 1.5’ of soil media, and 0.5’ of gravel.

RATIONAL METHOD HYDROGRAPH PROGRAM
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RUN DATE 6/30/2017
HYDROGRAPH FILE NAME Text1
TIME OF CONCENTRATION 7 MIN.
6 HOUR RAINFALL 1.5 INCHES
BASIN AREA 0.19 ACRES
RUNOFF COEFFICIENT 0.57
PEAK DISCHARGE 0.38 CFS

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TIME (MIN) = 14	DISCHARGE (CFS) = 0
TIME (MIN) = 21	DISCHARGE (CFS) = 0
TIME (MIN) = 28	DISCHARGE (CFS) = 0
TIME (MIN) = 35	DISCHARGE (CFS) = 0
TIME (MIN) = 42	DISCHARGE (CFS) = 0
TIME (MIN) = 49	DISCHARGE (CFS) = 0
TIME (MIN) = 56	DISCHARGE (CFS) = 0
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TIME (MIN) = 161	DISCHARGE (CFS) = 0
TIME (MIN) = 168	DISCHARGE (CFS) = 0
TIME (MIN) = 175	DISCHARGE (CFS) = 0
TIME (MIN) = 182	DISCHARGE (CFS) = 0
TIME (MIN) = 189	DISCHARGE (CFS) = 0
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TIME (MIN) = 217	DISCHARGE (CFS) = 0
TIME (MIN) = 224	DISCHARGE (CFS) = 0
TIME (MIN) = 231	DISCHARGE (CFS) = 0.1
TIME (MIN) = 238	DISCHARGE (CFS) = 0.1
TIME (MIN) = 245	DISCHARGE (CFS) = 0.38
TIME (MIN) = 252	DISCHARGE (CFS) = 0.1
TIME (MIN) = 259	DISCHARGE (CFS) = 0
TIME (MIN) = 266	DISCHARGE (CFS) = 0
TIME (MIN) = 273	DISCHARGE (CFS) = 0
TIME (MIN) = 280	DISCHARGE (CFS) = 0
TIME (MIN) = 287	DISCHARGE (CFS) = 0
TIME (MIN) = 294	DISCHARGE (CFS) = 0
TIME (MIN) = 301	DISCHARGE (CFS) = 0
TIME (MIN) = 308	DISCHARGE (CFS) = 0
TIME (MIN) = 315	DISCHARGE (CFS) = 0
TIME (MIN) = 322	DISCHARGE (CFS) = 0
TIME (MIN) = 329	DISCHARGE (CFS) = 0
TIME (MIN) = 336	DISCHARGE (CFS) = 0
TIME (MIN) = 343	DISCHARGE (CFS) = 0
TIME (MIN) = 350	DISCHARGE (CFS) = 0
TIME (MIN) = 357	DISCHARGE (CFS) = 0
TIME (MIN) = 364	DISCHARGE (CFS) = 0

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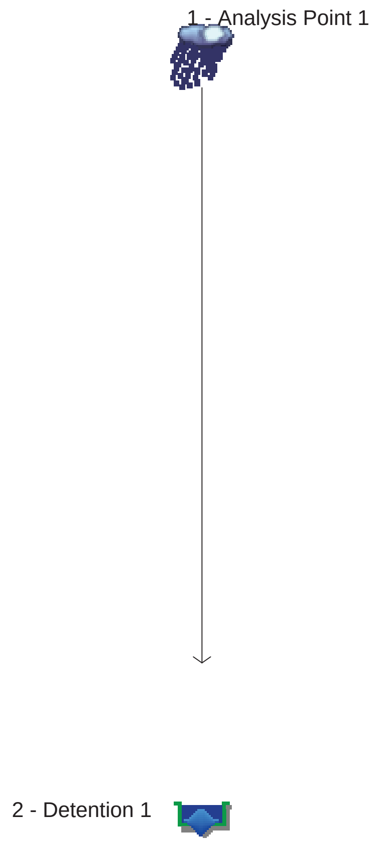
Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4



Project: Det-1 YR 10.gpw	Monday, 07 / 3 / 2017

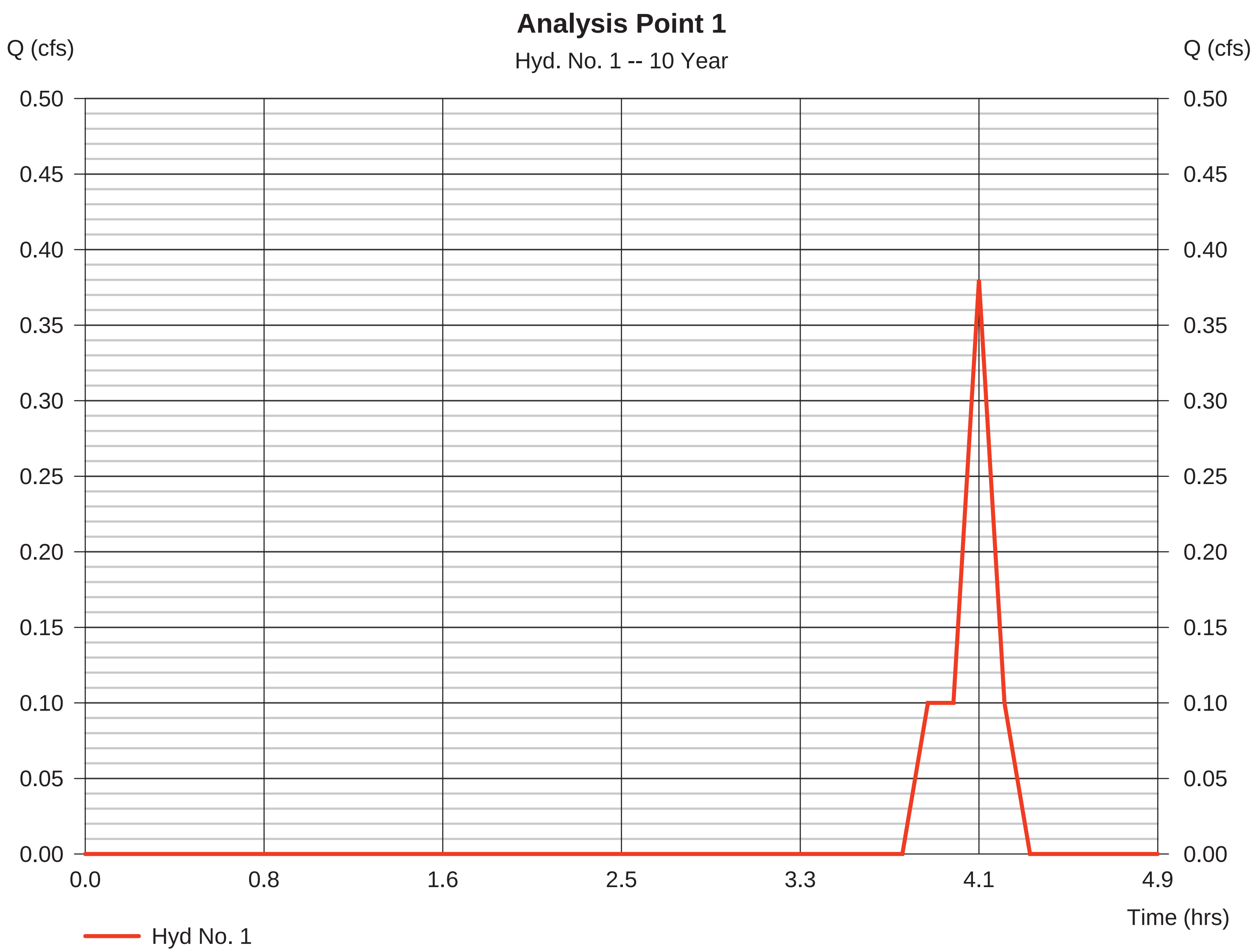
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 07 / 3 / 2017

Hyd. No. 1

Analysis Point 1

Hydrograph type	= Manual	Peak discharge	= 0.380 cfs
Storm frequency	= 10 yrs	Time to peak	= 4.08 hrs
Time interval	= 7 min	Hyd. volume	= 286 cuft



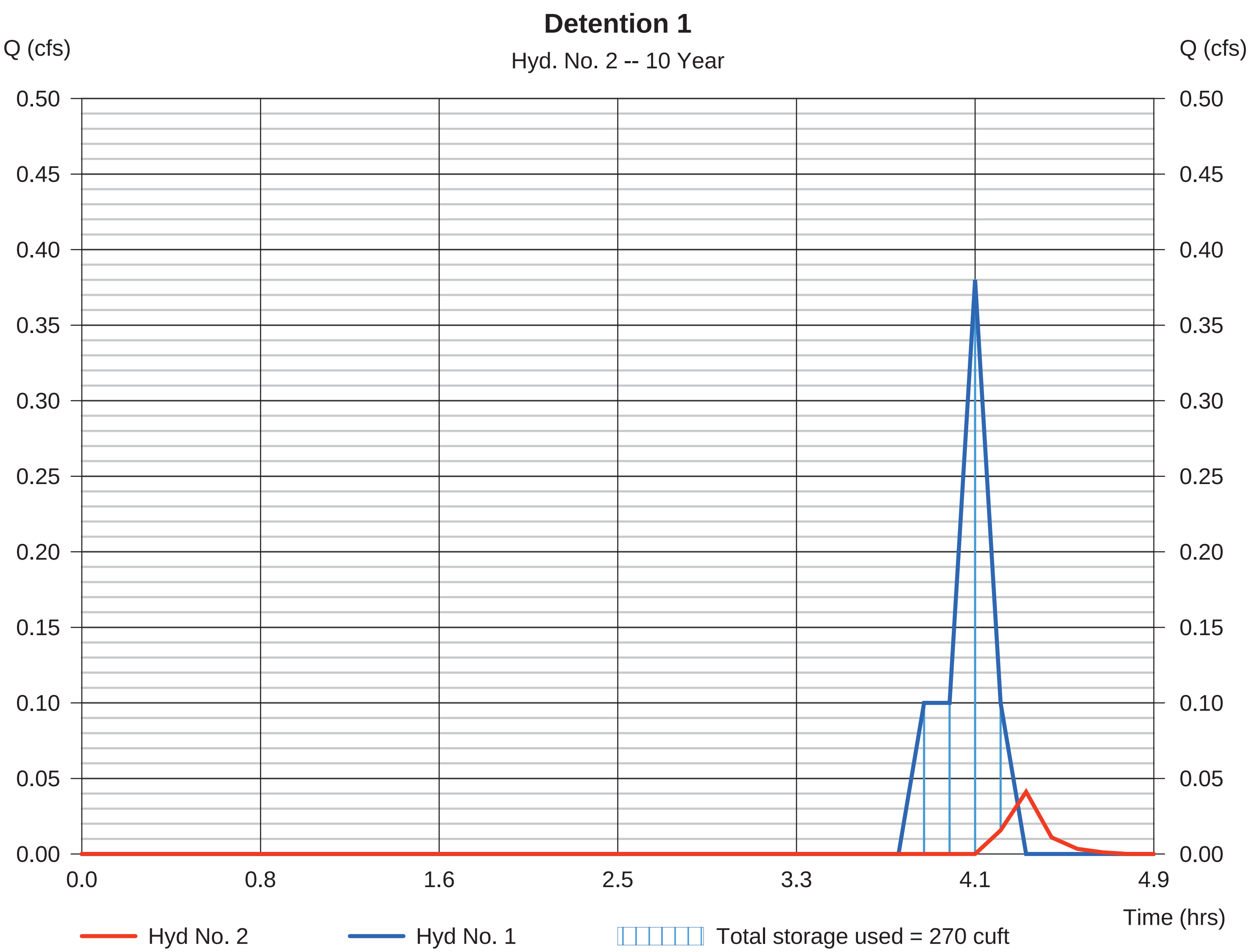
Hydrograph Report

Hyd. No. 2

Detention 1

Hydrograph type	= Reservoir	Peak discharge	= 0.041 cfs
Storm frequency	= 10 yrs	Time to peak	= 4.32 hrs
Time interval	= 7 min	Hyd. volume	= 30 cuft
Inflow hyd. No.	= 1 - Analysis Point 1	Max. Elevation	= 101.86 ft
Reservoir name	= Detention 1	Max. Storage	= 270 cuft

Storage Indication method used.



Pond Report

Pond No. 1 - Detention 1

Pond Data

Pond storage is based on user-defined values.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	100.00	n/a	0	0
1.00	101.00	n/a	150	150
2.00	102.00	n/a	150	300

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	Inactive	Inactive	Inactive	Inactive
Span (in)	= 0.00	1.00	0.00	0.00
No. Barrels	= 1	1	1	1
Invert El. (ft)	= 300.00	302.00	0.00	0.00
Length (ft)	= 10.00	0.00	0.00	2.00
Slope (%)	= 1.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	Inactive	1.00	Inactive	Inactive
Crest El. (ft)	= 0.00	101.75	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	Rect	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	100.00	---	0.00	---	---	0.00	0.00	---	---	---	---	0.000
1.00	150	101.00	---	0.00	---	---	0.00	0.00	---	---	---	---	0.000
2.00	300	102.00	---	0.00	---	---	0.00	0.42	---	---	---	---	0.416

RATIONAL METHOD HYDROGRAPH PROGRAM
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RUN DATE 6/30/2017
HYDROGRAPH FILE NAME Text1
TIME OF CONCENTRATION 7 MIN.
6 HOUR RAINFALL 1.5 INCHES
BASIN AREA 0.38 ACRES
RUNOFF COEFFICIENT 0.57
PEAK DISCHARGE 0.7 CFS

TIME (MIN) = 0	DISCHARGE (CFS) = 0
TIME (MIN) = 7	DISCHARGE (CFS) = 0
TIME (MIN) = 14	DISCHARGE (CFS) = 0
TIME (MIN) = 21	DISCHARGE (CFS) = 0
TIME (MIN) = 28	DISCHARGE (CFS) = 0
TIME (MIN) = 35	DISCHARGE (CFS) = 0
TIME (MIN) = 42	DISCHARGE (CFS) = 0
TIME (MIN) = 49	DISCHARGE (CFS) = 0
TIME (MIN) = 56	DISCHARGE (CFS) = 0
TIME (MIN) = 63	DISCHARGE (CFS) = 0
TIME (MIN) = 70	DISCHARGE (CFS) = 0
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TIME (MIN) = 91	DISCHARGE (CFS) = 0
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TIME (MIN) = 105	DISCHARGE (CFS) = 0
TIME (MIN) = 112	DISCHARGE (CFS) = 0
TIME (MIN) = 119	DISCHARGE (CFS) = 0
TIME (MIN) = 126	DISCHARGE (CFS) = 0
TIME (MIN) = 133	DISCHARGE (CFS) = 0
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TIME (MIN) = 168	DISCHARGE (CFS) = 0
TIME (MIN) = 175	DISCHARGE (CFS) = 0
TIME (MIN) = 182	DISCHARGE (CFS) = 0
TIME (MIN) = 189	DISCHARGE (CFS) = 0.1
TIME (MIN) = 196	DISCHARGE (CFS) = 0.1
TIME (MIN) = 203	DISCHARGE (CFS) = 0.1
TIME (MIN) = 210	DISCHARGE (CFS) = 0.1
TIME (MIN) = 217	DISCHARGE (CFS) = 0.1
TIME (MIN) = 224	DISCHARGE (CFS) = 0.1
TIME (MIN) = 231	DISCHARGE (CFS) = 0.1
TIME (MIN) = 238	DISCHARGE (CFS) = 0.2
TIME (MIN) = 245	DISCHARGE (CFS) = 0.7
TIME (MIN) = 252	DISCHARGE (CFS) = 0.1
TIME (MIN) = 259	DISCHARGE (CFS) = 0.1
TIME (MIN) = 266	DISCHARGE (CFS) = 0.1
TIME (MIN) = 273	DISCHARGE (CFS) = 0
TIME (MIN) = 280	DISCHARGE (CFS) = 0
TIME (MIN) = 287	DISCHARGE (CFS) = 0
TIME (MIN) = 294	DISCHARGE (CFS) = 0
TIME (MIN) = 301	DISCHARGE (CFS) = 0
TIME (MIN) = 308	DISCHARGE (CFS) = 0
TIME (MIN) = 315	DISCHARGE (CFS) = 0
TIME (MIN) = 322	DISCHARGE (CFS) = 0
TIME (MIN) = 329	DISCHARGE (CFS) = 0
TIME (MIN) = 336	DISCHARGE (CFS) = 0
TIME (MIN) = 343	DISCHARGE (CFS) = 0
TIME (MIN) = 350	DISCHARGE (CFS) = 0
TIME (MIN) = 357	DISCHARGE (CFS) = 0
TIME (MIN) = 364	DISCHARGE (CFS) = 0

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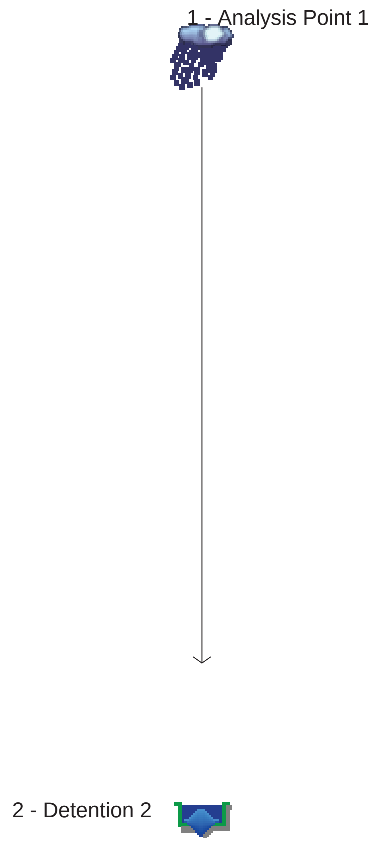
Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4



Project: Det-2 YR 10.gpw	Monday, 07 / 3 / 2017

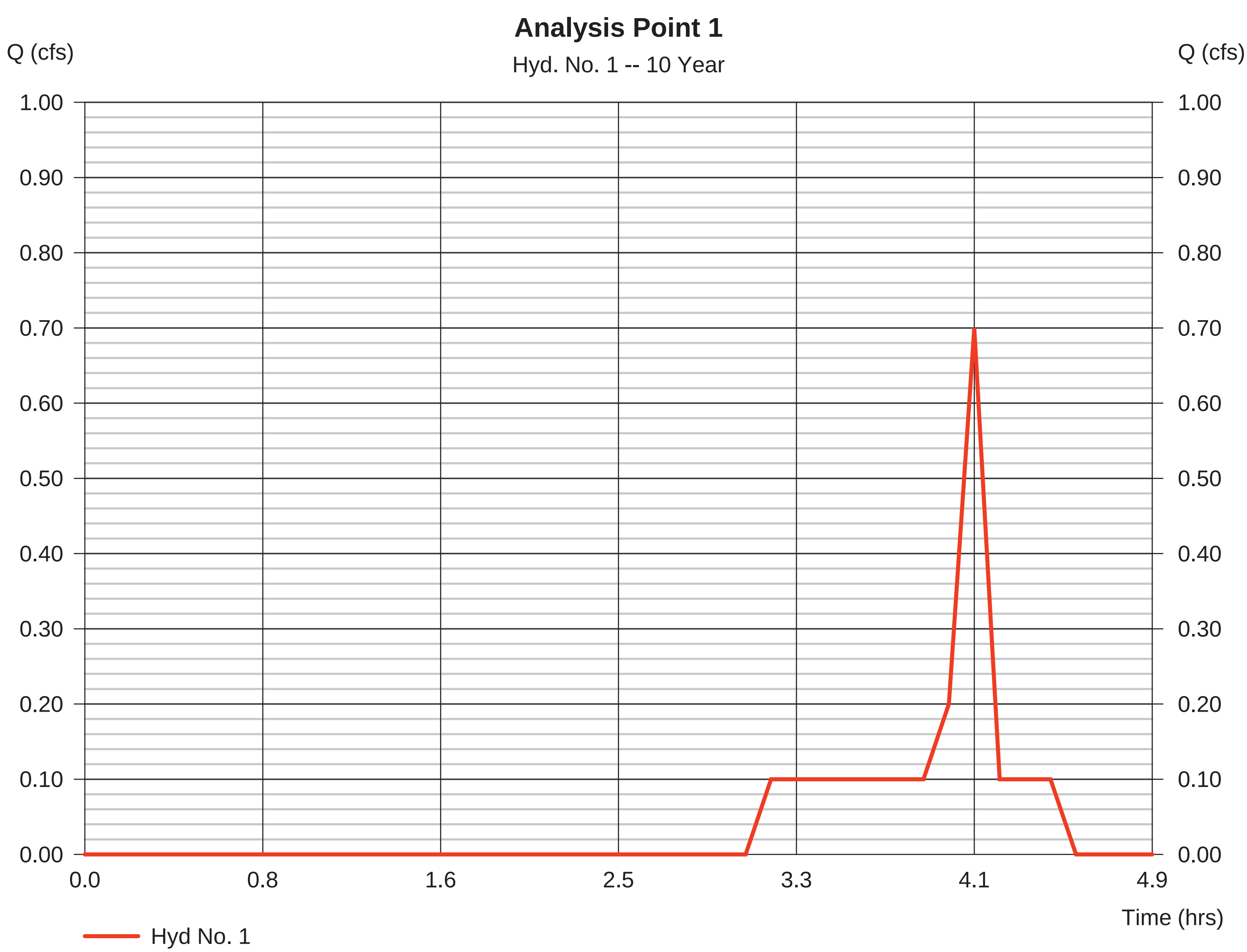
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 — Monday, 07 / 3 / 2017

Hyd. No. 1

Analysis Point 1

Hydrograph type	= Manual	Peak discharge	= 0.700 cfs
Storm frequency	= 10 yrs	Time to peak	= 4.08 hrs
Time interval	= 7 min	Hyd. volume	= 798 cuft



Hydrograph Report

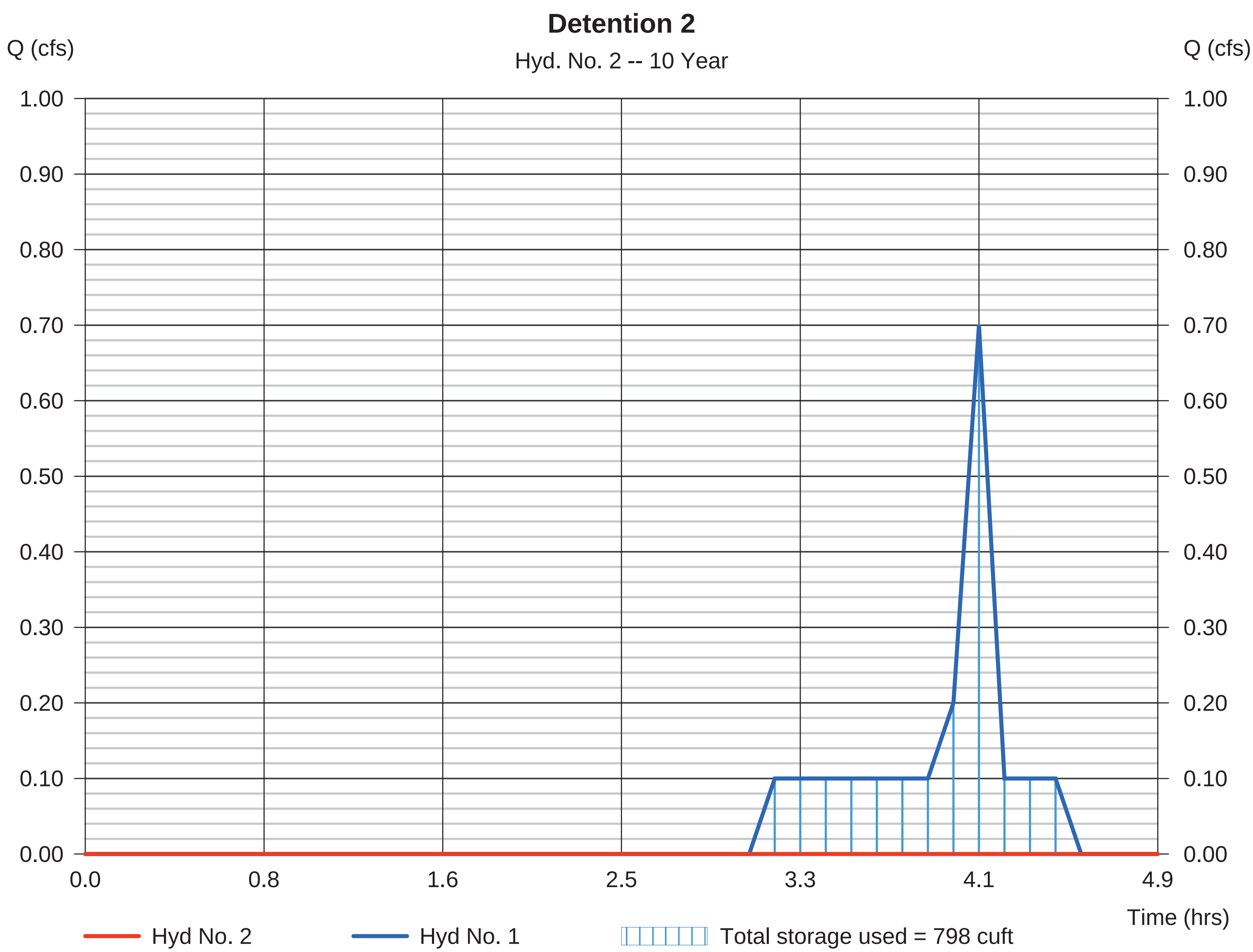
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 — Monday, 07 / 3 / 2017

Hyd. No. 2

Detention 2

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= n/a
Time interval	= 7 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 1 - Analysis Point 1	Max. Elevation	= 102.66 ft
Reservoir name	= Detention 2	Max. Storage	= 798 cuft

Storage Indication method used.



Pond Report

Pond No. 1 - Detention 2

Pond Data

Pond storage is based on user-defined values.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	100.00	n/a	0	0
1.00	101.00	n/a	300	300
2.00	102.00	n/a	300	600
3.00	103.00	n/a	300	900

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 6.00	Inactive	Inactive	Inactive
Span (in)	= 6.00	1.00	0.00	0.00
No. Barrels	= 1	1	1	1
Invert El. (ft)	= 100.00	302.00	0.00	0.00
Length (ft)	= 75.00	0.00	0.00	2.00
Slope (%)	= 2.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 3.14	Inactive	Inactive	Inactive
Crest El. (ft)	= 102.75	102.75	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	Rect	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	100.00	0.00	0.00	---	---	0.00	0.00	---	---	---	---	0.000
1.00	300	101.00	0.00	0.00	---	---	0.00	0.00	---	---	---	---	0.000
2.00	600	102.00	0.00	0.00	---	---	0.00	0.00	---	---	---	---	0.000
3.00	900	103.00	1.14 oc	0.00	---	---	1.14 s	0.00	---	---	---	---	1.142

RATIONAL METHOD HYDROGRAPH PROGRAM
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RUN DATE 6/30/2017
HYDROGRAPH FILE NAME Text1
TIME OF CONCENTRATION 6 MIN.
6 HOUR RAINFALL 1.5 INCHES
BASIN AREA 0.14 ACRES
RUNOFF COEFFICIENT 0.57
PEAK DISCHARGE 0.3 CFS

TIME (MIN) = 0	DISCHARGE (CFS) = 0
TIME (MIN) = 6	DISCHARGE (CFS) = 0
TIME (MIN) = 12	DISCHARGE (CFS) = 0
TIME (MIN) = 18	DISCHARGE (CFS) = 0
TIME (MIN) = 24	DISCHARGE (CFS) = 0
TIME (MIN) = 30	DISCHARGE (CFS) = 0
TIME (MIN) = 36	DISCHARGE (CFS) = 0
TIME (MIN) = 42	DISCHARGE (CFS) = 0
TIME (MIN) = 48	DISCHARGE (CFS) = 0
TIME (MIN) = 54	DISCHARGE (CFS) = 0
TIME (MIN) = 60	DISCHARGE (CFS) = 0
TIME (MIN) = 66	DISCHARGE (CFS) = 0
TIME (MIN) = 72	DISCHARGE (CFS) = 0
TIME (MIN) = 78	DISCHARGE (CFS) = 0
TIME (MIN) = 84	DISCHARGE (CFS) = 0
TIME (MIN) = 90	DISCHARGE (CFS) = 0
TIME (MIN) = 96	DISCHARGE (CFS) = 0
TIME (MIN) = 102	DISCHARGE (CFS) = 0
TIME (MIN) = 108	DISCHARGE (CFS) = 0
TIME (MIN) = 114	DISCHARGE (CFS) = 0
TIME (MIN) = 120	DISCHARGE (CFS) = 0
TIME (MIN) = 126	DISCHARGE (CFS) = 0
TIME (MIN) = 132	DISCHARGE (CFS) = 0
TIME (MIN) = 138	DISCHARGE (CFS) = 0
TIME (MIN) = 144	DISCHARGE (CFS) = 0
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TIME (MIN) = 156	DISCHARGE (CFS) = 0
TIME (MIN) = 162	DISCHARGE (CFS) = 0
TIME (MIN) = 168	DISCHARGE (CFS) = 0
TIME (MIN) = 174	DISCHARGE (CFS) = 0
TIME (MIN) = 180	DISCHARGE (CFS) = 0
TIME (MIN) = 186	DISCHARGE (CFS) = 0
TIME (MIN) = 192	DISCHARGE (CFS) = 0
TIME (MIN) = 198	DISCHARGE (CFS) = 0
TIME (MIN) = 204	DISCHARGE (CFS) = 0
TIME (MIN) = 210	DISCHARGE (CFS) = 0
TIME (MIN) = 216	DISCHARGE (CFS) = 0
TIME (MIN) = 222	DISCHARGE (CFS) = 0
TIME (MIN) = 228	DISCHARGE (CFS) = 0
TIME (MIN) = 234	DISCHARGE (CFS) = 0.1
TIME (MIN) = 240	DISCHARGE (CFS) = 0.1
TIME (MIN) = 246	DISCHARGE (CFS) = 0.3
TIME (MIN) = 252	DISCHARGE (CFS) = 0
TIME (MIN) = 258	DISCHARGE (CFS) = 0
TIME (MIN) = 264	DISCHARGE (CFS) = 0
TIME (MIN) = 270	DISCHARGE (CFS) = 0
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TIME (MIN) = 306	DISCHARGE (CFS) = 0
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TIME (MIN) = 360	DISCHARGE (CFS) = 0
TIME (MIN) = 366	DISCHARGE (CFS) = 0

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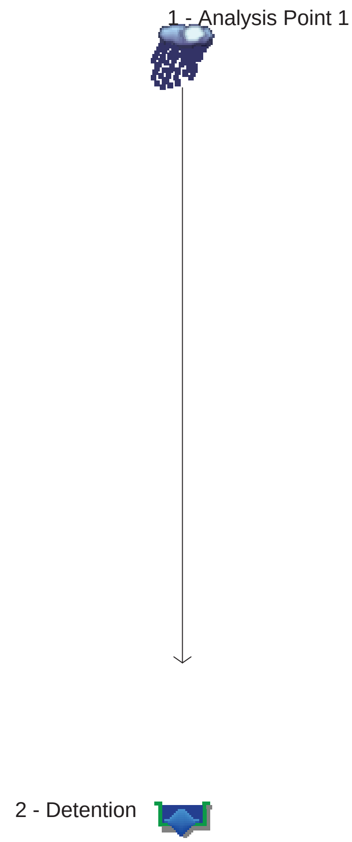
Watershed Model Schematic



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 — Monday, 07 / 3 / 2017

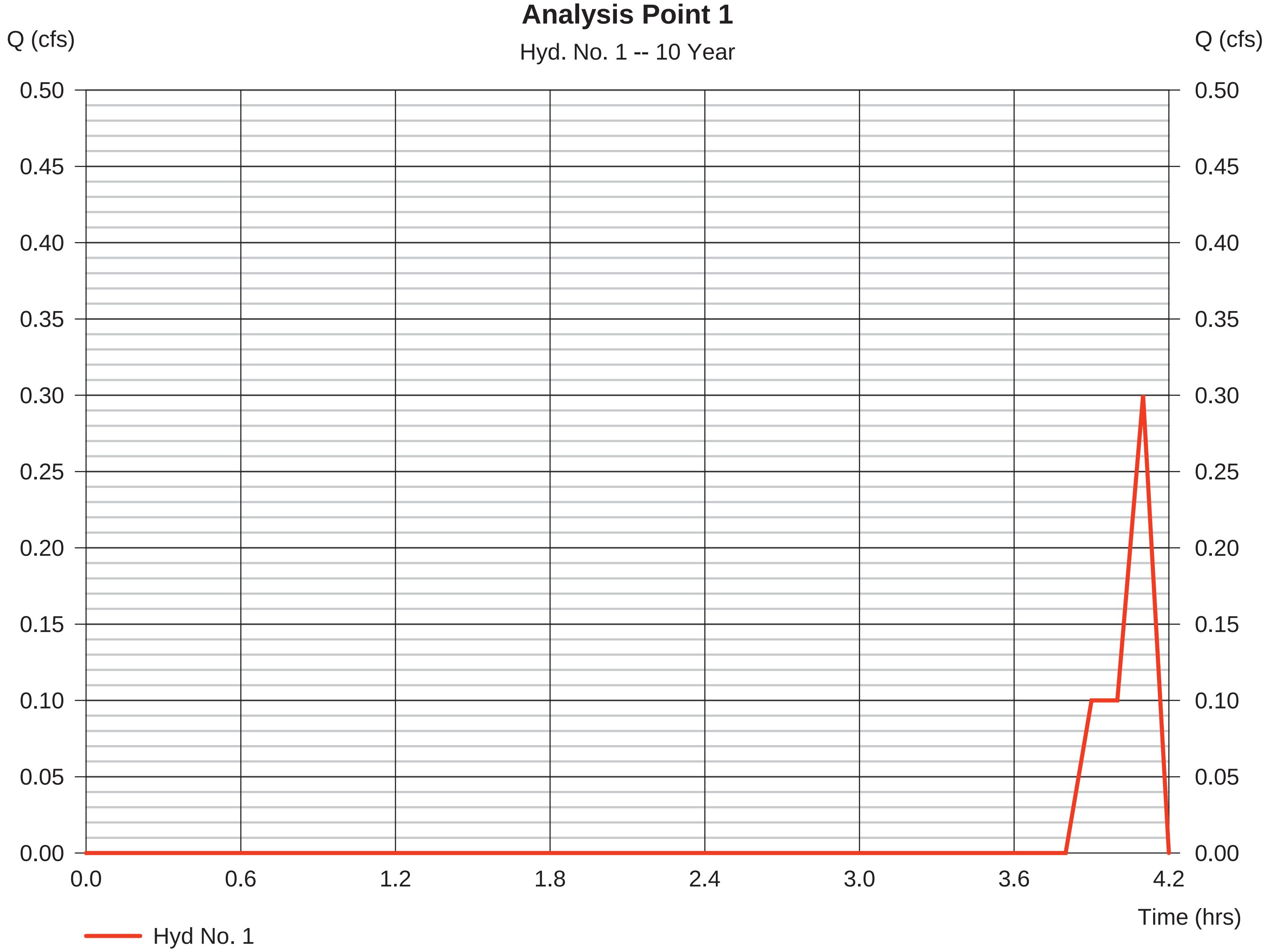
Hyd. No. 1

Analysis Point 1

Hydrograph type	= Manual	Peak discharge	= 0.300 cfs
Storm frequency	= 10 yrs	Time to peak	= 4.10 hrs
Time interval	= 6 min	Hyd. volume	= 180 cuft

Analysis Point 1

Hyd. No. 1 -- 10 Year



Hydrograph Report

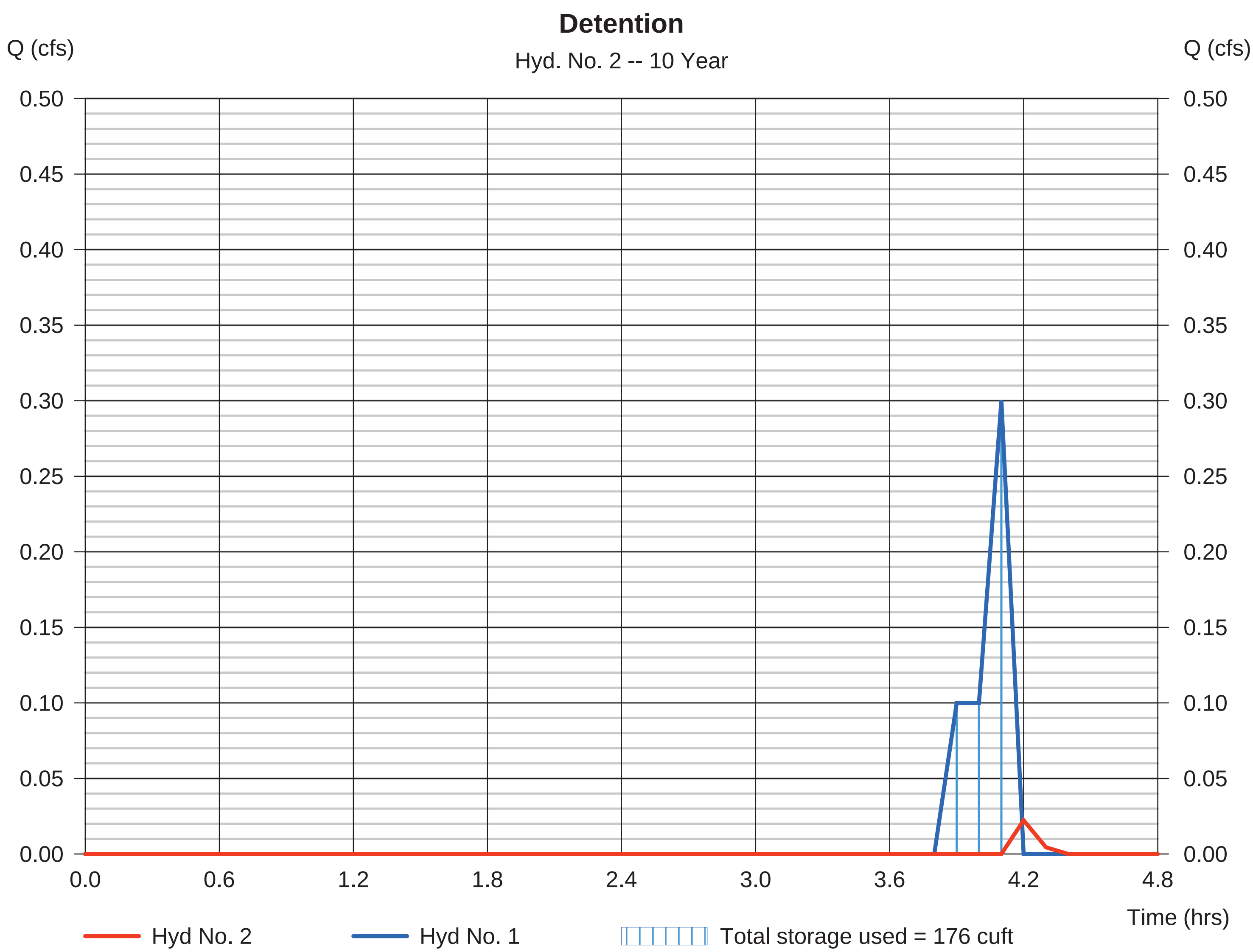
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 07 / 3 / 2017

Hyd. No. 2

Detention

Hydrograph type	= Reservoir	Peak discharge	= 0.022 cfs
Storm frequency	= 10 yrs	Time to peak	= 4.20 hrs
Time interval	= 6 min	Hyd. volume	= 10 cuft
Inflow hyd. No.	= 1 - Analysis Point 1	Max. Elevation	= 101.80 ft
Reservoir name	= Detention 3	Max. Storage	= 176 cuft

Storage Indication method used.



Pond Report

Pond No. 1 - Detention 3

Pond Data

Pond storage is based on user-defined values.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	100.00	n/a	0	0
1.00	101.00	n/a	100	100
2.00	102.00	n/a	100	200

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	Inactive	Inactive	Inactive	Inactive
Span (in)	= 18.00	1.00	0.00	0.00
No. Barrels	= 1	1	1	1
Invert El. (ft)	= 300.00	302.00	0.00	0.00
Length (ft)	= 10.00	0.00	0.00	2.00
Slope (%)	= 1.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	Inactive	1.00	Inactive	Inactive
Crest El. (ft)	= 0.00	101.75	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	Rect	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	100.00	0.00	0.00	---	---	0.00	0.00	---	---	---	---	0.000
1.00	100	101.00	0.00	0.00	---	---	0.00	0.00	---	---	---	---	0.000
2.00	200	102.00	0.00	0.00	---	---	0.00	0.42	---	---	---	---	0.416

RATIONAL METHOD HYDROGRAPH PROGRAM

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RUN DATE 6/30/2017
HYDROGRAPH FILE NAME Text1
TIME OF CONCENTRATION 5 MIN.
6 HOUR RAINFALL 1.5 INCHES
BASIN AREA 0.11 ACRES
RUNOFF COEFFICIENT 0.57
PEAK DISCHARGE 0.18 CFS

TIME (MIN) = 0	DISCHARGE (CFS) = 0
TIME (MIN) = 5	DISCHARGE (CFS) = 0
TIME (MIN) = 10	DISCHARGE (CFS) = 0
TIME (MIN) = 15	DISCHARGE (CFS) = 0
TIME (MIN) = 20	DISCHARGE (CFS) = 0
TIME (MIN) = 25	DISCHARGE (CFS) = 0
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TIME (MIN) = 55	DISCHARGE (CFS) = 0
TIME (MIN) = 60	DISCHARGE (CFS) = 0
TIME (MIN) = 65	DISCHARGE (CFS) = 0
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TIME (MIN) = 95	DISCHARGE (CFS) = 0
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TIME (MIN) = 235	DISCHARGE (CFS) = 0
TIME (MIN) = 240	DISCHARGE (CFS) = 0.1
TIME (MIN) = 245	DISCHARGE (CFS) = 0.18
TIME (MIN) = 250	DISCHARGE (CFS) = 0
TIME (MIN) = 255	DISCHARGE (CFS) = 0
TIME (MIN) = 260	DISCHARGE (CFS) = 0
TIME (MIN) = 265	DISCHARGE (CFS) = 0
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TIME (MIN) = 305	DISCHARGE (CFS) = 0
TIME (MIN) = 310	DISCHARGE (CFS) = 0
TIME (MIN) = 315	DISCHARGE (CFS) = 0
TIME (MIN) = 320	DISCHARGE (CFS) = 0
TIME (MIN) = 325	DISCHARGE (CFS) = 0
TIME (MIN) = 330	DISCHARGE (CFS) = 0
TIME (MIN) = 335	DISCHARGE (CFS) = 0
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TIME (MIN) = 345	DISCHARGE (CFS) = 0
TIME (MIN) = 350	DISCHARGE (CFS) = 0
TIME (MIN) = 355	DISCHARGE (CFS) = 0
TIM	

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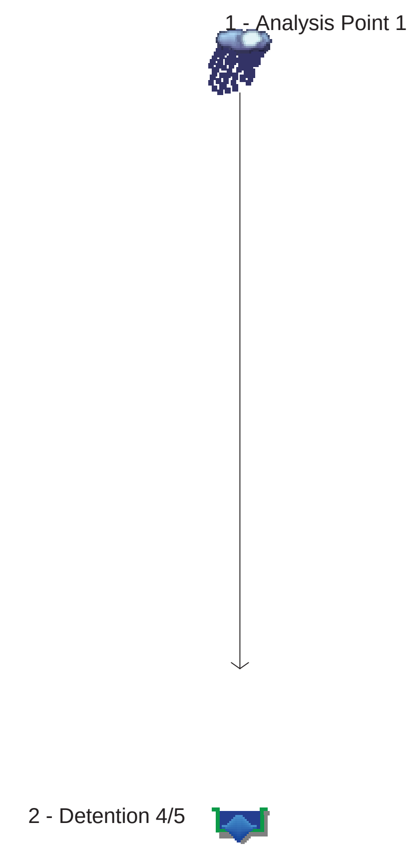
Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4



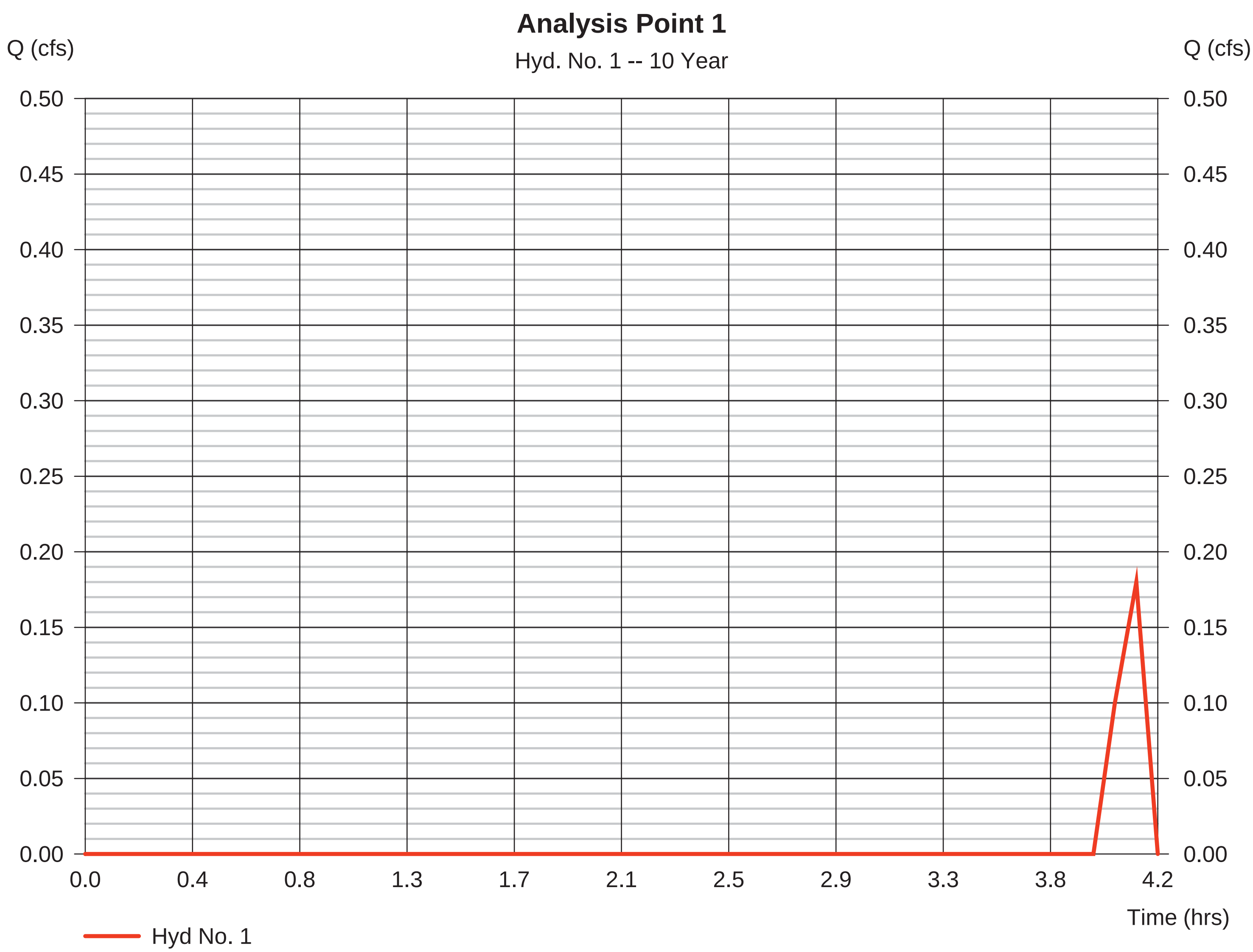
Project: Det-4-5 YR 10.gpw	Monday, 07 / 3 / 2017

Hydrograph Report

Hyd. No. 1

Analysis Point 1

Hydrograph type	= Manual	Peak discharge	= 0.180 cfs
Storm frequency	= 10 yrs	Time to peak	= 4.08 hrs
Time interval	= 5 min	Hyd. volume	= 84 cuft



Hydrograph Report

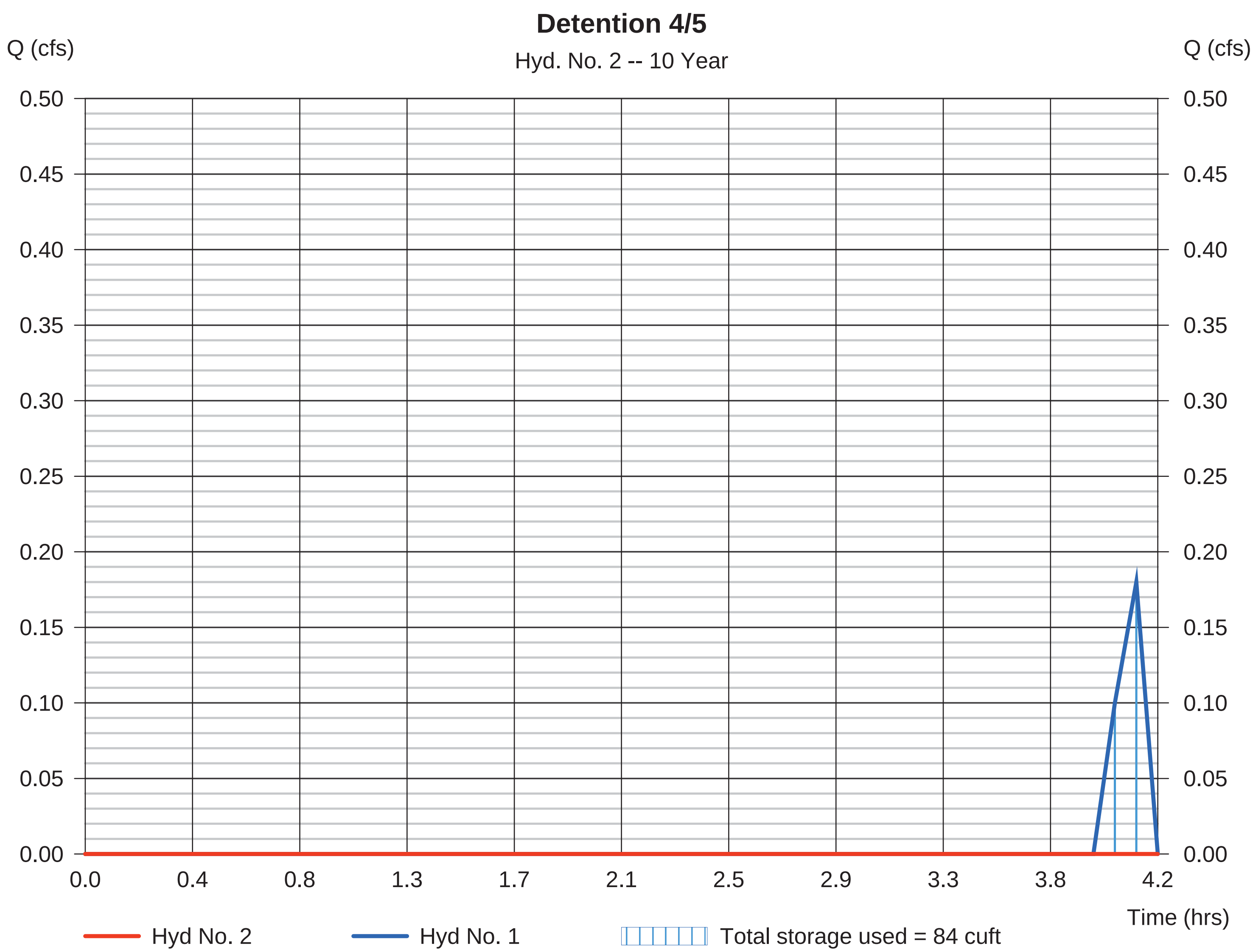
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 07 / 3 / 2017

Hyd. No. 2

Detention 4/5

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= n/a
Time interval	= 5 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 1 - Analysis Point 1	Max. Elevation	= 101.12 ft
Reservoir name	= Detention 4/5	Max. Storage	= 84 cuft

Storage Indication method used.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 07 / 3 / 2017

Pond No. 1 - Detention 4/5

Pond Data

Pond storage is based on user-defined values.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	100.00	n/a	0	0
1.00	101.00	n/a	75	75
2.00	102.00	n/a	75	150

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	Inactive	Inactive	Inactive	Inactive
Span (in)	= 0.00	1.00	0.00	0.00
No. Barrels	= 1	1	1	1
Invert El. (ft)	= 300.00	302.00	0.00	0.00
Length (ft)	= 10.00	0.00	0.00	2.00
Slope (%)	= 1.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	Inactive	1.00	Inactive	Inactive
Crest El. (ft)	= 304.30	101.75	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	Rect	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	100.00	---	0.00	---	---	---	0.00	---	---	---	---	0.000
1.00	75	101.00	---	0.00	---	---	---	0.00	---	---	---	---	0.000
2.00	150	102.00	---	0.00	---	---	---	0.42	---	---	---	---	0.416

RATIONAL METHOD HYDROGRAPH PROGRAM
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RUN DATE 6/30/2017
HYDROGRAPH FILE NAME Text1
TIME OF CONCENTRATION 5 MIN.
6 HOUR RAINFALL 1.5 INCHES
BASIN AREA 0.15 ACRES
RUNOFF COEFFICIENT 0.57
PEAK DISCHARGE 0.25 CFS

TIME (MIN) = 0	DISCHARGE (CFS) = 0
TIME (MIN) = 5	DISCHARGE (CFS) = 0
TIME (MIN) = 10	DISCHARGE (CFS) = 0
TIME (MIN) = 15	DISCHARGE (CFS) = 0
TIME (MIN) = 20	DISCHARGE (CFS) = 0
TIME (MIN) = 25	DISCHARGE (CFS) = 0
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TIME (MIN) = 295	DISCHARGE (CFS) = 0
TIME (MIN) = 300	DISCHARGE (CFS) = 0
TIME (MIN) = 305	DISCHARGE (CFS) = 0
TIME (MIN) = 310	DISCHARGE (CFS) = 0
TIME (MIN) = 315	DISCHARGE (CFS) = 0
TIME (MIN) = 320	DISCHARGE (CFS) = 0
TIME (MIN) = 325	DISCHARGE (CFS) = 0
TIME (MIN) = 330	DISCHARGE (CFS) = 0
TIME (MIN) = 335	DISCHARGE (CFS) = 0
TIME (MIN) = 340	DISCHARGE (CFS) = 0
TIME (MIN) = 345	DISCHARGE (CFS) = 0
TIME (MIN) = 350	DISCHARGE (CFS) = 0
TIME (MIN) = 355	DISCHARGE (CFS) = 0
TIM	

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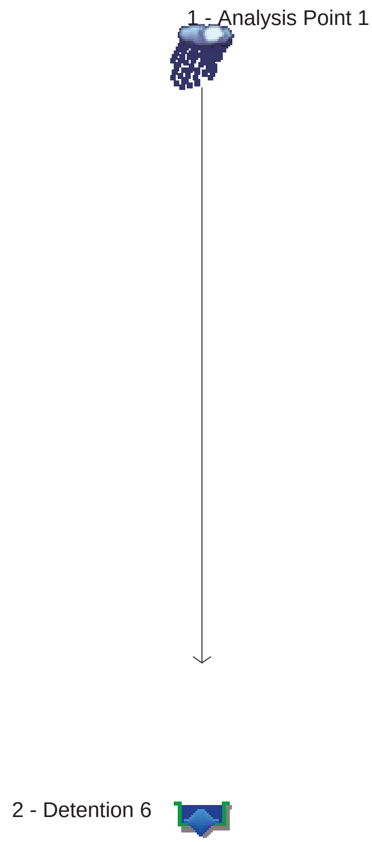
Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4



Project: Det-6 YR 10.gpw	Monday, 07 / 3 / 2017

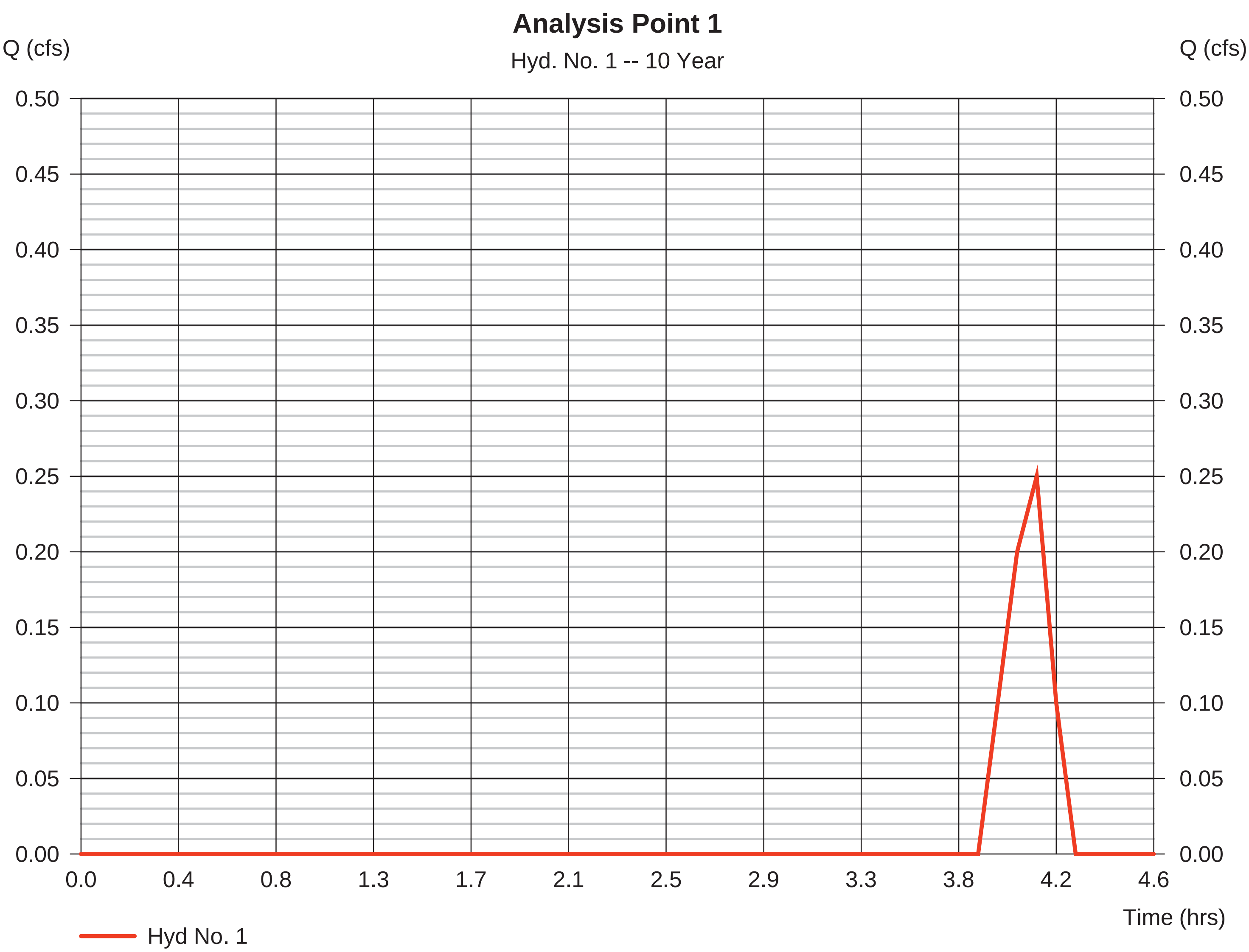
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 07 / 3 / 2017

Hyd. No. 1

Analysis Point 1

Hydrograph type	= Manual	Peak discharge	= 0.250 cfs
Storm frequency	= 10 yrs	Time to peak	= 4.08 hrs
Time interval	= 5 min	Hyd. volume	= 195 cuft



Hydrograph Report

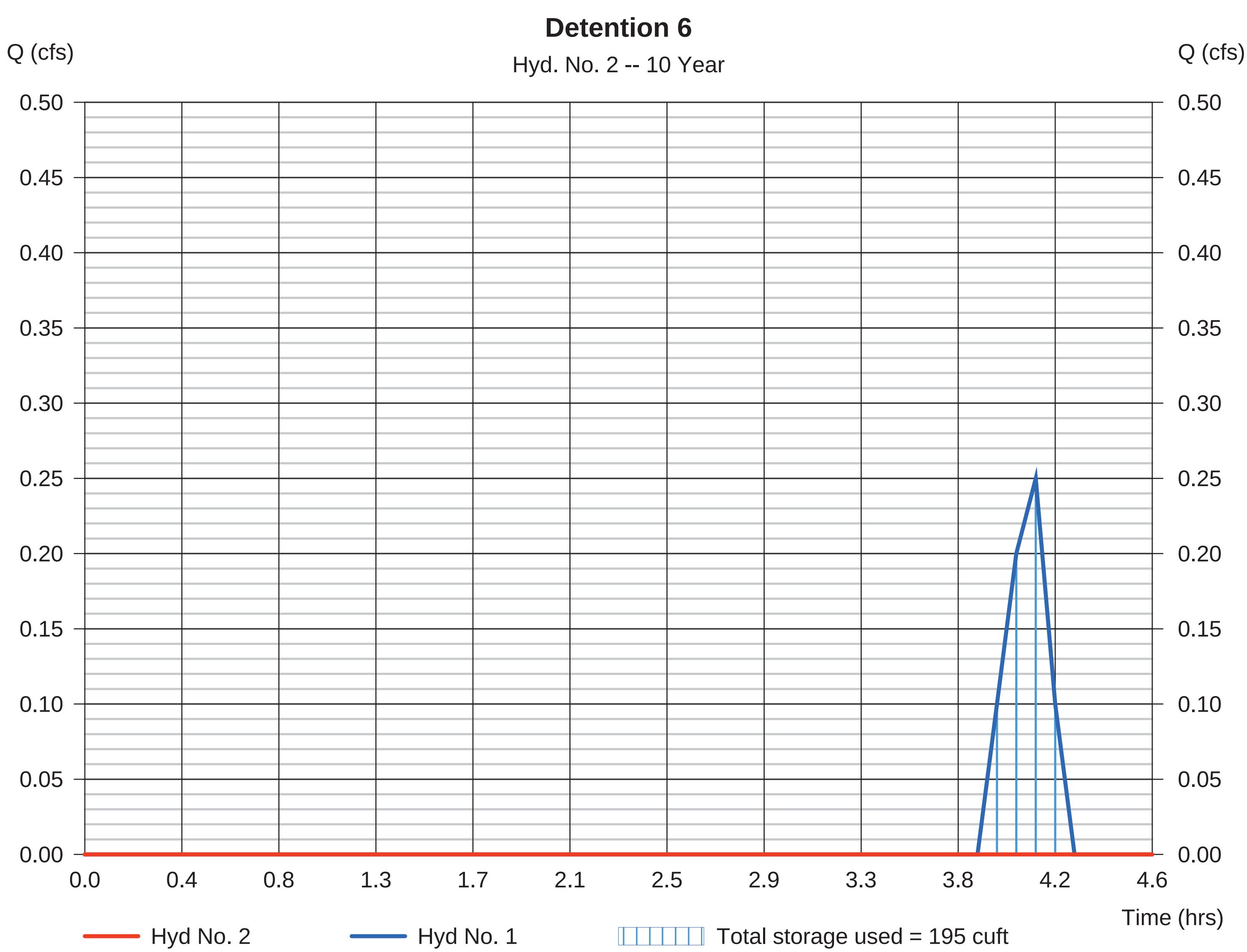
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 07 / 3 / 2017

Hyd. No. 2

Detention 6

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 10 yrs	Time to peak	= n/a
Time interval	= 5 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 1 - Analysis Point 1	Max. Elevation	= 101.62 ft
Reservoir name	= Detention 6	Max. Storage	= 195 cuft

Storage Indication method used.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 07 / 3 / 2017

Pond No. 1 - Detention 6

Pond Data

Pond storage is based on user-defined values.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	100.00	n/a	0	0
1.00	101.00	n/a	120	120
2.00	102.00	n/a	120	240

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	Inactive	Inactive	Inactive	Inactive
Span (in)	= 18.00	1.00	0.00	0.00
No. Barrels	= 1	1	1	1
Invert El. (ft)	= 300.00	302.00	0.00	0.00
Length (ft)	= 10.00	0.00	0.00	2.00
Slope (%)	= 1.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	Inactive	1.00	Inactive	Inactive
Crest El. (ft)	= 0.00	101.75	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	Rect	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	100.00	0.00	0.00	---	---	0.00	0.00	---	---	---	---	0.000
1.00	120	101.00	0.00	0.00	---	---	0.00	0.00	---	---	---	---	0.000
2.00	240	102.00	0.00	0.00	---	---	0.00	0.42	---	---	---	---	0.416

RATIONAL METHOD HYDROGRAPH PROGRAM
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RUN DATE 6/30/2017
HYDROGRAPH FILE NAME Text1
TIME OF CONCENTRATION 7 MIN.
6 HOUR RAINFALL 1.5 INCHES
BASIN AREA 0.74 ACRES
RUNOFF COEFFICIENT 0.57
PEAK DISCHARGE 1.28 CFS

TIME (MIN) = 0	DISCHARGE (CFS) = 0
TIME (MIN) = 7	DISCHARGE (CFS) = 0
TIME (MIN) = 14	DISCHARGE (CFS) = 0
TIME (MIN) = 21	DISCHARGE (CFS) = 0
TIME (MIN) = 28	DISCHARGE (CFS) = 0
TIME (MIN) = 35	DISCHARGE (CFS) = 0
TIME (MIN) = 42	DISCHARGE (CFS) = 0
TIME (MIN) = 49	DISCHARGE (CFS) = 0
TIME (MIN) = 56	DISCHARGE (CFS) = 0
TIME (MIN) = 63	DISCHARGE (CFS) = 0
TIME (MIN) = 70	DISCHARGE (CFS) = 0
TIME (MIN) = 77	DISCHARGE (CFS) = 0
TIME (MIN) = 84	DISCHARGE (CFS) = 0
TIME (MIN) = 91	DISCHARGE (CFS) = 0.1
TIME (MIN) = 98	DISCHARGE (CFS) = 0.1
TIME (MIN) = 105	DISCHARGE (CFS) = 0.1
TIME (MIN) = 112	DISCHARGE (CFS) = 0.1
TIME (MIN) = 119	DISCHARGE (CFS) = 0.1
TIME (MIN) = 126	DISCHARGE (CFS) = 0.1
TIME (MIN) = 133	DISCHARGE (CFS) = 0.1
TIME (MIN) = 140	DISCHARGE (CFS) = 0.1
TIME (MIN) = 147	DISCHARGE (CFS) = 0.1
TIME (MIN) = 154	DISCHARGE (CFS) = 0.1
TIME (MIN) = 161	DISCHARGE (CFS) = 0.1
TIME (MIN) = 168	DISCHARGE (CFS) = 0.1
TIME (MIN) = 175	DISCHARGE (CFS) = 0.1
TIME (MIN) = 182	DISCHARGE (CFS) = 0.1
TIME (MIN) = 189	DISCHARGE (CFS) = 0.1
TIME (MIN) = 196	DISCHARGE (CFS) = 0.1
TIME (MIN) = 203	DISCHARGE (CFS) = 0.1
TIME (MIN) = 210	DISCHARGE (CFS) = 0.1
TIME (MIN) = 217	DISCHARGE (CFS) = 0.2
TIME (MIN) = 224	DISCHARGE (CFS) = 0.2
TIME (MIN) = 231	DISCHARGE (CFS) = 0.3
TIME (MIN) = 238	DISCHARGE (CFS) = 0.4
TIME (MIN) = 245	DISCHARGE (CFS) = 1.28
TIME (MIN) = 252	DISCHARGE (CFS) = 0.2
TIME (MIN) = 259	DISCHARGE (CFS) = 0.1
TIME (MIN) = 266	DISCHARGE (CFS) = 0.1
TIME (MIN) = 273	DISCHARGE (CFS) = 0.1
TIME (MIN) = 280	DISCHARGE (CFS) = 0.1
TIME (MIN) = 287	DISCHARGE (CFS) = 0.1
TIME (MIN) = 294	DISCHARGE (CFS) = 0.1
TIME (MIN) = 301	DISCHARGE (CFS) = 0.1
TIME (MIN) = 308	DISCHARGE (CFS) = 0.1
TIME (MIN) = 315	DISCHARGE (CFS) = 0.1
TIME (MIN) = 322	DISCHARGE (CFS) = 0
TIME (MIN) = 329	DISCHARGE (CFS) = 0
TIME (MIN) = 336	DISCHARGE (CFS) = 0
TIME (MIN) = 343	DISCHARGE (CFS) = 0
TIME (MIN) = 350	DISCHARGE (CFS) = 0
TIME (MIN) = 357	DISCHARGE (CFS) = 0
TIME (MIN) = 364	DISCHARGE (CFS) = 0

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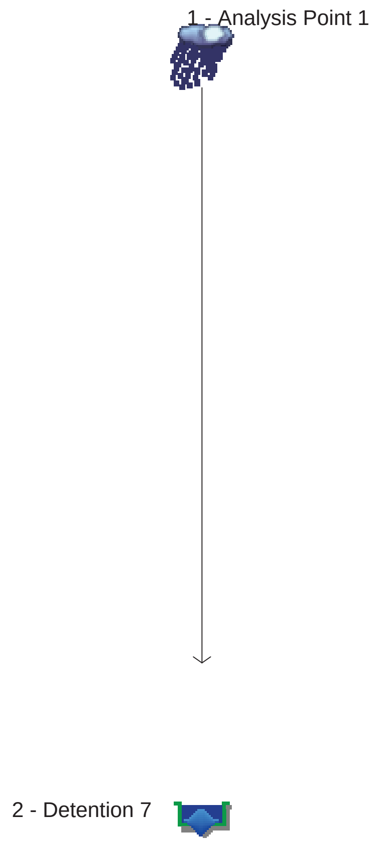
Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4



Project: Det-7 YR 10.gpw

Monday, 07 / 3 / 2017

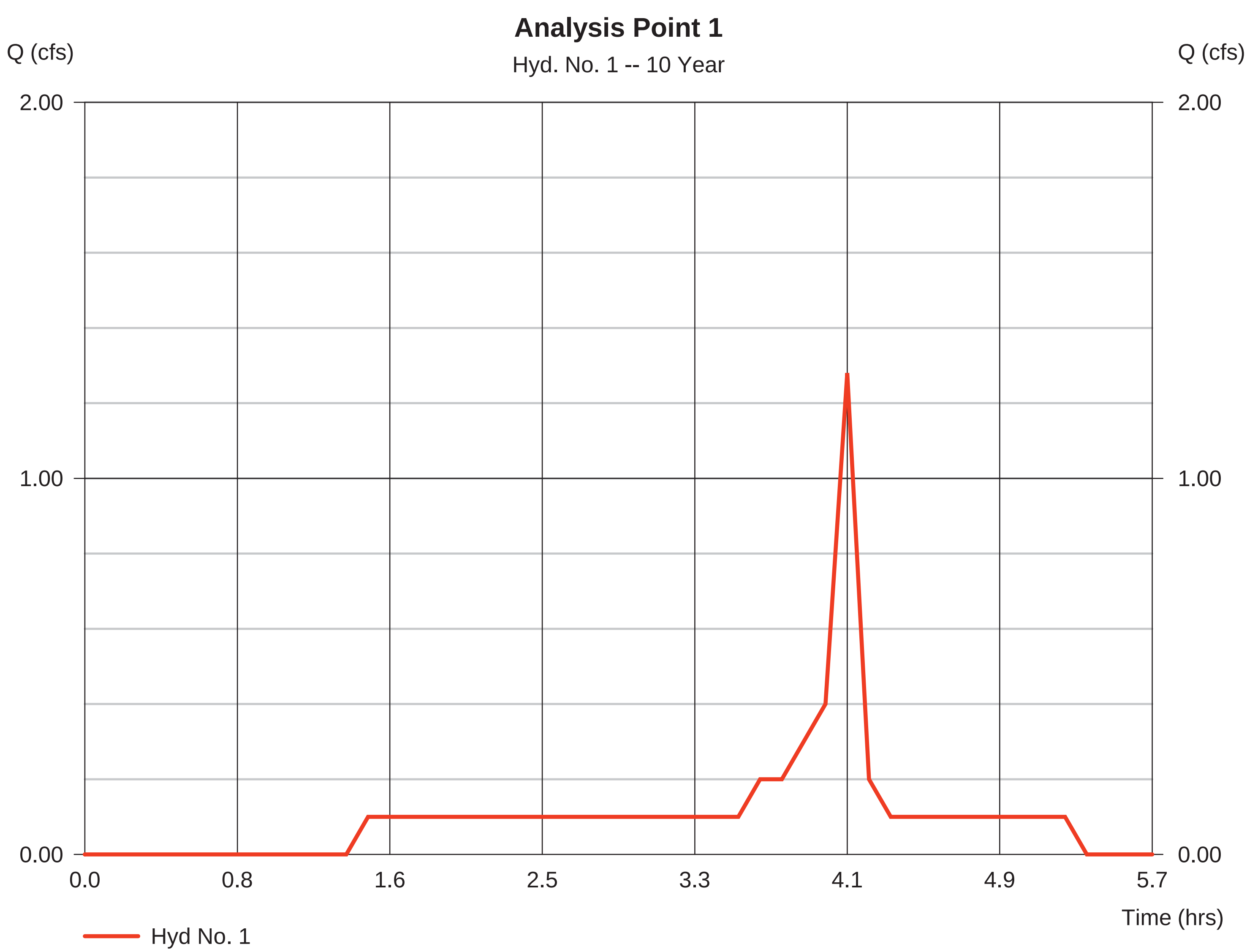
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 07 / 3 / 2017

Hyd. No. 1

Analysis Point 1

Hydrograph type	= Manual	Peak discharge	= 1.280 cfs
Storm frequency	= 10 yrs	Time to peak	= 4.08 hrs
Time interval	= 7 min	Hyd. volume	= 2,218 cuft



Hydrograph Report

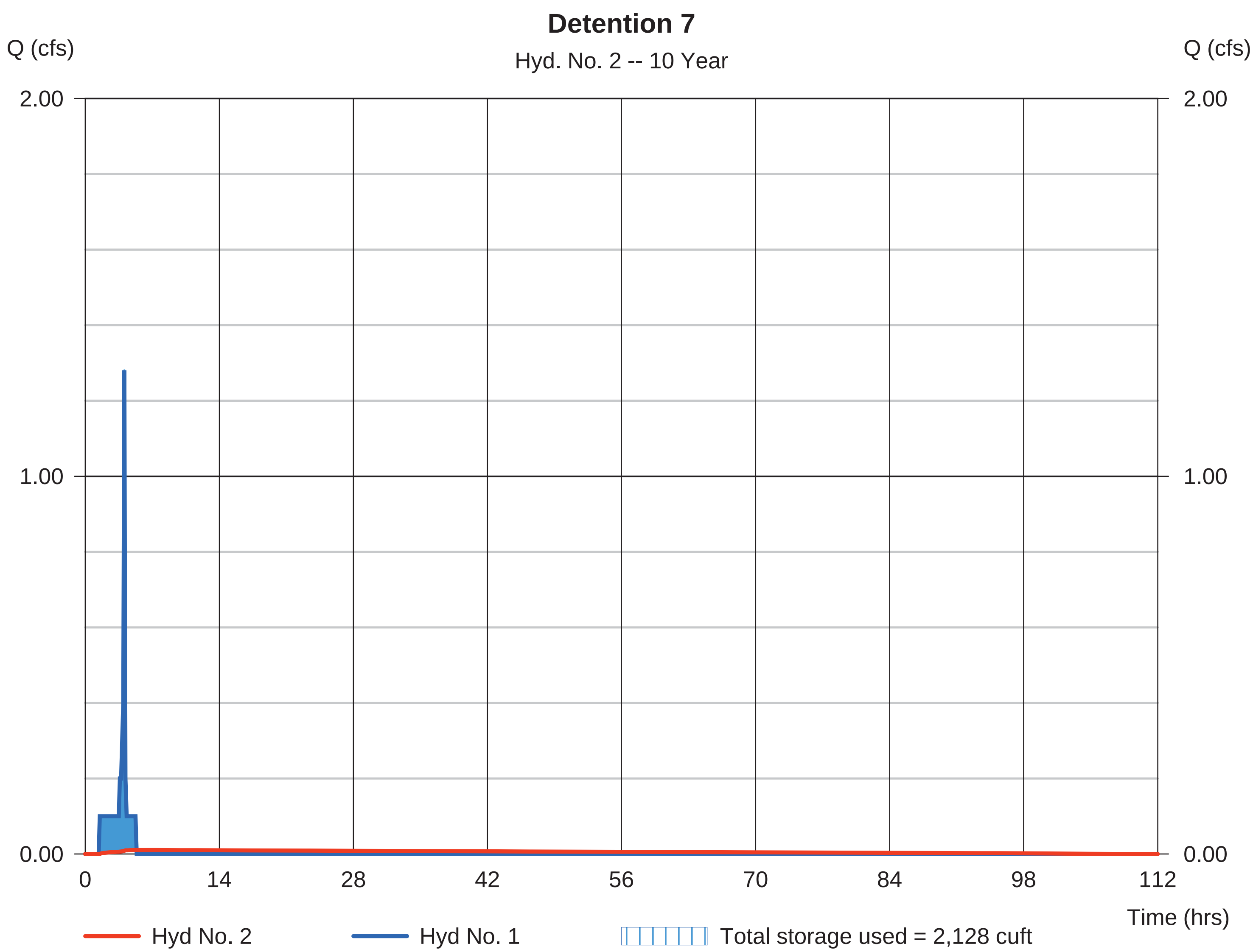
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 07 / 3 / 2017

Hyd. No. 2

Detention 7

Hydrograph type	= Reservoir	Peak discharge	= 0.011 cfs
Storm frequency	= 10 yrs	Time to peak	= 5.37 hrs
Time interval	= 7 min	Hyd. volume	= 2,174 cuft
Inflow hyd. No.	= 1 - Analysis Point 1	Max. Elevation	= 102.66 ft
Reservoir name	= Detention 7	Max. Storage	= 2,128 cuft

Storage Indication method used.



Pond Report

Pond No. 1 - Detention 7

Pond Data

Pond storage is based on user-defined values.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	100.00	n/a	0	0
1.00	101.00	n/a	800	800
2.00	102.00	n/a	800	1,600
3.00	103.00	n/a	800	2,400

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 10.00	0.50	Inactive	Inactive
Span (in)	= 10.00	0.50	0.00	0.00
No. Barrels	= 1	1	1	1
Invert El. (ft)	= 100.00	100.00	0.00	0.00
Length (ft)	= 75.00	0.00	0.00	2.00
Slope (%)	= 2.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 3.14	Inactive	Inactive	Inactive
Crest El. (ft)	= 102.75	102.75	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	Rect	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	100.00	0.00	0.00	---	---	0.00	0.00	---	---	---	---	0.000
1.00	800	101.00	0.01 ic	0.01 ic	---	---	0.00	0.00	---	---	---	---	0.006
2.00	1,600	102.00	0.01 ic	0.01 ic	---	---	0.00	0.00	---	---	---	---	0.009
3.00	2,400	103.00	1.32 ic	0.01 ic	---	---	1.31	0.00	---	---	---	---	1.317

RATIONAL METHOD HYDROGRAPH PROGRAM
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RUN DATE 7/3/2017
HYDROGRAPH FILE NAME Text1
TIME OF CONCENTRATION 7 MIN.
6 HOUR RAINFALL 2.3 INCHES
BASIN AREA 0.19 ACRES
RUNOFF COEFFICIENT 0.57
PEAK DISCHARGE 0.52 CFS

TIME (MIN) = 0	DISCHARGE (CFS) = 0
TIME (MIN) = 7	DISCHARGE (CFS) = 0
TIME (MIN) = 14	DISCHARGE (CFS) = 0
TIME (MIN) = 21	DISCHARGE (CFS) = 0
TIME (MIN) = 28	DISCHARGE (CFS) = 0
TIME (MIN) = 35	DISCHARGE (CFS) = 0
TIME (MIN) = 42	DISCHARGE (CFS) = 0
TIME (MIN) = 49	DISCHARGE (CFS) = 0
TIME (MIN) = 56	DISCHARGE (CFS) = 0
TIME (MIN) = 63	DISCHARGE (CFS) = 0
TIME (MIN) = 70	DISCHARGE (CFS) = 0
TIME (MIN) = 77	DISCHARGE (CFS) = 0
TIME (MIN) = 84	DISCHARGE (CFS) = 0
TIME (MIN) = 91	DISCHARGE (CFS) = 0
TIME (MIN) = 98	DISCHARGE (CFS) = 0
TIME (MIN) = 105	DISCHARGE (CFS) = 0
TIME (MIN) = 112	DISCHARGE (CFS) = 0
TIME (MIN) = 119	DISCHARGE (CFS) = 0
TIME (MIN) = 126	DISCHARGE (CFS) = 0
TIME (MIN) = 133	DISCHARGE (CFS) = 0
TIME (MIN) = 140	DISCHARGE (CFS) = 0
TIME (MIN) = 147	DISCHARGE (CFS) = 0
TIME (MIN) = 154	DISCHARGE (CFS) = 0
TIME (MIN) = 161	DISCHARGE (CFS) = 0
TIME (MIN) = 168	DISCHARGE (CFS) = 0
TIME (MIN) = 175	DISCHARGE (CFS) = 0
TIME (MIN) = 182	DISCHARGE (CFS) = 0
TIME (MIN) = 189	DISCHARGE (CFS) = 0
TIME (MIN) = 196	DISCHARGE (CFS) = 0
TIME (MIN) = 203	DISCHARGE (CFS) = 0
TIME (MIN) = 210	DISCHARGE (CFS) = 0.1
TIME (MIN) = 217	DISCHARGE (CFS) = 0.1
TIME (MIN) = 224	DISCHARGE (CFS) = 0.1
TIME (MIN) = 231	DISCHARGE (CFS) = 0.1
TIME (MIN) = 238	DISCHARGE (CFS) = 0.2
TIME (MIN) = 245	DISCHARGE (CFS) = 0.52
TIME (MIN) = 252	DISCHARGE (CFS) = 0.1
TIME (MIN) = 259	DISCHARGE (CFS) = 0.1
TIME (MIN) = 266	DISCHARGE (CFS) = 0
TIME (MIN) = 273	DISCHARGE (CFS) = 0
TIME (MIN) = 280	DISCHARGE (CFS) = 0
TIME (MIN) = 287	DISCHARGE (CFS) = 0
TIME (MIN) = 294	DISCHARGE (CFS) = 0
TIME (MIN) = 301	DISCHARGE (CFS) = 0
TIME (MIN) = 308	DISCHARGE (CFS) = 0
TIME (MIN) = 315	DISCHARGE (CFS) = 0
TIME (MIN) = 322	DISCHARGE (CFS) = 0
TIME (MIN) = 329	DISCHARGE (CFS) = 0
TIME (MIN) = 336	DISCHARGE (CFS) = 0
TIME (MIN) = 343	DISCHARGE (CFS) = 0
TIME (MIN) = 350	DISCHARGE (CFS) = 0
TIME (MIN) = 357	DISCHARGE (CFS) = 0
TIME (MIN) = 364	DISCHARGE (CFS) = 0

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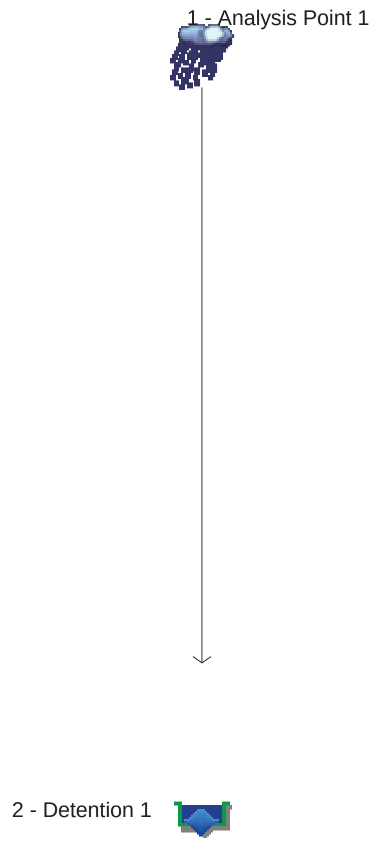
Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4



Project: Det-1 YR 100.gpw	Monday, 07 / 3 / 2017

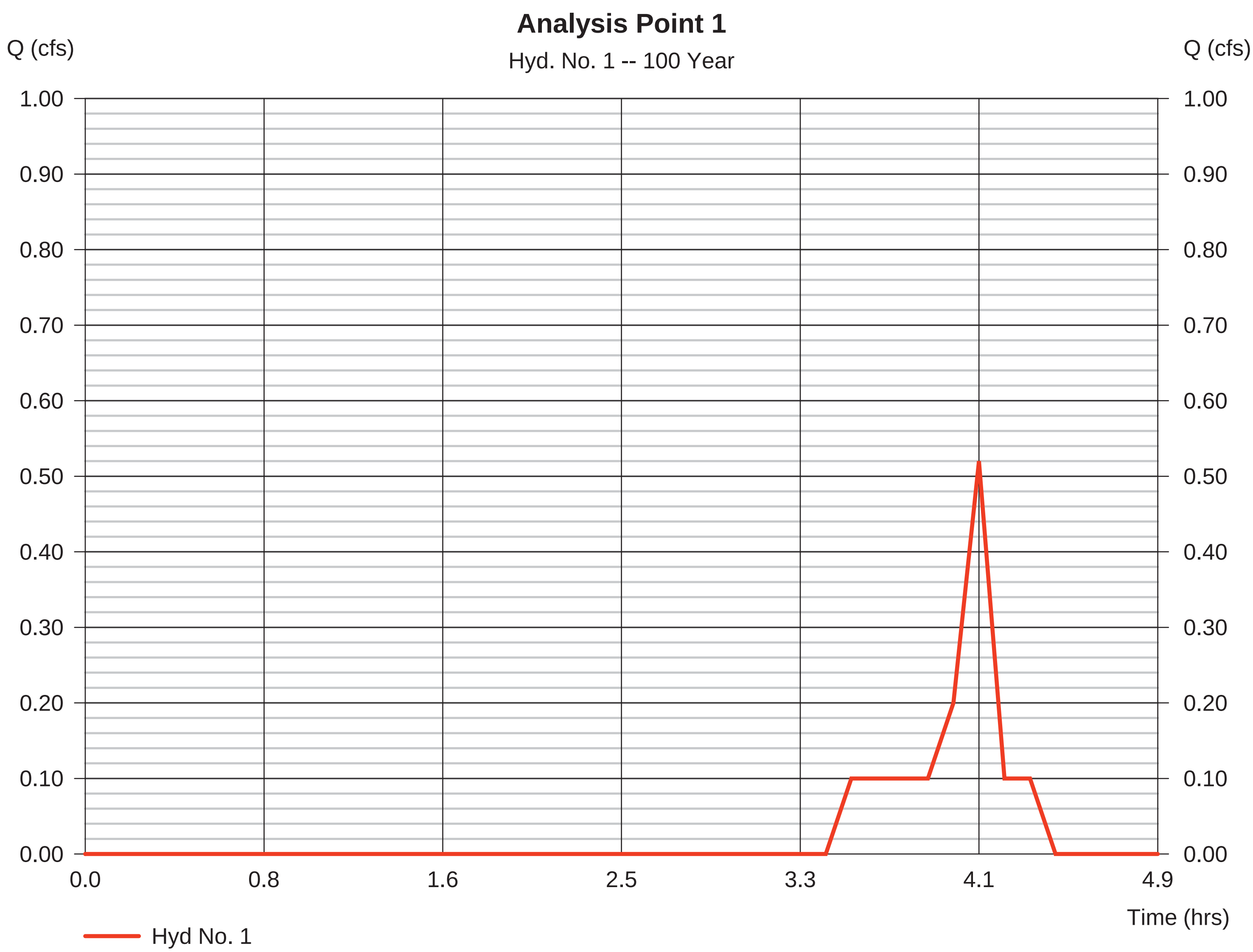
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 07 / 3 / 2017

Hyd. No. 1

Analysis Point 1

Hydrograph type	= Manual	Peak discharge	= 0.520 cfs
Storm frequency	= 100 yrs	Time to peak	= 4.08 hrs
Time interval	= 7 min	Hyd. volume	= 554 cuft



Hydrograph Report

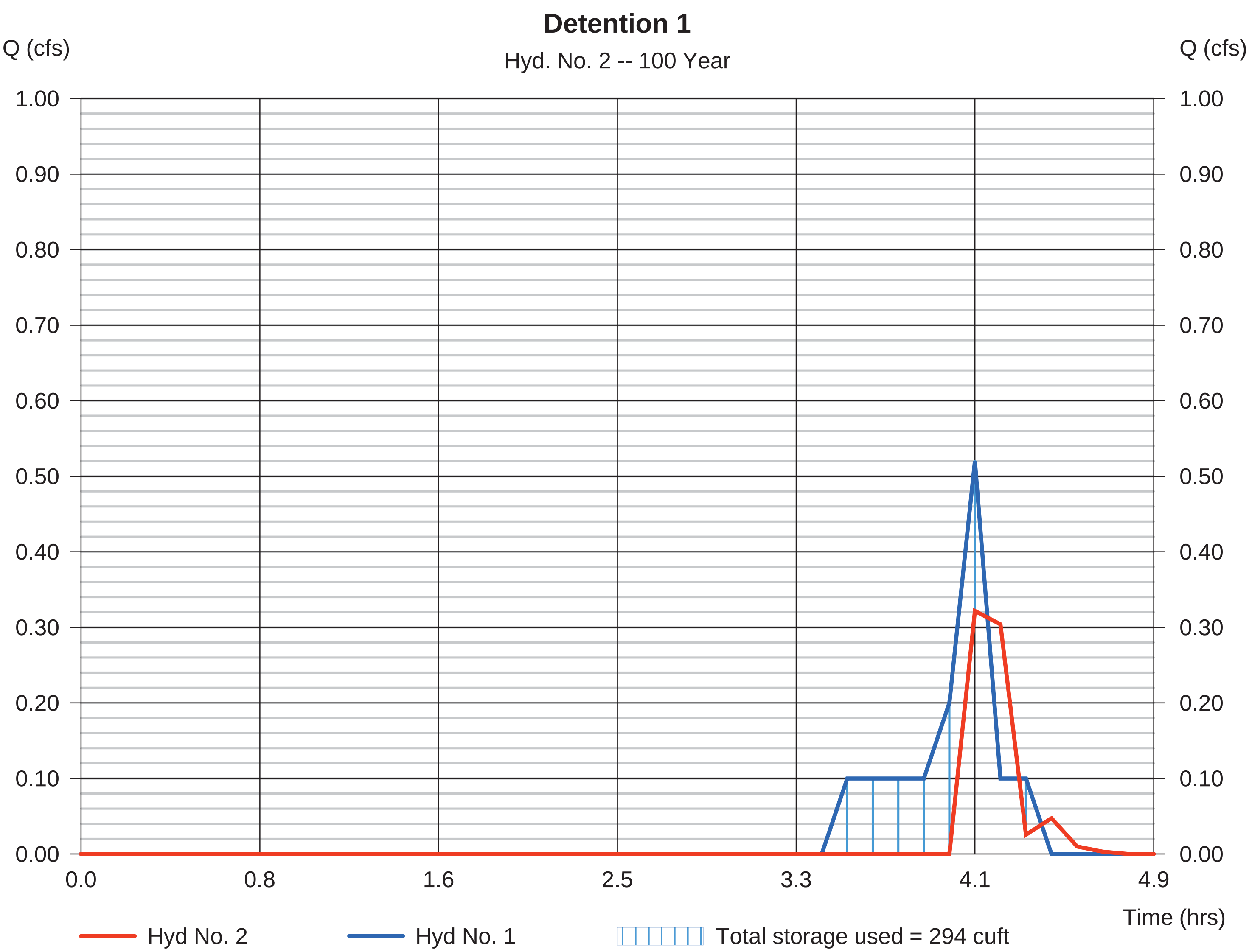
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 07 / 3 / 2017

Hyd. No. 2

Detention 1

Hydrograph type	= Reservoir	Peak discharge	= 0.322 cfs
Storm frequency	= 100 yrs	Time to peak	= 4.08 hrs
Time interval	= 7 min	Hyd. volume	= 299 cuft
Inflow hyd. No.	= 1 - Analysis Point 1	Max. Elevation	= 102.00 ft
Reservoir name	= Detention 1	Max. Storage	= 294 cuft

Storage Indication method used.



Pond Report

Pond No. 1 - Detention 1

Pond Data

Pond storage is based on user-defined values.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	100.00	n/a	0	0
1.00	101.00	n/a	150	150
2.00	102.00	n/a	150	300

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	Inactive	Inactive	Inactive	Inactive
Span (in)	= 18.00	1.00	0.00	0.00
No. Barrels	= 1	1	1	1
Invert El. (ft)	= 300.00	302.00	0.00	0.00
Length (ft)	= 10.00	0.00	0.00	2.00
Slope (%)	= 1.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	Inactive	1.00	Inactive	Inactive
Crest El. (ft)	= 304.30	101.75	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	Rect	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	100.00	0.00	0.00	---	---	0.00	0.00	---	---	---	---	0.000
1.00	150	101.00	0.00	0.00	---	---	0.00	0.00	---	---	---	---	0.000
2.00	300	102.00	0.00	0.00	---	---	0.00	0.42	---	---	---	---	0.416

RATIONAL METHOD HYDROGRAPH PROGRAM
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RUN DATE 7/3/2017
HYDROGRAPH FILE NAME Text1
TIME OF CONCENTRATION 7 MIN.
6 HOUR RAINFALL 2.3 INCHES
BASIN AREA 0.38 ACRES
RUNOFF COEFFICIENT 0.57
PEAK DISCHARGE 1.08 CFS

TIME (MIN) = 0	DISCHARGE (CFS) = 0
TIME (MIN) = 7	DISCHARGE (CFS) = 0
TIME (MIN) = 14	DISCHARGE (CFS) = 0
TIME (MIN) = 21	DISCHARGE (CFS) = 0
TIME (MIN) = 28	DISCHARGE (CFS) = 0
TIME (MIN) = 35	DISCHARGE (CFS) = 0
TIME (MIN) = 42	DISCHARGE (CFS) = 0
TIME (MIN) = 49	DISCHARGE (CFS) = 0
TIME (MIN) = 56	DISCHARGE (CFS) = 0
TIME (MIN) = 63	DISCHARGE (CFS) = 0
TIME (MIN) = 70	DISCHARGE (CFS) = 0
TIME (MIN) = 77	DISCHARGE (CFS) = 0
TIME (MIN) = 84	DISCHARGE (CFS) = 0
TIME (MIN) = 91	DISCHARGE (CFS) = 0
TIME (MIN) = 98	DISCHARGE (CFS) = 0
TIME (MIN) = 105	DISCHARGE (CFS) = 0
TIME (MIN) = 112	DISCHARGE (CFS) = 0
TIME (MIN) = 119	DISCHARGE (CFS) = 0
TIME (MIN) = 126	DISCHARGE (CFS) = 0
TIME (MIN) = 133	DISCHARGE (CFS) = 0
TIME (MIN) = 140	DISCHARGE (CFS) = 0.1
TIME (MIN) = 147	DISCHARGE (CFS) = 0.1
TIME (MIN) = 154	DISCHARGE (CFS) = 0.1
TIME (MIN) = 161	DISCHARGE (CFS) = 0.1
TIME (MIN) = 168	DISCHARGE (CFS) = 0.1
TIME (MIN) = 175	DISCHARGE (CFS) = 0.1
TIME (MIN) = 182	DISCHARGE (CFS) = 0.1
TIME (MIN) = 189	DISCHARGE (CFS) = 0.1
TIME (MIN) = 196	DISCHARGE (CFS) = 0.1
TIME (MIN) = 203	DISCHARGE (CFS) = 0.1
TIME (MIN) = 210	DISCHARGE (CFS) = 0.1
TIME (MIN) = 217	DISCHARGE (CFS) = 0.1
TIME (MIN) = 224	DISCHARGE (CFS) = 0.1
TIME (MIN) = 231	DISCHARGE (CFS) = 0.2
TIME (MIN) = 238	DISCHARGE (CFS) = 0.3
TIME (MIN) = 245	DISCHARGE (CFS) = 1.08
TIME (MIN) = 252	DISCHARGE (CFS) = 0.2
TIME (MIN) = 259	DISCHARGE (CFS) = 0.1
TIME (MIN) = 266	DISCHARGE (CFS) = 0.1
TIME (MIN) = 273	DISCHARGE (CFS) = 0.1
TIME (MIN) = 280	DISCHARGE (CFS) = 0.1
TIME (MIN) = 287	DISCHARGE (CFS) = 0.1
TIME (MIN) = 294	DISCHARGE (CFS) = 0.1
TIME (MIN) = 301	DISCHARGE (CFS) = 0
TIME (MIN) = 308	DISCHARGE (CFS) = 0
TIME (MIN) = 315	DISCHARGE (CFS) = 0
TIME (MIN) = 322	DISCHARGE (CFS) = 0
TIME (MIN) = 329	DISCHARGE (CFS) = 0
TIME (MIN) = 336	DISCHARGE (CFS) = 0
TIME (MIN) = 343	DISCHARGE (CFS) = 0
TIME (MIN) = 350	DISCHARGE (CFS) = 0
TIME (MIN) = 357	DISCHARGE (CFS) = 0
TIME (MIN) = 364	DISCHARGE (CFS) = 0

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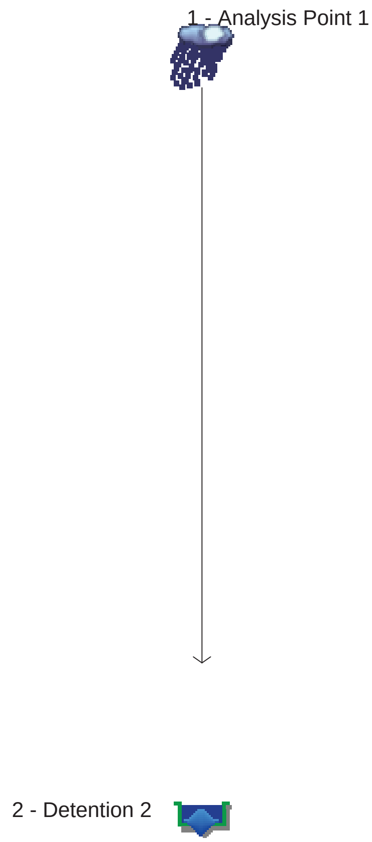
Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4



Project: Det-2 YR 100.gpw	Monday, 07 / 3 / 2017

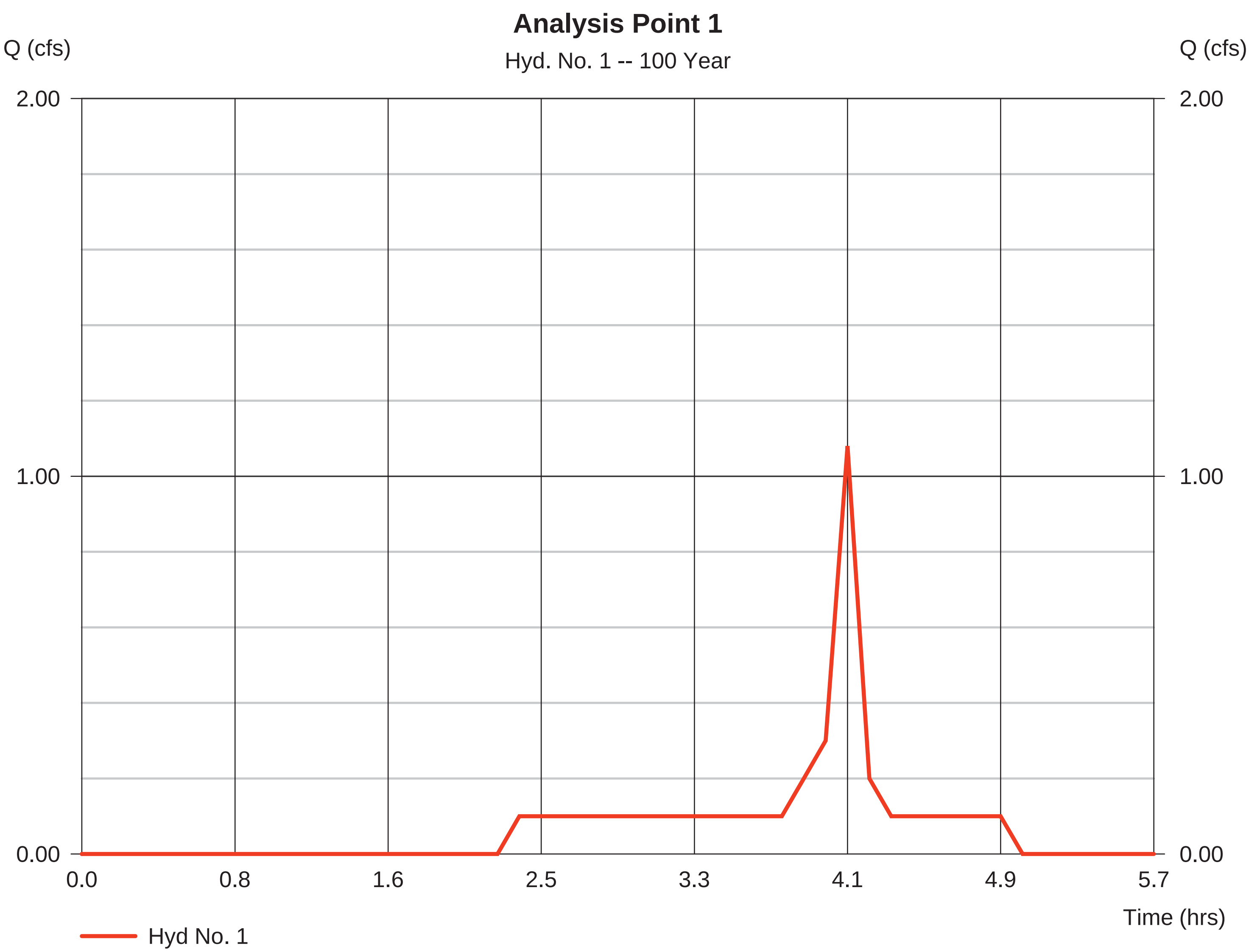
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 07 / 3 / 2017

Hyd. No. 1

Analysis Point 1

Hydrograph type	= Manual	Peak discharge	= 1.080 cfs
Storm frequency	= 100 yrs	Time to peak	= 4.08 hrs
Time interval	= 7 min	Hyd. volume	= 1,546 cuft



Hydrograph Report

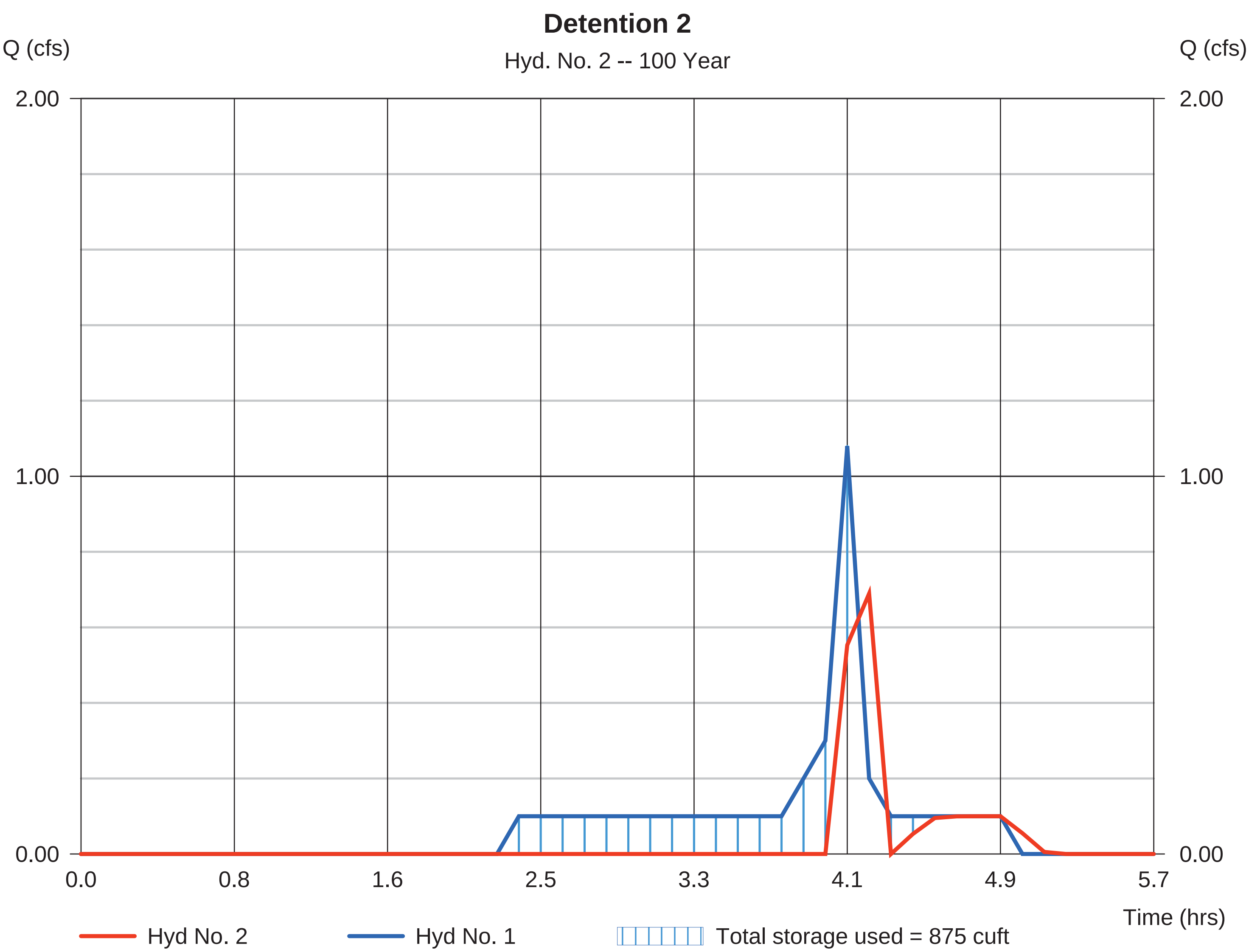
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 07 / 3 / 2017

Hyd. No. 2

Detention 2

Hydrograph type	= Reservoir	Peak discharge	= 0.689 cfs
Storm frequency	= 100 yrs	Time to peak	= 4.20 hrs
Time interval	= 7 min	Hyd. volume	= 735 cuft
Inflow hyd. No.	= 1 - Analysis Point 1	Max. Elevation	= 103.00 ft
Reservoir name	= Detention 2	Max. Storage	= 875 cuft

Storage Indication method used.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 07 / 3 / 2017

Pond No. 1 - Detention 2

Pond Data

Pond storage is based on user-defined values.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	100.00	n/a	0	0
1.00	101.00	n/a	300	300
2.00	102.00	n/a	300	600
3.00	103.00	n/a	300	900

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 6.00	Inactive	Inactive	Inactive
Span (in)	= 6.00	1.00	0.00	0.00
No. Barrels	= 1	1	1	1
Invert El. (ft)	= 100.00	302.00	0.00	0.00
Length (ft)	= 75.00	0.00	0.00	2.00
Slope (%)	= 2.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 3.14	Inactive	Inactive	Inactive
Crest El. (ft)	= 102.75	102.75	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	Rect	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	100.00	0.00	0.00	---	---	0.00	0.00	---	---	---	---	0.000
1.00	300	101.00	0.00	0.00	---	---	0.00	0.00	---	---	---	---	0.000
2.00	600	102.00	0.00	0.00	---	---	0.00	0.00	---	---	---	---	0.000
3.00	900	103.00	1.14 oc	0.00	---	---	1.14 s	0.00	---	---	---	---	1.142

RATIONAL METHOD HYDROGRAPH PROGRAM
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RUN DATE 7/3/2017
HYDROGRAPH FILE NAME Text1
TIME OF CONCENTRATION 6 MIN.
6 HOUR RAINFALL 2.3 INCHES
BASIN AREA 0.14 ACRES
RUNOFF COEFFICIENT 0.57
PEAK DISCHARGE 0.46 CFS

TIME (MIN) = 0	DISCHARGE (CFS) = 0
TIME (MIN) = 6	DISCHARGE (CFS) = 0
TIME (MIN) = 12	DISCHARGE (CFS) = 0
TIME (MIN) = 18	DISCHARGE (CFS) = 0
TIME (MIN) = 24	DISCHARGE (CFS) = 0
TIME (MIN) = 30	DISCHARGE (CFS) = 0
TIME (MIN) = 36	DISCHARGE (CFS) = 0
TIME (MIN) = 42	DISCHARGE (CFS) = 0
TIME (MIN) = 48	DISCHARGE (CFS) = 0
TIME (MIN) = 54	DISCHARGE (CFS) = 0
TIME (MIN) = 60	DISCHARGE (CFS) = 0
TIME (MIN) = 66	DISCHARGE (CFS) = 0
TIME (MIN) = 72	DISCHARGE (CFS) = 0
TIME (MIN) = 78	DISCHARGE (CFS) = 0
TIME (MIN) = 84	DISCHARGE (CFS) = 0
TIME (MIN) = 90	DISCHARGE (CFS) = 0
TIME (MIN) = 96	DISCHARGE (CFS) = 0
TIME (MIN) = 102	DISCHARGE (CFS) = 0
TIME (MIN) = 108	DISCHARGE (CFS) = 0
TIME (MIN) = 114	DISCHARGE (CFS) = 0
TIME (MIN) = 120	DISCHARGE (CFS) = 0
TIME (MIN) = 126	DISCHARGE (CFS) = 0
TIME (MIN) = 132	DISCHARGE (CFS) = 0
TIME (MIN) = 138	DISCHARGE (CFS) = 0
TIME (MIN) = 144	DISCHARGE (CFS) = 0
TIME (MIN) = 150	DISCHARGE (CFS) = 0
TIME (MIN) = 156	DISCHARGE (CFS) = 0
TIME (MIN) = 162	DISCHARGE (CFS) = 0
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TIME (MIN) = 210	DISCHARGE (CFS) = 0
TIME (MIN) = 216	DISCHARGE (CFS) = 0
TIME (MIN) = 222	DISCHARGE (CFS) = 0.1
TIME (MIN) = 228	DISCHARGE (CFS) = 0.1
TIME (MIN) = 234	DISCHARGE (CFS) = 0.1
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TIME (MIN) = 252	DISCHARGE (CFS) = 0.1
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TIME (MIN) = 318	DISCHARGE (CFS) = 0
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TIME (MIN) = 336	DISCHARGE (CFS) = 0
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TIME (MIN) = 354	DISCHARGE (CFS) = 0
TIME (MIN) = 360	DISCHARGE (CFS) = 0
TIME (MIN) = 366	DISCHARGE (CFS) = 0

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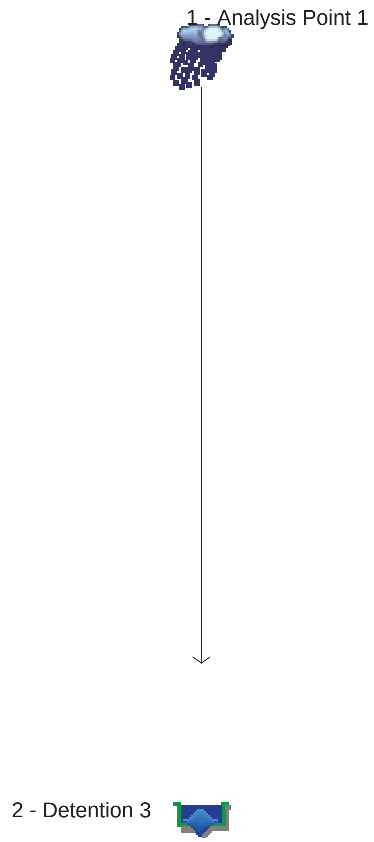
Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4



Project: Det-3 YR 100.gpw	Monday, 07 / 3 / 2017

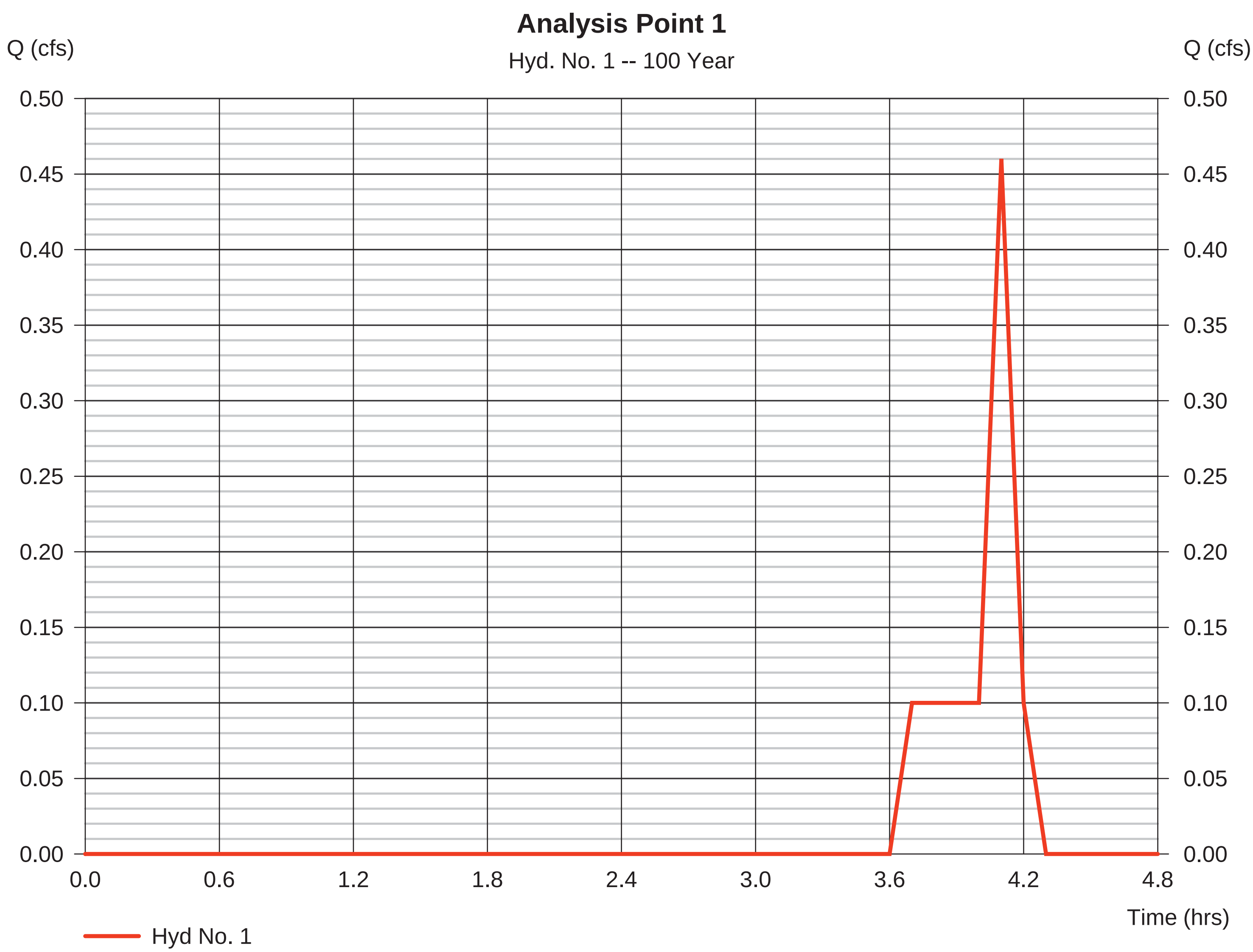
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 07 / 3 / 2017

Hyd. No. 1

Analysis Point 1

Hydrograph type	= Manual	Peak discharge	= 0.460 cfs
Storm frequency	= 100 yrs	Time to peak	= 4.10 hrs
Time interval	= 6 min	Hyd. volume	= 346 cuft



Hydrograph Report

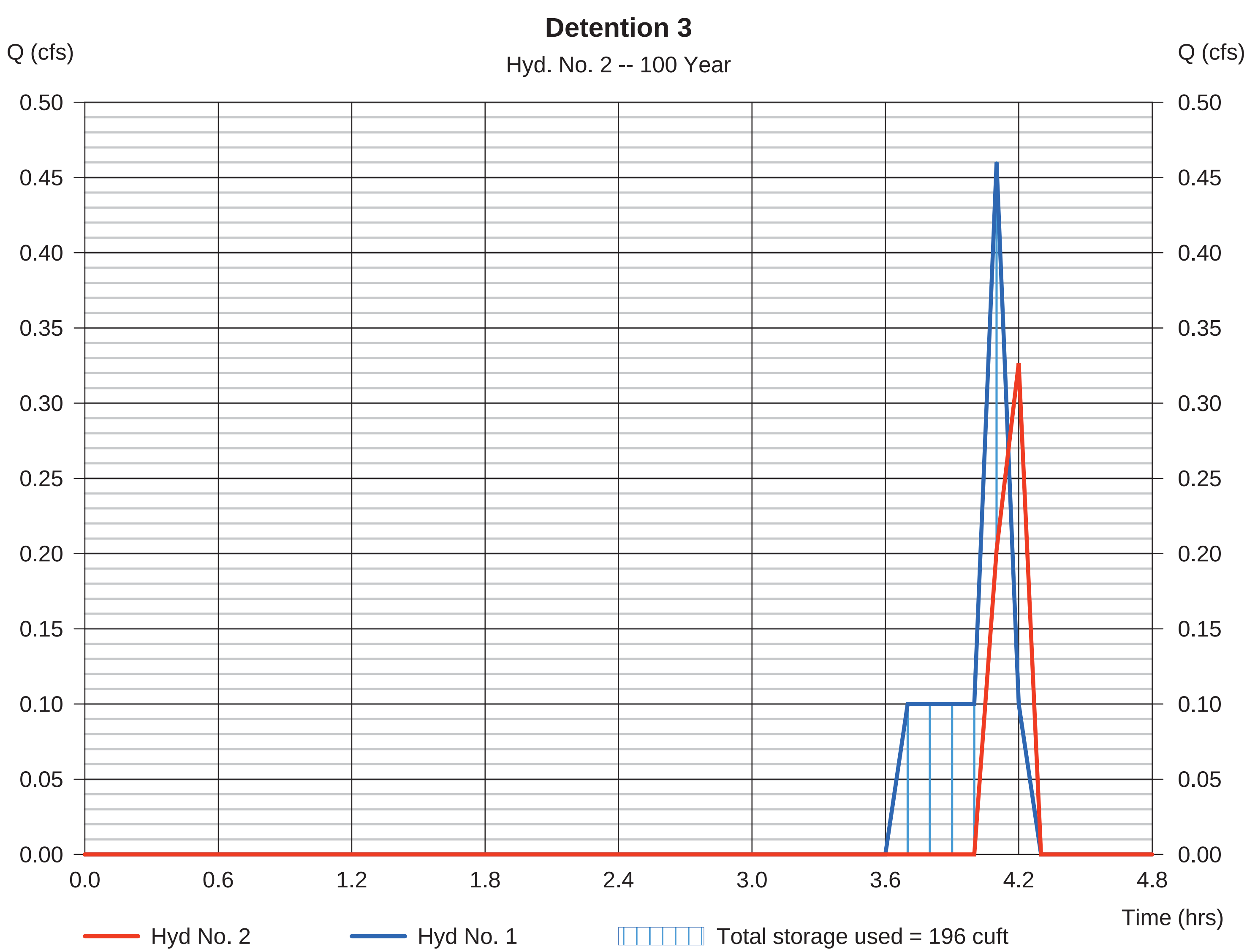
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 — Monday, 07 / 3 / 2017

Hyd. No. 2

Detention 3

Hydrograph type	= Reservoir	Peak discharge	= 0.327 cfs
Storm frequency	= 100 yrs	Time to peak	= 4.20 hrs
Time interval	= 6 min	Hyd. volume	= 190 cuft
Inflow hyd. No.	= 1 - Analysis Point 1	Max. Elevation	= 102.00 ft
Reservoir name	= Detention 3	Max. Storage	= 196 cuft

Storage Indication method used.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 07 / 3 / 2017

Pond No. 1 - Detention 3

Pond Data

Pond storage is based on user-defined values.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	100.00	n/a	0	0
1.00	101.00	n/a	100	100
2.00	102.00	n/a	100	200

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	Inactive	Inactive	Inactive	Inactive
Span (in)	= 18.00	1.00	0.00	0.00
No. Barrels	= 1	1	1	1
Invert El. (ft)	= 300.00	302.00	0.00	0.00
Length (ft)	= 10.00	0.00	0.00	2.00
Slope (%)	= 1.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	Inactive	1.00	Inactive	Inactive
Crest El. (ft)	= 304.30	101.75	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	Rect	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	100.00	0.00	0.00	---	---	0.00	0.00	---	---	---	---	0.000
1.00	100	101.00	0.00	0.00	---	---	0.00	0.00	---	---	---	---	0.000
2.00	200	102.00	0.00	0.00	---	---	0.00	0.42	---	---	---	---	0.416

RATIONAL METHOD HYDROGRAPH PROGRAM
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RUN DATE 7/3/2017
HYDROGRAPH FILE NAME Text1
TIME OF CONCENTRATION 5 MIN.
6 HOUR RAINFALL 2.3 INCHES
BASIN AREA 0.11 ACRES
RUNOFF COEFFICIENT 0.57
PEAK DISCHARGE 0.29 CFS

TIME (MIN) = 0	DISCHARGE (CFS) = 0
TIME (MIN) = 5	DISCHARGE (CFS) = 0
TIME (MIN) = 10	DISCHARGE (CFS) = 0
TIME (MIN) = 15	DISCHARGE (CFS) = 0
TIME (MIN) = 20	DISCHARGE (CFS) = 0
TIME (MIN) = 25	DISCHARGE (CFS) = 0
TIME (MIN) = 30	DISCHARGE (CFS) = 0
TIME (MIN) = 35	DISCHARGE (CFS) = 0
TIME (MIN) = 40	DISCHARGE (CFS) = 0
TIME (MIN) = 45	DISCHARGE (CFS) = 0
TIME (MIN) = 50	DISCHARGE (CFS) = 0
TIME (MIN) = 55	DISCHARGE (CFS) = 0
TIME (MIN) = 60	DISCHARGE (CFS) = 0
TIME (MIN) = 65	DISCHARGE (CFS) = 0
TIME (MIN) = 70	DISCHARGE (CFS) = 0
TIME (MIN) = 75	DISCHARGE (CFS) = 0
TIME (MIN) = 80	DISCHARGE (CFS) = 0
TIME (MIN) = 85	DISCHARGE (CFS) = 0
TIME (MIN) = 90	DISCHARGE (CFS) = 0
TIME (MIN) = 95	DISCHARGE (CFS) = 0
TIME (MIN) = 100	DISCHARGE (CFS) = 0
TIME (MIN) = 105	DISCHARGE (CFS) = 0
TIME (MIN) = 110	DISCHARGE (CFS) = 0
TIME (MIN) = 115	DISCHARGE (CFS) = 0
TIME (MIN) = 120	DISCHARGE (CFS) = 0
TIME (MIN) = 125	DISCHARGE (CFS) = 0
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TIME (MIN) = 175	DISCHARGE (CFS) = 0
TIME (MIN) = 180	DISCHARGE (CFS) = 0
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TIME (MIN) = 190	DISCHARGE (CFS) = 0
TIME (MIN) = 195	DISCHARGE (CFS) = 0
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TIME (MIN) = 220	DISCHARGE (CFS) = 0
TIME (MIN) = 225	DISCHARGE (CFS) = 0
TIME (MIN) = 230	DISCHARGE (CFS) = 0.1
TIME (MIN) = 235	DISCHARGE (CFS) = 0.1
TIME (MIN) = 240	DISCHARGE (CFS) = 0.2
TIME (MIN) = 245	DISCHARGE (CFS) = 0.29
TIME (MIN) = 250	DISCHARGE (CFS) = 0.1
TIME (MIN) = 255	DISCHARGE (CFS) = 0
TIME (MIN) = 260	DISCHARGE (CFS) = 0
TIME (MIN) = 265	DISCHARGE (CFS) = 0
TIME (MIN) = 270	DISCHARGE (CFS) = 0
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TIME (MIN) = 295	DISCHARGE (CFS) = 0
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TIME (MIN) = 315	DISCHARGE (CFS) = 0
TIME (MIN) = 320	DISCHARGE (CFS) = 0
TIME (MIN) = 325	DISCHARGE (CFS) = 0
TIME (MIN) = 330	DISCHARGE (CFS) = 0
TIME (MIN) = 335	DISCHARGE (CFS) = 0
TIME (MIN) = 340	DISCHARGE (CFS) = 0
TIME (MIN) = 345	DISCHARGE (CFS) = 0
TIME (MIN) = 350	DISCHARGE (CFS) = 0
TIME (MIN) = 355	DISCHARGE (CFS) = 0
TIM	

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Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4

Project: Det-4-5 YR 100.gpw	Monday, 07 / 3 / 2017

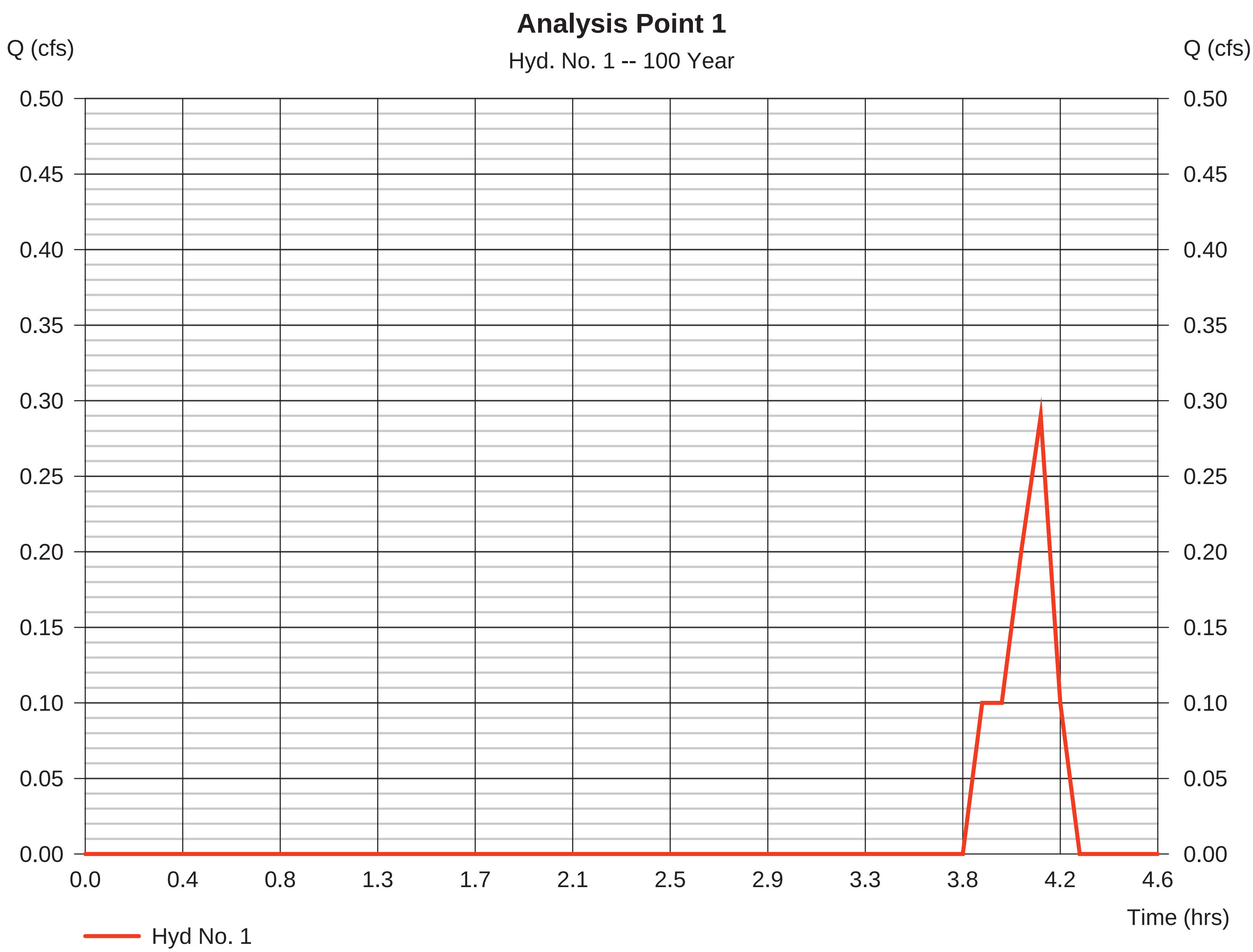
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 07 / 3 / 2017

Hyd. No. 1

Analysis Point 1

Hydrograph type	= Manual	Peak discharge	= 0.290 cfs
Storm frequency	= 100 yrs	Time to peak	= 4.08 hrs
Time interval	= 5 min	Hyd. volume	= 237 cuft



Hydrograph Report

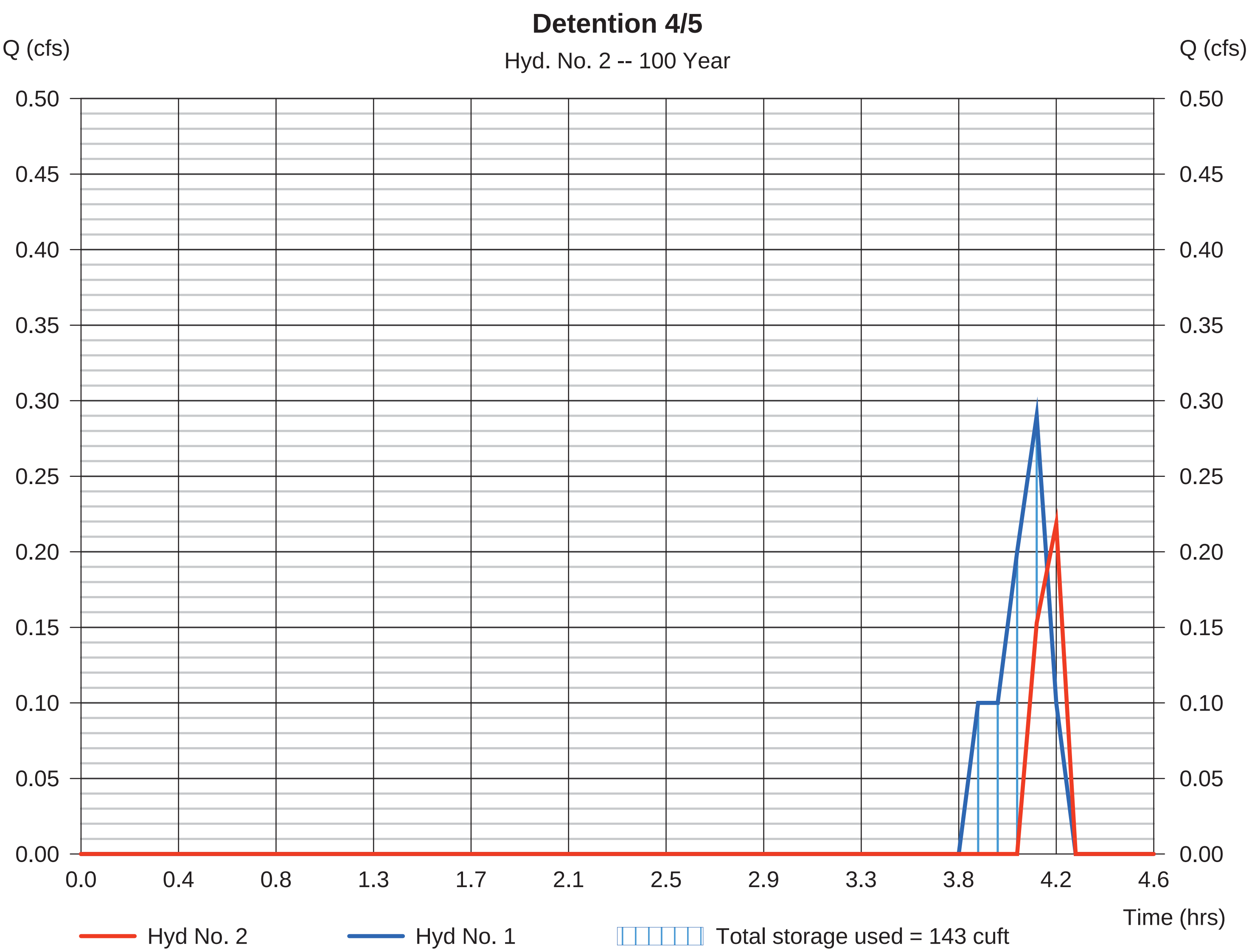
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 07 / 3 / 2017

Hyd. No. 2

Detention 4/5

Hydrograph type	= Reservoir	Peak discharge	= 0.218 cfs
Storm frequency	= 100 yrs	Time to peak	= 4.17 hrs
Time interval	= 5 min	Hyd. volume	= 111 cuft
Inflow hyd. No.	= 1 - Analysis Point 1	Max. Elevation	= 102.00 ft
Reservoir name	= Detention 4/5	Max. Storage	= 143 cuft

Storage Indication method used.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 07 / 3 / 2017

Pond No. 1 - Detention 4/5

Pond Data

Pond storage is based on user-defined values.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	100.00	n/a	0	0
1.00	101.00	n/a	75	75
2.00	102.00	n/a	75	150

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	Inactive	Inactive	Inactive	Inactive
Span (in)	= 0.00	1.00	0.00	0.00
No. Barrels	= 1	1	1	1
Invert El. (ft)	= 300.00	302.00	0.00	0.00
Length (ft)	= 10.00	0.00	0.00	2.00
Slope (%)	= 1.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	Inactive	1.00	Inactive	Inactive
Crest El. (ft)	= 0.00	101.75	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	Rect	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	100.00	---	0.00	---	---	0.00	0.00	---	---	---	---	0.000
1.00	75	101.00	---	0.00	---	---	0.00	0.00	---	---	---	---	0.000
2.00	150	102.00	---	0.00	---	---	0.00	0.42	---	---	---	---	0.416

RATIONAL METHOD HYDROGRAPH PROGRAM
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RUN DATE 7/3/2017
HYDROGRAPH FILE NAME Text1
TIME OF CONCENTRATION 5 MIN.
6 HOUR RAINFALL 2.3 INCHES
BASIN AREA 0.15 ACRES
RUNOFF COEFFICIENT 0.57
PEAK DISCHARGE 0.39 CFS

TIME (MIN) = 0	DISCHARGE (CFS) = 0
TIME (MIN) = 5	DISCHARGE (CFS) = 0
TIME (MIN) = 10	DISCHARGE (CFS) = 0
TIME (MIN) = 15	DISCHARGE (CFS) = 0
TIME (MIN) = 20	DISCHARGE (CFS) = 0
TIME (MIN) = 25	DISCHARGE (CFS) = 0
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TIME (MIN) = 35	DISCHARGE (CFS) = 0
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TIME (MIN) = 65	DISCHARGE (CFS) = 0
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TIME (MIN) = 210	DISCHARGE (CFS) = 0
TIME (MIN) = 215	DISCHARGE (CFS) = 0
TIME (MIN) = 220	DISCHARGE (CFS) = 0.1
TIME (MIN) = 225	DISCHARGE (CFS) = 0.1
TIME (MIN) = 230	DISCHARGE (CFS) = 0.1
TIME (MIN) = 235	DISCHARGE (CFS) = 0.1
TIME (MIN) = 240	DISCHARGE (CFS) = 0.3
TIME (MIN) = 245	DISCHARGE (CFS) = 0.39
TIME (MIN) = 250	DISCHARGE (CFS) = 0.1
TIME (MIN) = 255	DISCHARGE (CFS) = 0.1
TIME (MIN) = 260	DISCHARGE (CFS) = 0
TIME (MIN) = 265	DISCHARGE (CFS) = 0
TIME (MIN) = 270	DISCHARGE (CFS) = 0
TIME (MIN) = 275	DISCHARGE (CFS) = 0
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TIME (MIN) = 285	DISCHARGE (CFS) = 0
TIME (MIN) = 290	DISCHARGE (CFS) = 0
TIME (MIN) = 295	DISCHARGE (CFS) = 0
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TIME (MIN) = 310	DISCHARGE (CFS) = 0
TIME (MIN) = 315	DISCHARGE (CFS) = 0
TIME (MIN) = 320	DISCHARGE (CFS) = 0
TIME (MIN) = 325	DISCHARGE (CFS) = 0
TIME (MIN) = 330	DISCHARGE (CFS) = 0
TIME (MIN) = 335	DISCHARGE (CFS) = 0
TIME (MIN) = 340	DISCHARGE (CFS) = 0
TIME (MIN) = 345	DISCHARGE (CFS) = 0
TIME (MIN) = 350	DISCHARGE (CFS) = 0
TIME (MIN) = 355	DISCHARGE (CFS) = 0
TIM	

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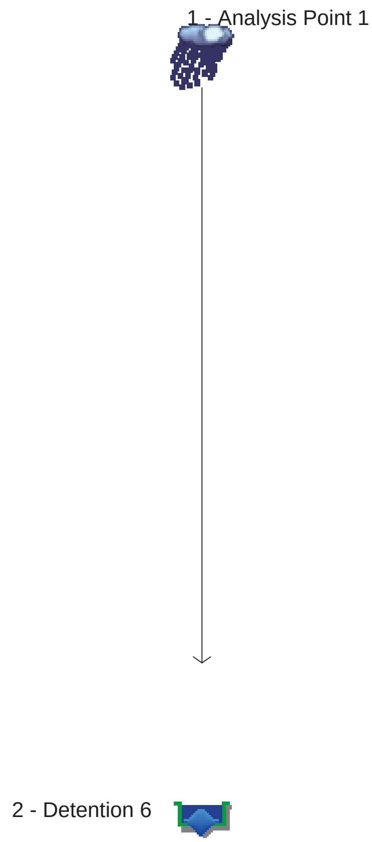
Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4



Project: Det-6 YR 100.gpw	Monday, 07 / 3 / 2017

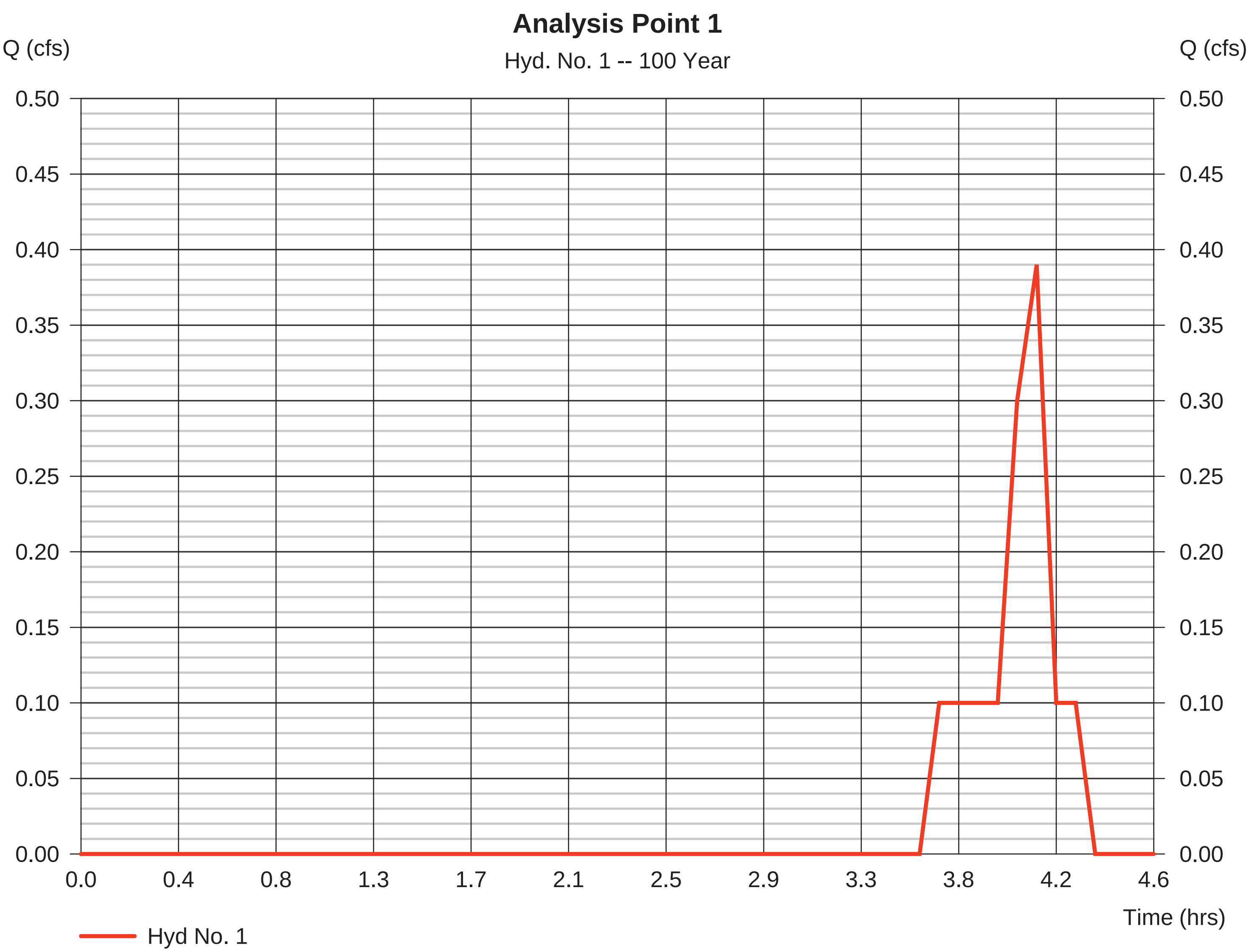
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 — Monday, 07 / 3 / 2017

Hyd. No. 1

Analysis Point 1

Hydrograph type	= Manual	Peak discharge	= 0.390 cfs
Storm frequency	= 100 yrs	Time to peak	= 4.08 hrs
Time interval	= 5 min	Hyd. volume	= 387 cuft



Hydrograph Report

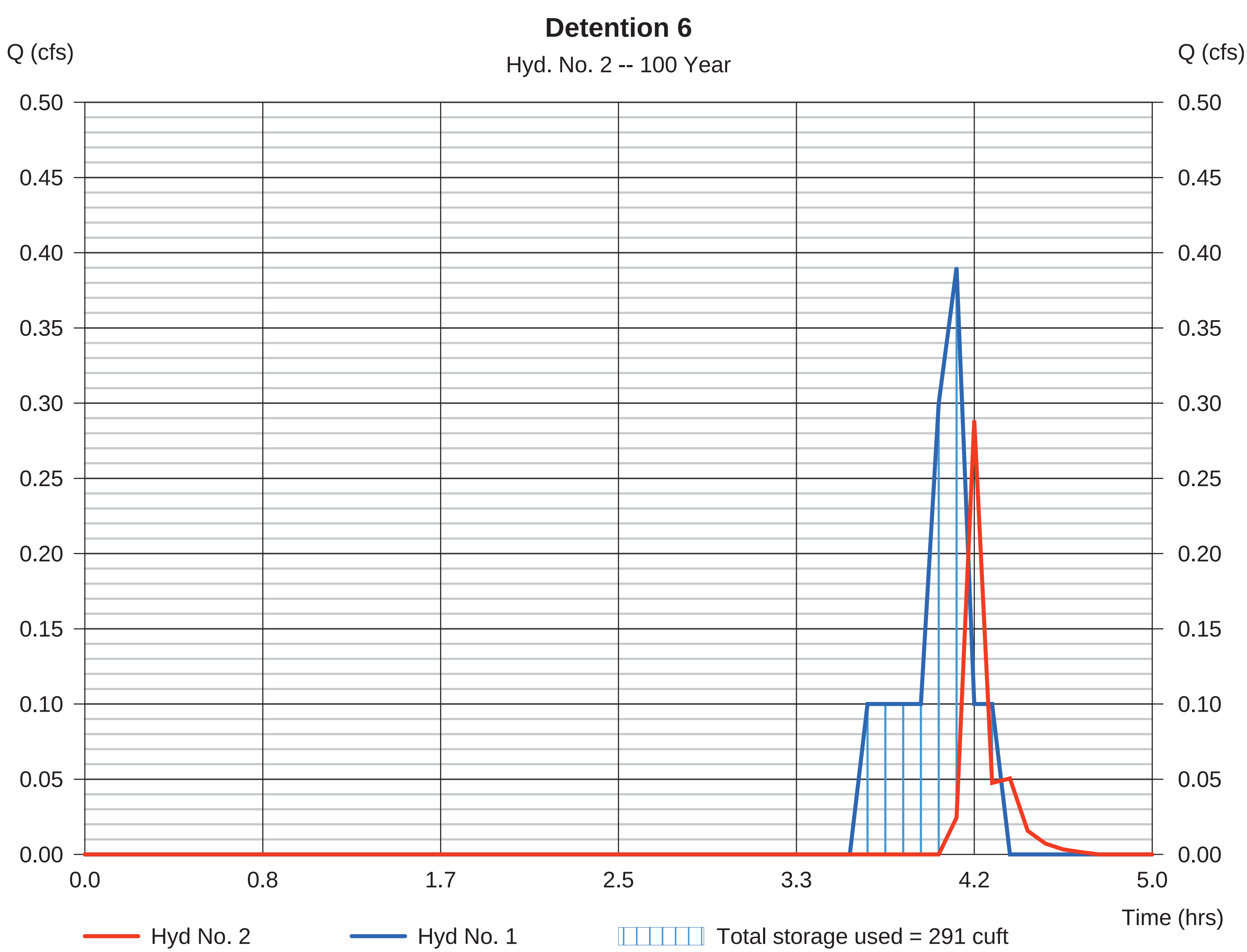
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 07 / 3 / 2017

Hyd. No. 2

Detention 6

Hydrograph type	= Reservoir	Peak discharge	= 0.289 cfs
Storm frequency	= 100 yrs	Time to peak	= 4.17 hrs
Time interval	= 5 min	Hyd. volume	= 132 cuft
Inflow hyd. No.	= 1 - Analysis Point 1	Max. Elevation	= 102.00 ft
Reservoir name	= Detention 6	Max. Storage	= 291 cuft

Storage Indication method used.



Pond Report

Pond No. 1 - Detention 6

Pond Data

Pond storage is based on user-defined values.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	100.00	n/a	0	0
1.00	101.00	n/a	150	150
2.00	102.00	n/a	150	300

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	Inactive	Inactive	Inactive	Inactive
Span (in)	= 18.00	1.00	0.00	0.00
No. Barrels	= 1	1	1	1
Invert El. (ft)	= 300.00	302.00	0.00	0.00
Length (ft)	= 10.00	0.00	0.00	2.00
Slope (%)	= 1.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	Inactive	1.00	Inactive	Inactive
Crest El. (ft)	= 304.30	101.75	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	Rect	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	100.00	0.00	0.00	---	---	0.00	0.00	---	---	---	---	0.000
1.00	150	101.00	0.00	0.00	---	---	0.00	0.00	---	---	---	---	0.000
2.00	300	102.00	0.00	0.00	---	---	0.00	0.42	---	---	---	---	0.416

RATIONAL METHOD HYDROGRAPH PROGRAM
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RUN DATE 7/3/2017
HYDROGRAPH FILE NAME Text1
TIME OF CONCENTRATION 7 MIN.
6 HOUR RAINFALL 2.3 INCHES
BASIN AREA 0.74 ACRES
RUNOFF COEFFICIENT 0.57
PEAK DISCHARGE 1.97 CFS

TIME (MIN) = 0	DISCHARGE (CFS) = 0
TIME (MIN) = 7	DISCHARGE (CFS) = 0.1
TIME (MIN) = 14	DISCHARGE (CFS) = 0.1
TIME (MIN) = 21	DISCHARGE (CFS) = 0.1
TIME (MIN) = 28	DISCHARGE (CFS) = 0.1
TIME (MIN) = 35	DISCHARGE (CFS) = 0.1
TIME (MIN) = 42	DISCHARGE (CFS) = 0.1
TIME (MIN) = 49	DISCHARGE (CFS) = 0.1
TIME (MIN) = 56	DISCHARGE (CFS) = 0.1
TIME (MIN) = 63	DISCHARGE (CFS) = 0.1
TIME (MIN) = 70	DISCHARGE (CFS) = 0.1
TIME (MIN) = 77	DISCHARGE (CFS) = 0.1
TIME (MIN) = 84	DISCHARGE (CFS) = 0.1
TIME (MIN) = 91	DISCHARGE (CFS) = 0.1
TIME (MIN) = 98	DISCHARGE (CFS) = 0.1
TIME (MIN) = 105	DISCHARGE (CFS) = 0.1
TIME (MIN) = 112	DISCHARGE (CFS) = 0.1
TIME (MIN) = 119	DISCHARGE (CFS) = 0.1
TIME (MIN) = 126	DISCHARGE (CFS) = 0.1
TIME (MIN) = 133	DISCHARGE (CFS) = 0.1
TIME (MIN) = 140	DISCHARGE (CFS) = 0.1
TIME (MIN) = 147	DISCHARGE (CFS) = 0.1
TIME (MIN) = 154	DISCHARGE (CFS) = 0.1
TIME (MIN) = 161	DISCHARGE (CFS) = 0.1
TIME (MIN) = 168	DISCHARGE (CFS) = 0.1
TIME (MIN) = 175	DISCHARGE (CFS) = 0.1
TIME (MIN) = 182	DISCHARGE (CFS) = 0.1
TIME (MIN) = 189	DISCHARGE (CFS) = 0.2
TIME (MIN) = 196	DISCHARGE (CFS) = 0.2
TIME (MIN) = 203	DISCHARGE (CFS) = 0.2
TIME (MIN) = 210	DISCHARGE (CFS) = 0.2
TIME (MIN) = 217	DISCHARGE (CFS) = 0.2
TIME (MIN) = 224	DISCHARGE (CFS) = 0.3
TIME (MIN) = 231	DISCHARGE (CFS) = 0.4
TIME (MIN) = 238	DISCHARGE (CFS) = 0.7
TIME (MIN) = 245	DISCHARGE (CFS) = 1.97
TIME (MIN) = 252	DISCHARGE (CFS) = 0.3
TIME (MIN) = 259	DISCHARGE (CFS) = 0.2
TIME (MIN) = 266	DISCHARGE (CFS) = 0.2
TIME (MIN) = 273	DISCHARGE (CFS) = 0.1
TIME (MIN) = 280	DISCHARGE (CFS) = 0.1
TIME (MIN) = 287	DISCHARGE (CFS) = 0.1
TIME (MIN) = 294	DISCHARGE (CFS) = 0.1
TIME (MIN) = 301	DISCHARGE (CFS) = 0.1
TIME (MIN) = 308	DISCHARGE (CFS) = 0.1
TIME (MIN) = 315	DISCHARGE (CFS) = 0.1
TIME (MIN) = 322	DISCHARGE (CFS) = 0.1
TIME (MIN) = 329	DISCHARGE (CFS) = 0.1
TIME (MIN) = 336	DISCHARGE (CFS) = 0.1
TIME (MIN) = 343	DISCHARGE (CFS) = 0.1
TIME (MIN) = 350	DISCHARGE (CFS) = 0.1
TIME (MIN) = 357	DISCHARGE (CFS) = 0.1
TIME (MIN) = 364	DISCHARGE (CFS) = 0

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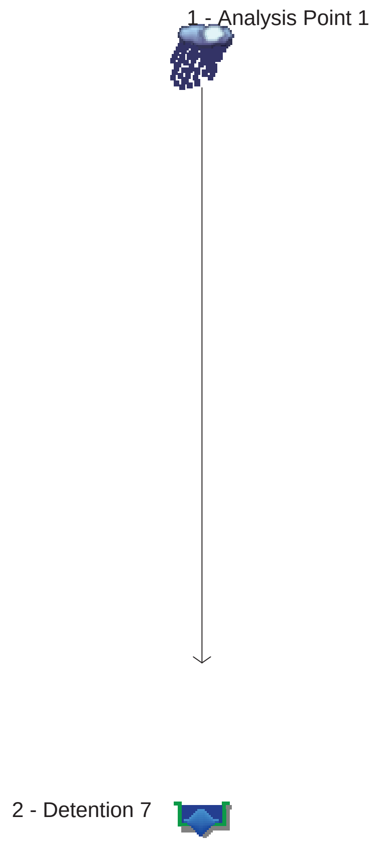
Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4



Project: Det-7 YR 100.gpw	Monday, 07 / 3 / 2017

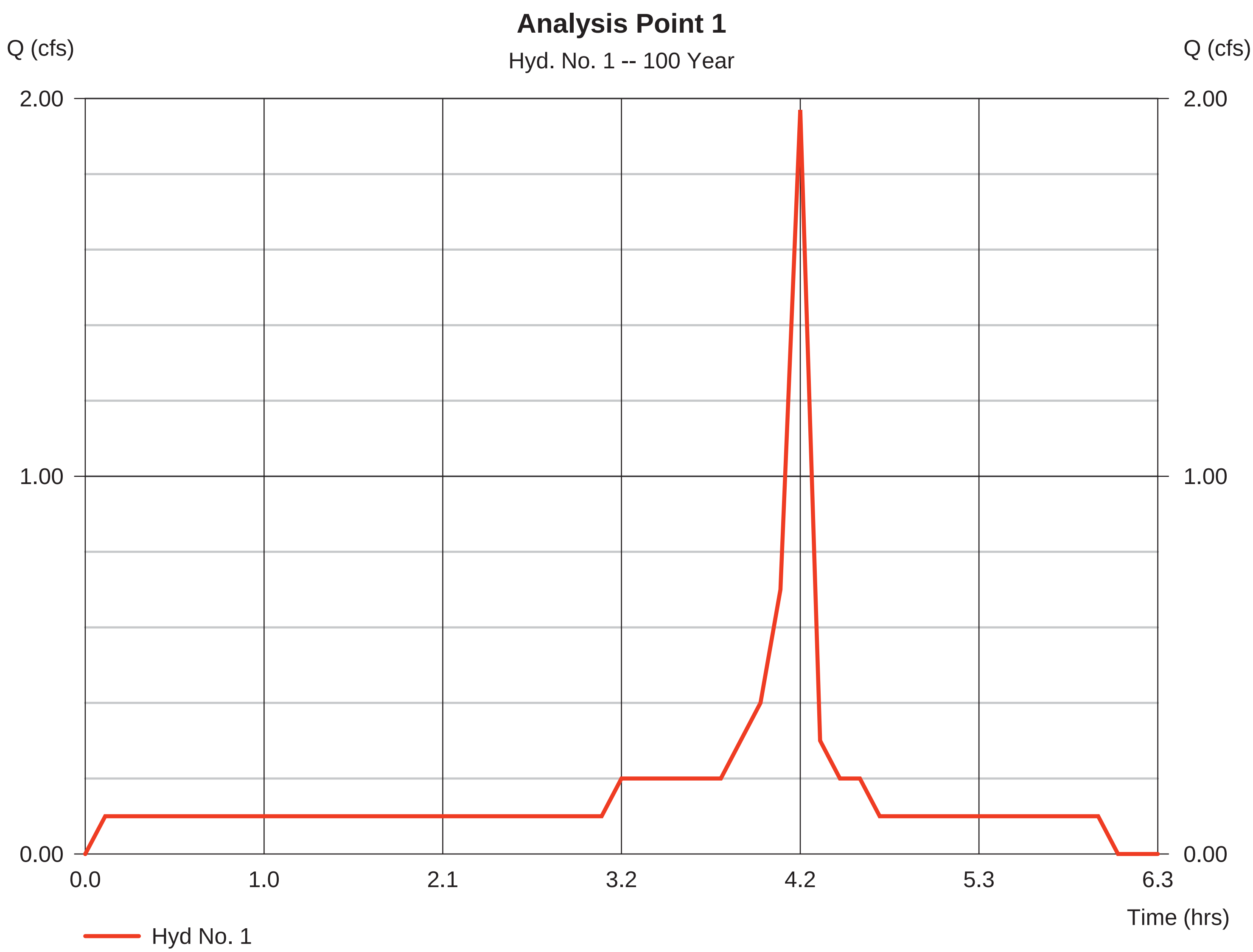
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 — Monday, 07 / 3 / 2017

Hyd. No. 1

Analysis Point 1

Hydrograph type	= Manual	Peak discharge	= 1.970 cfs
Storm frequency	= 100 yrs	Time to peak	= 4.20 hrs
Time interval	= 7 min	Hyd. volume	= 3,809 cuft



Hydrograph Report

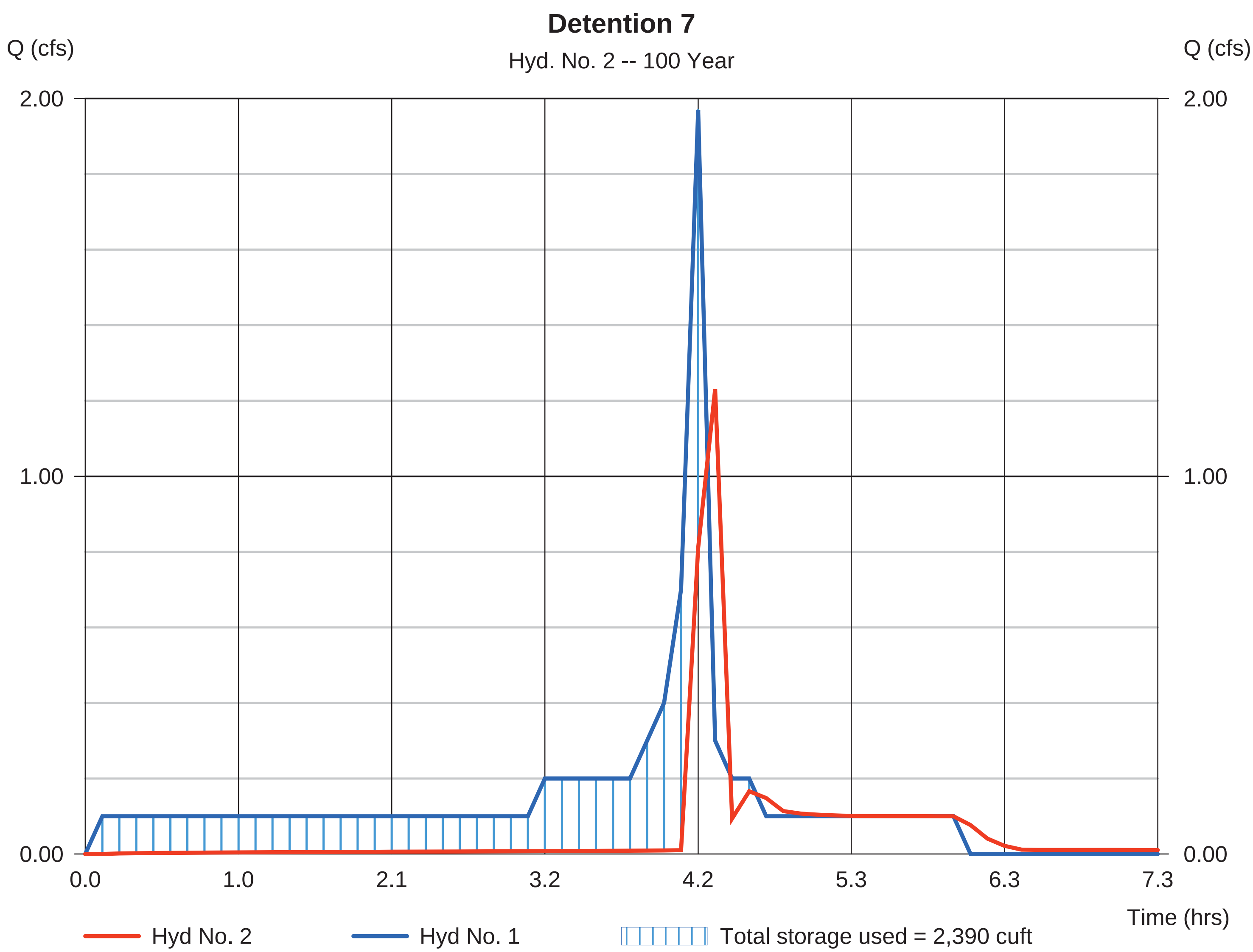
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 07 / 3 / 2017

Hyd. No. 2

Detention 7

Hydrograph type	= Reservoir	Peak discharge	= 1.231 cfs
Storm frequency	= 100 yrs	Time to peak	= 4.32 hrs
Time interval	= 7 min	Hyd. volume	= 3,766 cuft
Inflow hyd. No.	= 1 - Analysis Point 1	Max. Elevation	= 103.00 ft
Reservoir name	= Detention 7	Max. Storage	= 2,390 cuft

Storage Indication method used.



Pond Report

Pond No. 1 - Detention 7

Pond Data

Pond storage is based on user-defined values.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	100.00	n/a	0	0
1.00	101.00	n/a	800	800
2.00	102.00	n/a	800	1,600
3.00	103.00	n/a	800	2,400

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 10.00	0.50	Inactive	Inactive
Span (in)	= 10.00	0.50	0.00	0.00
No. Barrels	= 1	1	1	1
Invert El. (ft)	= 100.00	100.00	0.00	0.00
Length (ft)	= 75.00	0.00	0.00	2.00
Slope (%)	= 2.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 3.14	Inactive	Inactive	Inactive
Crest El. (ft)	= 102.75	102.75	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	Rect	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

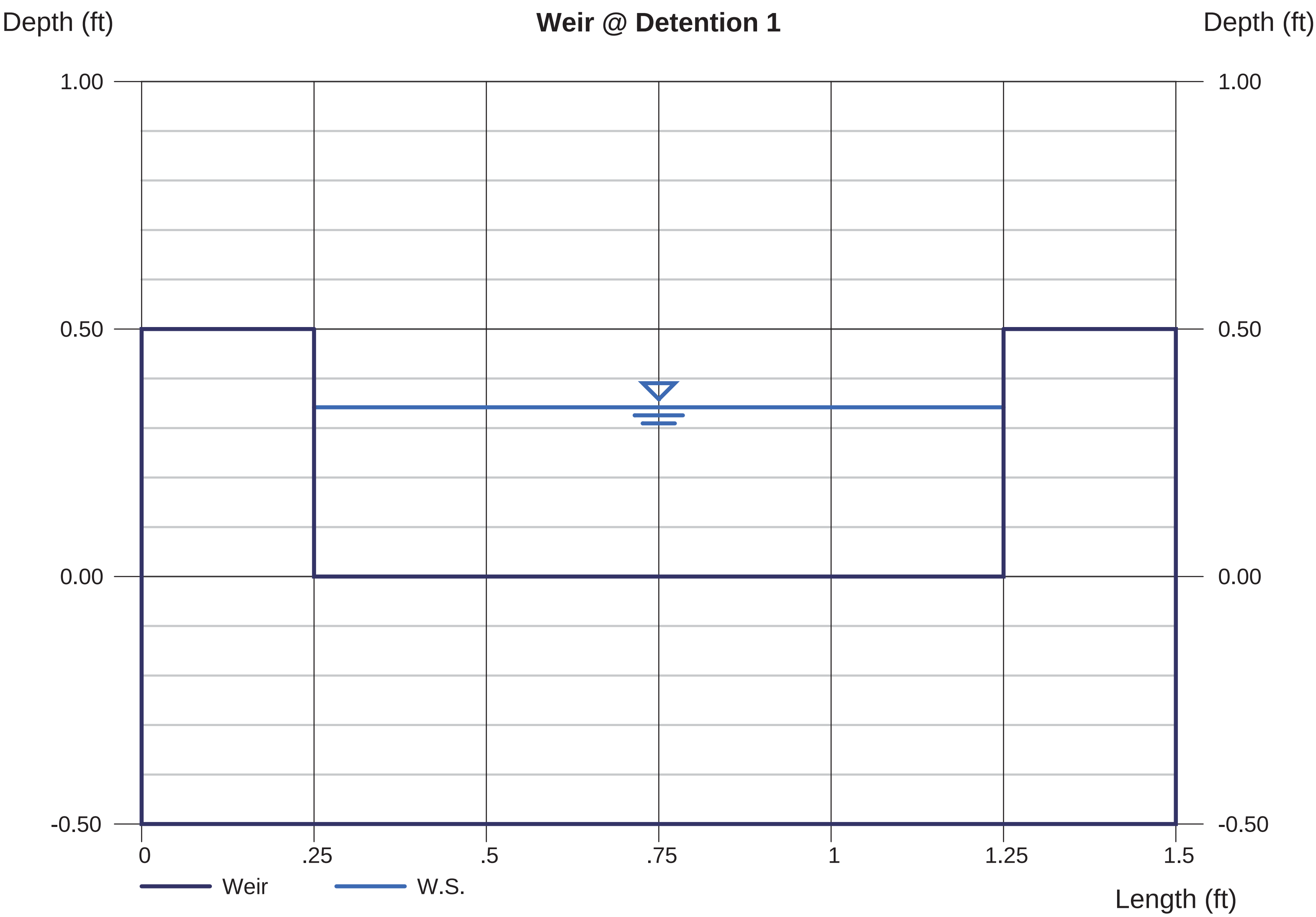
Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	100.00	0.00	0.00	---	---	0.00	0.00	---	---	---	---	0.000
1.00	800	101.00	0.01 ic	0.01 ic	---	---	0.00	0.00	---	---	---	---	0.006
2.00	1,600	102.00	0.01 ic	0.01 ic	---	---	0.00	0.00	---	---	---	---	0.009
3.00	2,400	103.00	1.32 ic	0.01 ic	---	---	1.31	0.00	---	---	---	---	1.318

Weir Report

Weir @ Detention 1

Rectangular Weir		**Highlighted**	
Crest	= Broad	Depth (ft)	= 0.34
Bottom Length (ft)	= 1.00	Q (cfs)	= 0.520
Total Depth (ft)	= 0.50	Area (sqft)	= 0.34
		Velocity (ft/s)	= 1.52
Calculations		Top Width (ft)	= 1.00
Weir Coeff. Cw	= 2.60		
Compute by:	Known Q		
Known Q (cfs)	= 0.52		



Weir Report

Weir @ Detention 2

Rectangular Weir

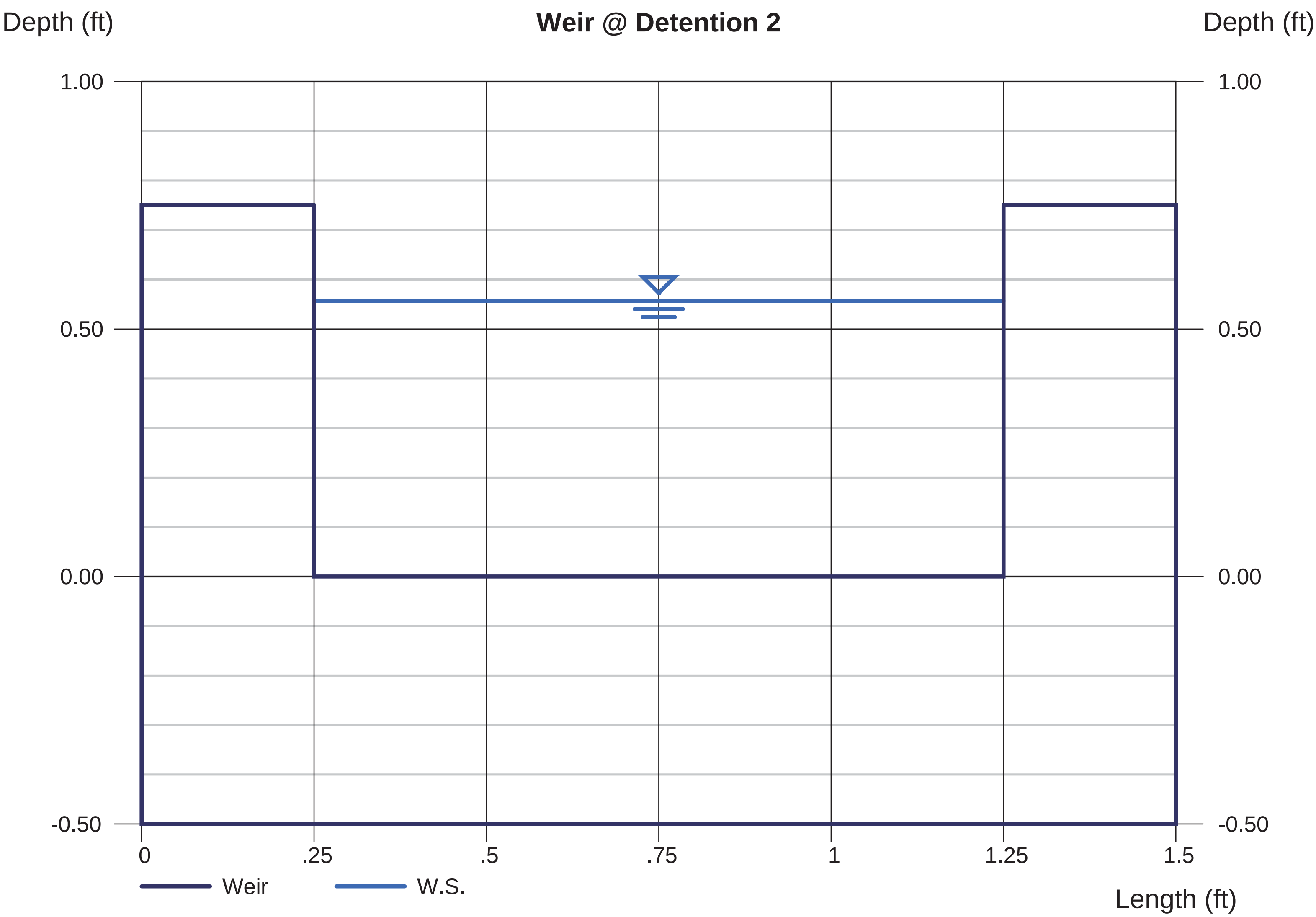
Crest	= Broad
Bottom Length (ft)	= 1.00
Total Depth (ft)	= 0.75

Calculations

Weir Coeff. Cw	= 2.60
Compute by:	Known Q
Known Q (cfs)	= 1.08

Highlighted

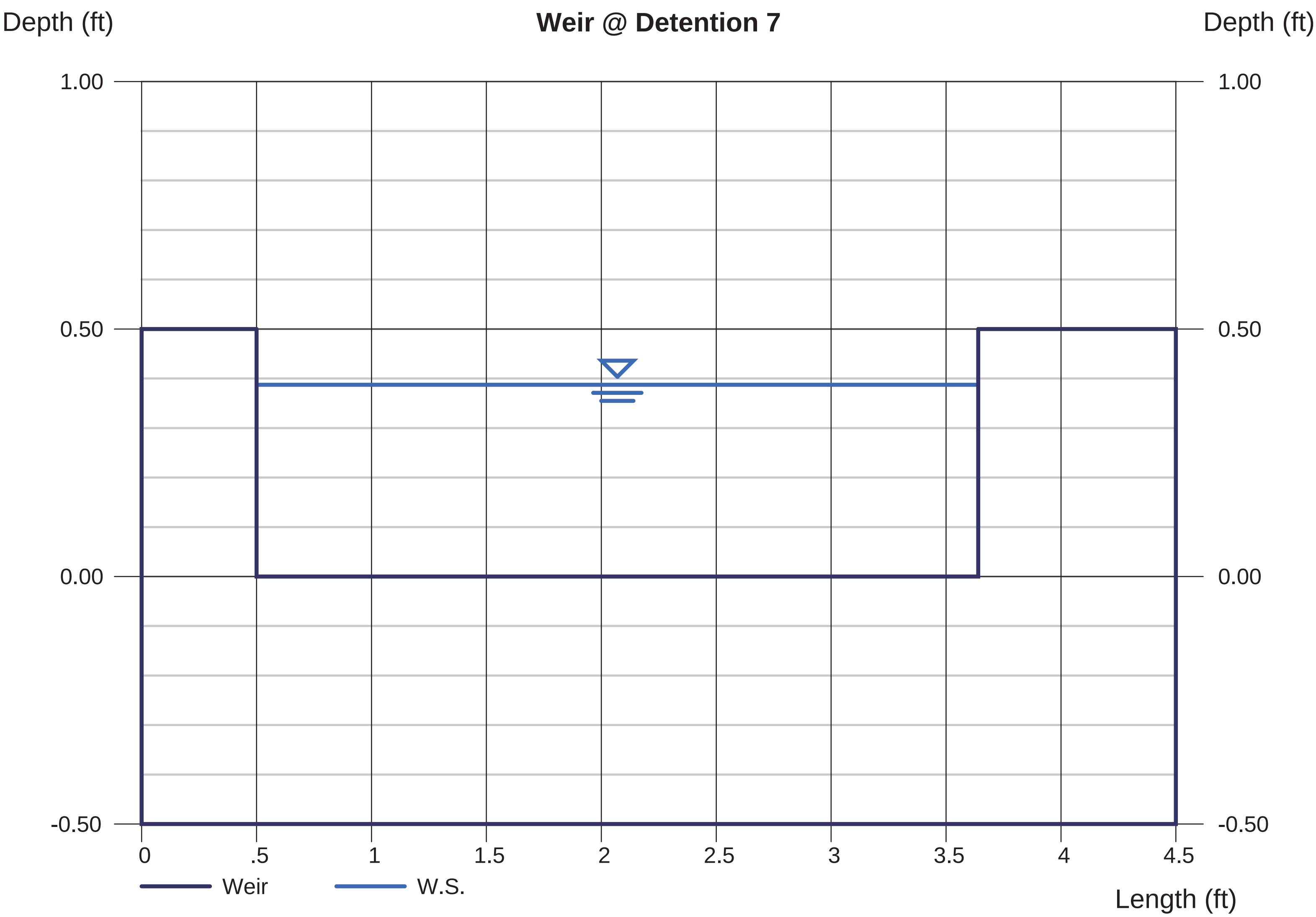
Depth (ft)	= 0.56
Q (cfs)	= 1.080
Area (sqft)	= 0.56
Velocity (ft/s)	= 1.94
Top Width (ft)	= 1.00



Weir Report

Weir @ Detention 7

Rectangular Weir		**Highlighted**	
Crest	= Broad	Depth (ft)	= 0.39
Bottom Length (ft)	= 3.14	Q (cfs)	= 1.970
Total Depth (ft)	= 0.50	Area (sqft)	= 1.22
		Velocity (ft/s)	= 1.62
Calculations		Top Width (ft)	= 3.14
Weir Coeff. Cw	= 2.60		
Compute by:	Known Q		
Known Q (cfs)	= 1.97		



APPENDIX D:

Hydrologic Information

SECTION 3
RATIONAL METHOD AND MODIFIED RATIONAL METHOD

3.1 THE RATIONAL METHOD

The Rational Method (RM) is a mathematical formula used to determine the maximum runoff rate from a given rainfall. It has particular application in urban storm drainage, where it is used to estimate peak runoff rates from small urban and rural watersheds for the design of storm drains and small drainage structures. The RM is recommended for analyzing the runoff response from drainage areas up to approximately 1 square mile in size. It should not be used in instances where there is a junction of independent drainage systems or for drainage areas greater than approximately 1 square mile in size. In these instances, the Modified Rational Method (MRM) should be used for junctions of independent drainage systems in watersheds up to approximately 1 square mile in size (see Section 3.4); or the NRCS Hydrologic Method should be used for watersheds greater than approximately 1 square mile in size (see Section 4).

The RM can be applied using any design storm frequency (e.g., 100-year, 50-year, 10-year, etc.). The local agency determines the design storm frequency that must be used based on the type of project and specific local requirements. A discussion of design storm frequency is provided in Section 2.3 of this manual. A procedure has been developed that converts the 6-hour and 24-hour precipitation isopluvial map data to an Intensity-Duration curve that can be used for the rainfall intensity in the RM formula as shown in Figure 3-1. The RM is applicable to a 6-hour storm duration because the procedure uses Intensity-Duration Design Charts that are based on a 6-hour storm duration.

3.1.1 Rational Method Formula

The RM formula estimates the peak rate of runoff at any location in a watershed as a function of the drainage area (A), runoff coefficient (C), and rainfall intensity (I) for a duration equal to the time of concentration (T_c), which is the time required for water to flow from the most remote point of the basin to the location being analyzed. The RM formula is expressed as follows:

$$Q = C\,I\,A$$

Where:
- Q = peak discharge, in cubic feet per second (cfs)
- C = runoff coefficient, proportion of the rainfall that runs off the surface (no units)
- I = average rainfall intensity for a duration equal to the T_c for the area, in inches per hour (Note: If the computed T_c is less than 5 minutes, use 5 minutes for computing the peak discharge, Q)
- A = drainage area contributing to the design location, in acres

Combining the units for the expression CIA yields:

$$\left(\frac{1\,\text{acre} \times \text{inch}}{\text{hour}}\right)\left(\frac{43{,}560\,\text{ft}^2}{\text{acre}}\right)\left(\frac{1\,\text{foot}}{12\,\text{inches}}\right)\left(\frac{1\,\text{hour}}{3{,}600\,\text{seconds}}\right) \Rightarrow 1.008\,\text{cfs}$$

For practical purposes the unit conversion coefficient difference of 0.8% can be ignored.

The RM formula is based on the assumption that for constant rainfall intensity, the peak discharge rate at a point will occur when the raindrop that falls at the most upstream point in the tributary drainage basin arrives at the point of interest.

Unlike the MRM (discussed in Section 3.4) or the NRCS hydrologic method (discussed in Section 4), the RM does not create hydrographs and therefore does not add separate subarea hydrographs at collection points. Instead, the RM develops peak discharges in the main line by increasing the T_c as flow travels downstream.

Characteristics of, or assumptions inherent to, the RM are listed below:

- The discharge flow rate resulting from any I is maximum when the I lasts as long as or longer than the T_c.

- The storm frequency of peak discharges is the same as that of I for the given T_c.
- The fraction of rainfall that becomes runoff (or the runoff coefficient, C) is independent of I or precipitation zone number (PZN) condition (PZN Condition is discussed in Section 4.1.2.4).
- The peak rate of runoff is the only information produced by using the RM.

3.1.2 Runoff Coefficient

Table 3-1 lists the estimated runoff coefficients for urban areas. The concepts related to the runoff coefficient were evaluated in a report entitled *Evaluation, Rational Method "C" Values* (Hill, 2002) that was reviewed by the Hydrology Manual Committee. The Report is available at San Diego County Department of Public Works, Flood Control Section and on the San Diego County Department of Public Works web page.

The runoff coefficients are based on land use and soil type. Soil type can be determined from the soil type map provided in Appendix A. An appropriate runoff coefficient (C) for each type of land use in the subarea should be selected from this table and multiplied by the percentage of the total area (A) included in that class. The sum of the products for all land uses is the weighted runoff coefficient (Σ[CA]). Good engineering judgment should be used when applying the values presented in Table 3-1, as adjustments to these values may be appropriate based on site-specific characteristics. In any event, the impervious percentage (% Impervious) as given in the table, for any area, shall govern the selected value for C. The runoff coefficient can also be calculated for an area based on soil type and impervious percentage using the following formula:

$$C = 0.90 \times (\% \text{ Impervious}) + C_p \times (1 - \% \text{ Impervious})$$

Where: C_p = Pervious Coefficient Runoff Value for the soil type (shown in Table 3-1 as Undisturbed Natural Terrain/Permanent Open Space, 0% Impervious). Soil type can be determined from the soil type map provided in Appendix A.

The values in Table 3-1 are typical for most urban areas. However, if the basin contains rural or agricultural land use, parks, golf courses, or other types of nonurban land use that are expected to be permanent, the appropriate value should be selected based upon the soil and cover and approved by the local agency.

Table 3-1
RUNOFF COEFFICIENTS FOR URBAN AREAS

Land Use		Runoff Coefficient "C"				
			Soil Type			
NRCS Elements	County Elements	% IMPER.	A	B	C	D
Undisturbed Natural Terrain (Natural)	Permanent Open Space	0*	0.20	0.25	0.30	0.35
Low Density Residential (LDR)	Residential, 1.0 DU/A or less	10	0.27	0.32	0.36	0.41
Low Density Residential (LDR)	Residential, 2.0 DU/A or less	20	0.34	0.38	0.42	0.46
Low Density Residential (LDR)	Residential, 2.9 DU/A or less	25	0.38	0.41	0.45	0.49
Medium Density Residential (MDR)	Residential, 4.3 DU/A or less	30	0.41	0.45	0.48	0.52
Medium Density Residential (MDR)	Residential, 7.3 DU/A or less	40	0.48	0.51	0.54	0.57
Medium Density Residential (MDR)	Residential, 10.9 DU/A or less	45	0.52	0.54	0.57	0.60
Medium Density Residential (MDR)	Residential, 14.5 DU/A or less	50	0.55	0.58	0.60	0.63
High Density Residential (HDR)	Residential, 24.0 DU/A or less	65	0.66	0.67	0.69	0.71
High Density Residential (HDR)	Residential, 43.0 DU/A or less	80	0.76	0.77	0.78	0.79
Commercial/Industrial (N. Com)	Neighborhood Commercial	80	0.76	0.77	0.78	0.79
Commercial/Industrial (G. Com)	General Commercial	85	0.80	0.80	0.81	0.82
Commercial/Industrial (O.P. Com)	Office Professional/Commercial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (Limited I.)	Limited Industrial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (General I.)	General Industrial	95	0.87	0.87	0.87	0.87

*The values associated with 0% impervious may be used for direct calculation of the runoff coefficient as described in Section 3.1.2 (representing the pervious runoff coefficient, Cp, for the soil type), or for areas that will remain undisturbed in perpetuity. Justification must be given that the area will remain natural forever (e.g., the area is located in Cleveland National Forest).
DU/A = dwelling units per acre
NRCS = National Resources Conservation Service

1. HANDICAPPED ACCESS

a. Provide site and building access to physically handicapped persons in accordance with the requirements of California Code of Regulations, Title 24, and Uniform Federal Accessibility Standards as applicable.

2. PHYSICAL PLANNING

Physical Planning
http://physicalplanning.ucsd.edu/Default.htm is responsible for overseeing land use planning for the UCSD Campus, including Scripps Institution of Oceanography and the Medical Centers, and site planning for some renovation projects. Included within this scope of responsibility is urban planning, landscape planning, environmental reporting and monitoring, signage, implementation of the campus's 2004 Long Range Development Plan (LRDP) http://physicalplanning.ucsd.edu/PPW-PlansStudiesProjects/LRDP2004/Default.htm
and oversight of the process and production of neighborhood planning studies that extend, refine and, when necessary, amend the land use and design guidelines set forth in the 1989 UCSD Master Plan http://physicalplanning.ucsd.edu/PPW-PlansStudiesProjects/mstrplan.html. A Planner is usually designated to the project.

b. Environmental Review http://physicalplanning.ucsd.edu/envir.html

1) A standing duty of Physical Planning is the conduct of environmental impact reviews, in accordance with the guidelines established by the California Environmental Quality Act (CEQA), from initiation of environmental classification forms (EICs) through certification by The Regents and filing with the State Clearinghouse. An Environmental Planner is usually designated to the project and may require information from the design team to produce the environmental report for the project.

2) During design, care must be taken to adhere to the project environmental requirements. These requirements could include limits of grading, storm water treatment and discharge, and scheduling restrictions due to noise limits, geotechnical considerations and prohibition of vegetation removal during certain times of the year due to biological habitat.

c. Coastal Commission permitting

1) Approximately half of the main campus acreage lies within the California Coastal Zone (http://physicalplanning.ucsd.edu/LRDP2004/LRDP_Chap1.pdf). The boundary of the zone runs north along Torrey Pines Road and North Torrey Pines Road to the intersection of La Jolla Shores Drive, northeast to Voigt Drive and Interstate 5, then north along Interstate 5. Development within the seaward areas north and west of this boundary line is contingent upon the California Coastal Commission's review of the proposed project and granting of the requisite permit.

2) Development proposals within the Coastal Zone should be reviewed as early as possible in the design process with Government and Community Relations staff. Early review and coordination will facilitate timely processing.

3. GEOTECHNICAL REPORT

a. The University shall provide a geotechnical report for all projects. Typically, the consultant structural engineer will provide a sketch of where the boreholes and other information are needed. The geotechnical consultant will evaluate existing reports which can be obtained from FD&C. The site investigation data gathered are then translated into recommendations for:

1) Site preparation, such as compaction or replacing existing unsuitable soils.

2) Bearing loads for foundation designs and the predicted settlement and soil design parameters for retaining walls.

3) Dealing with ground water and surface water as they may affect construction operations and the finished project.

4) Road pavement thickness design.

b. It is recommended that the geotechnical engineer review the construction documents and submittals for compliance with the recommendations made in the Geotechnical Report. The Geotechnical Consultant should be present during construction excavation in order to verify that actual conditions agree with the anticipated conditions.

c. The Geotechnical Consultant should provide a final construction report.

d. Environmental Site Assessment and Soils Management Policy

Prior to construction of a building on the UCSD Campus an Environmental Site Assessment is required to determine the presence of hazardous materials/wastes/ammunitions on a proposed project site. Samples should be collected in accordance with industry-standard ASTM recommendations, and the samples be analyzed using USEPA-approved methods, and the results be included in the Geotechnical Report in an Appendix.

Project location and historical site activities will guide the sampling scheme. Based on the attached figure of the Camp Mathews Boundary [LINK], if the project is located inside the historic Camp Matthews boundary, samples shall be taken based on horizontal grid of the site into 100 foot by 100 foot blocks (approximately ¼ acre each) or as directed by FD&C who will consult with EH&S. If the project does not fall inside the Camp Matthews boundary, samples shall be taken from the boreholes for the geotechnical report. The following guidelines apply to the sampling:

1) All chemical analyses must be performed by State of California certified laboratories.

2) At a minimum, perform the following soil sampling and analyses:

a) Collect soil samples from each of the locations using appropriate methods (hollow stem auger, push rig, hand auger, etc.) at approximately 2 feet below surface, 5 feet below historic surface and at 5 foot intervals thereafter to the bottom elevation of the proposed excavation.
b) Analyze all samples for the following constituents:
Total Petroleum Hydrocarbons (TPH) Extended Range (C8-C40) by EPA Method 8015 Modified.
California Toxic Metals Total Concentration for Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Cobalt, Copper, Lead, Mercury, Molybdenum, Nickel, Selenium, Silver, Thallium, Vanadium, and Zinc.
c) Explosives by EPA Method 8330.
d) Submit laboratory results to FD&C who will forward them to EH&S for review, which will provide recommendations for further investigation and remedial actions, if necessary.
e) Containerize soil cuttings from the borings and backfill with slurry mixture, following DEH criteria. Characterize soil cuttings for offsite disposal.
f) Coordinate offsite soil disposal.

3) The results of the analyses of the soil sampling will be included in the geotechnical report as an appendices signed by a registered geologist or environmental scientist. All the technical data gathered during the course of the study, a map of the sampling locations, and any other applicable information should be included. The report will be provided as a hardcopy and in electronic format.

4) Buildings or sites with asbestos, lead paint, PCB containing light ballasts, underground tanks or other hazardous materials shall include a remediation and abatement plan in the Demolition Plan. This Plan should be prepared in coordination with EH&S Environmental Affairs.

4. HYDROLOGY STUDIES AND STORM WATER BEST MANAGEMENT PRACTICES (BMP's)

Storm water hydrology and water quality requirements shall be implemented on UCSD project sites in order to comply with the California Environmental Quality Act (CEQA), State Water Resources Board (SWRB), LEEDS, and Coastal Commission requirements.

Designing to Mitigate Storm Water Impacts

All university projects (excluding interior renovations), need to consider the effect of the project area on storm water quality and run-off rates. **All projects, regardless of size, are to implement storm water quantity and quality best management practices, including Low Impact Design (LID).** Examples of LID can be found at http://www.lid-stormwater.net/general/general_urban.htm or http://www.sdcounty.ca.gov/dplu/LID_PR.html

The LID approach: encourages conservation measures; promotes impact minimization techniques such as impervious surface reduction; provides for strategic runoff timing by slowing flow using the landscape; uses an array of integrated management practices to reduce and cleanse runoff; advocates pollution prevention measures to reduce the introduction of pollutants to the environment.

The Design Guidelines, posted on the UCSD Facilities Design and Construction (FD&C) web site (http://www.fdc.ucsd.edu/documentation/DesignGuidelinesVersion1-06.htm), provide detailed design requirements to mitigate storm water impacts. Design measures shall be consistent with UCSD's storm water management plan, shall be operational within a reasonable time from project occupancy, and shall be maintained by UCSD.

- Outdoor areas for storage of materials typically contribute pollutants to the storm water conveyance system and shall be covered and protected by secondary containment.
- Roofs or awnings shall be provided over all trash containers and loading docks to minimize direct precipitation and contamination of storm water. These areas shall not have any run-on of storm water.
- Pollutants of concern shall be minimized through the incorporation of design measures best suited to maximize the reduction of pollutant loadings in that runoff (see attached Table 4.7.1 from the UCSD Long Range Development Plan (LRDP) EIR). At least one treatment control is required for new parking areas or parking structures, or other new uses identified by FD&C, Environmental Planning or Environmental Health and Safety (EH&S) to have potential to generate substantial pollutants. Treatment controls include detention basins, infiltration basins, wet ponds or wetlands, drainage inserts, filtration, and hydrodynamic separator systems. Treatment controls shall incorporate volumetric or flow based treatment control design standards to mitigate (infiltrate, filter, or treat) storm water runoff, as appropriate.
- When reclaimed water is used for landscape irrigation the design must assure that only incidental runoff of the reclaimed water be allowed to enter the storm drain system per the reclaimed water permit. Please contact Jon Schmidt, UCSD EH&S for assistance.
- All projects shall be designed to eliminate non-storm water (dry weather flows) from entering the storm water conveyance system. Discharges from flushing and testing building fire sprinkler systems shall be placed into landscaping.

Hydrology Study

A hydrology/drainage study is necessary for any one of these conditions:

a) the development or redevelopment project that would result in an increase or decrease of impervious surface;
b) the project will install or modify an existing storm drain system;
c) the project is in the Coastal Zone and will be reviewed by the Coastal Commission as determined by the University;
d) the project site area is one acre or greater and a SWPPP is required;
e) to support the project level CEQA analysis; or
f) the building will be attaining LEEDS equivalency.

Hydrology study requirements: The hydrology study shall be performed by a registered civil engineering consultant. The study shall be based on a review of existing maps and records and the UCSD 2004 Long Range Development Plan (LRDP) EIR, as well as site-specific hydrologic factors. The campus-wide hydrology and drainage study prepared to support the LRDP EIR is an excellent source of baseline information available for use as a starting point for project level studies.

The hydrology study shall include:

1) The amount, in square feet, of increase or decrease of impervious surface from existing to proposed conditions. This will be used to determine site design requirements as detailed in the UCSD LRDP EIR, Section 4.7, (http://physicalplanning.ucsd.edu/LRDP2004/EIR) and in the University's Storm Water Management Program (SWMP). *All University projects increasing impervious surfaces by 10,000 sf or more are required to maintain the peak runoff at the pre-project rate for the 10-year, 6-hour storm event.*

2) Surface water drainage patterns and quantities, including run-on and runoff rates in cfs, for existing and proposed conditions, using the latest version of the City of San Diego Drainage Manual and the County of San Diego Hydrology Manual. Runoff rates shall be calculated for the 10-year and 100-year 6-hour storm event. These calculations shall be done for every drainage basin within, or impacted by, the project. The results shall be clearly reported in tabular form. Supporting data, calculations and figures shall be included.

3) Storm drainage system requirements, including the capacity of detention structures to mitigate run-off increases and appropriate options for mitigating storm water rate and quality impacts.

4) Areas of concern that should be addressed in the project design, such as erosion hazard areas, areas of potential flooding.

5) For project seeking LEEDS points for hydrology, the project design must reduce the pre-project 100 year, 6 hour storm event by 25%, and this would be documented in the study.

Timing of the work: The hydrology report should be submitted to the University no later than at the schematic design phase of the project. This information shall be incorporated into the design of the project at the earliest stages and will form the basis of the project specific CEQA analysis of the issue, with the overall goal being to minimize the project impact on storm water runoff quantity and quality through integrating building, site and landscaping design. The project civil engineer shall revise and refine the hydrologic and hydraulic calculations as necessary as the project design progresses.

Potential Pollutant Activity or Sources List [LINK]

5. LEED [Guidelines in process]

6. ENVIRONMENT, HEALTH AND SAFETY

a. The UCSD Department of Environment, Health and Safety (EH&S) http://blink.ucsd.edu/Blink/External/Topics/Policy/0,1162,15498,00.html advises on industrial hygiene and laboratory safety (HVAC systems, fume hoods, design specifications for bio-hazardous and infectious-agent containment, air emissions, design and locations of safety devices, etc.), sanitation, radiation safety, hazardous waste (asbestos, PCBs, sink traps, lead and lead paint, soil contamination, etc.) fire code compliance and environmental site assessment.

EH&S reviews environmental and occupational regulatory requirements and University policies and requirements that may affect a project. The involvement of EH&S in the pre-design through construction of a project offers the following benefits:

1) Provides EH&S insight into programmatic development and conceptual planning stages of a proposed project.

2) Avoidance of unnecessary project planning and construction delays due to overlooked EH&S issues and resulting cost overruns.

3) Reduction in building occupants' health and safety complaints and Workers' Compensation cases as well as avoidance of significant public health and safety

Table 4.7-4. UCSD 2004 LRDP Hydrology Study Results

Drainage Basin Number	Area (Ac)	Q_{10} (cfs) Existing	Q_{10} (cfs) Proposed	Q_{10} (cfs) dQ	Q_{100} (cfs) Existing	Q_{100} (cfs) Proposed	Q_{100} (cfs) dQ
Miramar Reservoir Hydrologic Area (6.1) – Drains to Los Peñasquitos Lagoon							
1000	16.3	11	11	0	15	15	0
1100, 1300	233.7	238	242	4	338	343	5
1900	6.6	16	16	0	21	21	0
2300	29.5	27	27	0	38	38	0
2600	4.9	4	4	0	5	5	0
2700	4.1	5	8	3	6	10	4
2800	8.1	11	11	0	16	16	0
Subtotal	*303.2*	*312*	*319*	*7*	*439*	*448*	*9*
Scripps Hydrologic Area (6.3) – Drains directly to Pacific Ocean							
700	71.1	138	141	4	191	196	5
1200	25.9	41	51	10	58	71	14
1500, 1600, 2000	117.8	123	132	9	174	186	12
1700	5.6	9	9	0	12	12	0
1800	27.7	27	39	12	38	56	18
2100	112.1	127	137	10	177	191	14
2200	19.7	23	33	10	33	44	12
2400	8.2	14	14	0	18	18	0
3000	5.4	14	14	0	19	19	0
Subtotal	*393.5*	*516*	*570*	*55*	*720*	*793*	*75*
Miramar Hydrologic Area (6.4) – Drains to Mission Bay							
100	25.3	48	59	11	67	79	13
200	17.7	36	36	0	49	49	0
300	46.9	43	43	0	61	61	0
400, 500*, 600	263.4	277	329	52*	387	460	73*
800	65.5	105	105	0	151	151	0
900	61.6	127	132	6	172	180	8
1400	3.9	7	7	0	9	9	0
2500	12.5	15	15	0	20	20	0
2900	9.2	13	13	0	19	19	0
Subtotal	*506*	*671*	*739*	*17*	*935*	*1028*	*94*
Total	***1,203***	***1,499***	***1,628***	***79***	***2,094***	***2,269***	***178***

See Figure 4.7-2 for corresponding drainage basins. The University House, beach properties, and La Jolla del Sol were not included in the analysis because no substantial increases to impervious areas are anticipated for these areas.
*The Science Research Park was graded at the time of study but not yet developed.
Q_{10} (cfs) – 10 year storm peak flow in cubic feet per second
Q_{100} (cfs) – 100 year storm peak flow in cubic feet per second
dQ – Change in peak flow between existing and 2004 LRDP developed conditions

Increased peak runoff associated with implementation of the 2004 LRDP may have detrimental effects on and off campus. Potential impacts associated with increased runoff include:

- Exceeding capacity of on-site storm water conveyance systems;
- Exceeding capacity of off-site storm water conveyance systems;
- Exceeding capacity of storm drain inlets and catch basins;
- Causing new erosion and worsening existing erosion problems on site; and
- Causing new erosion and worsening existing erosion problems off site, particularly coastal bluff areas.

Drainage basins 100, 400/500/600 and 900 drain southerly toward Mission Bay (Figure 4.7-2). Basin 100 is mostly developed and therefore it is less likely that increased runoff in this basin would result in on-campus erosion problems. More likely impacts would be exceedences of storm drain infrastructure capacity. Basins 400/500/600 and 900 both contain sloped open space areas that could be subject to erosion and these basins could also be impacted by exceedences of storm drain infrastructure capacity. In addition, runoff increases in the basins could also cause or contribute to impacts off campus such as erosion and capacity exceedences in the community to the south of campus and in Rose Canyon.

Drainage basin 1100/1300 drains northerly toward Los Peñasquitos Lagoon (Figure 4.7-2). This basin contains a large portion of the UCSD Park that is sloped open space. UCSD staff noted that erosion problems may exist in this portion of the Park, however, confirmation of these problems was not part of this analysis. If the problems do exist, increased runoff in this basin could contribute to the problems as well as potentially causing additional erosion problems. Storm drain infrastructure capacity problems could also occur within these drainages due to increase runoff. Off-campus, erosion and capacity exceedences could also occur in Soledad Canyon and Los Peñasquitos Creek.

Drainage basins 700, 1200, 1800, 1500/1600/2000, 2100, and 2200 drain westerly toward the Pacific Ocean (Figure 4.7-2). The drainage basins on the west campus are mostly developed and therefore it is less likely that increased runoff in these basins would result in on-campus erosion problems. However, Basin 1800, which includes the unpaved Gliderport, and Basins 1500/1600/2000 and 2200, which contain a large portion of UCSD Park in SIO, both encompass areas of open space that could be subject to erosion. All of the drainage basins have potential for negative impacts due to increased runoff to storm water conveyance systems from a capacity standpoint both on and off campus; however, because these basins drain to the Pacific Ocean their conveyance systems are generally short. Off-campus erosion problems could occur from runoff increases in these basins in the short coastal ravines that convey drainage to the beaches through the coastal bluffs and at the beach itself.

Substantial increased runoff volumes from individual project sites have the potential to overload the campus storm drain system and increase flows and velocity which could result in flooding at inlets, increased erosion, and impacts to downstream channel and habitat integrity. Therefore, projects involving a substantial increase in impervious surfaces would have potential significant impacts.

Mitigation Measures

Implementation of the following mitigation measures would reduce potentially significant impacts associated with drainage and hydrology alteration and the resulting potential for flooding, exceedence of drainage system capacity, and erosion, to below a level of significance. In order to mitigate for this increased runoff, future development on campus shall be required to maintain or reduce the peak runoff for the 10-year, 6-hour storm event under existing conditions in the post development condition as described below under the following mitigation measures (see Hyd-1A). Maintaining 10-year, 6-hour storm event peak runoff is the standard measure employed by public and regulatory agencies to mitigate for hydrologic impacts because larger storms occur less frequently, and the costs to mitigate for these larger storm events typically outweigh the benefits.

Hyd-1A For each development or redevelopment project that would result in an increase of 10,000 square feet or more of impervious surface, the engineer of record shall perform a drainage study commissioned by the Auxiliary and Plant Services (APS) or Facilities Design and Construction (FD&C) departments that would comply with the conditions that follow. Design measures and other recommendations used to comply with these conditions shall be incorporated into project development plans and construction documents. Design measures shall be consistent with UCSD's storm water management program, shall be operational within a reasonable time from project occupancy, and shall be maintained by UCSD.

i. Site design that controls runoff discharge volumes and durations shall be utilized where applicable and feasible.

ii. Measures that protect slopes and channels such as energy dissipaters, vegetation, and slope/channel stabilizers shall be applied where appropriate.

iii. All developments that will increase impervious surfaces by 10,000 square feet or more shall maintain the peak runoff for the 10-year, 6-hour storm event. In cases where known or potential on- or off-site erosion problems have been identified, the engineer of record in coordination with UCSD shall determine if maintenance of peak runoff for a larger storm event is necessary.

This standard shall be applied at the location where storm runoff from the drainage basin in which the project is located flows across UCSD property limits, either as overland flow or contained within a storm water conveyance system. In order to achieve this standard, detention may occur at one of the following locations:

a. The project site. Single-project detention or retention basins may be incorporated into project design with features including but not limited to: small on-site detention or retention basins; rooftop ponding; temporary flooding of parking areas, streets and gutters; landscaping or gravel beds designed to temporarily retain water; and gravel beds designed to collect and retain runoff;

b. The downstream campus boundary within the drainage basin encompassing the project site; or

c. An alternative location within the drainage basin encompassing the project site, detention at which results in no net increase of runoff at the downstream property limit. This alternative will be useful in cases where detention at the project site or at the downstream property limit is precluded due to site constraints.

Detention projects that fall under items b and c may be implemented as part of a campus-wide storm water detention study described under Hyd-1B. In campus drainage basins identified to have existing or potential erosion or capacity problems, detention downstream of the project site or at an alternative location may not be an acceptable alternative. In these cases, every attempt shall be made to detain increased runoff at the project site. If detention must occur at a downstream or alternative location, additional improvements may be required downstream of the site to mitigate the erosion or capacity problem.

Hyd-1B UCSD shall conduct a campus wide storm water detention study. The purpose of the study would be to provide an alternative or supplement to requiring a separate detention study for each project. At a minimum, the study shall include the following tasks:

a. Determine detention volumes in those basins where development is anticipated;

b. Determine optimum detention facility locations based on environmental impacts, runoff storage potential, utility conflicts, planned site improvements, and miscellaneous site constraints;

c. Determine detention facility configurations based on the site survey, confirming constructability;

d. Determine which, if any, major drainage basins have known on-site or off-site erosion or drainage facility capacity problems that may justify the need for detention in excess of the 10-year, 6-hour storm event; and

e. Provide preliminary cost estimates for basins.

Once the study is completed, the recommended detention facilities shall be considered by UCSD for implementation. Detention facilities identified shall be implemented when appropriate and feasible, either as a separate project or in conjunction with a development or redevelopment project, and would be addressed by a subsequent CEQA review process.

4.7.3.2 ISSUE 2 – WATER QUALITY

Hydrology and Water Quality Issue 2 Summary

Would implementation of the 2004 LRDP violate any water quality standards or waste discharge requirements, or otherwise substantially degrade water quality?

Impact: Implementation of the 2004 LRDP would have the potential to generate pollutants during construction and post construction activities that could impact downstream water quality if not properly controlled.

Mitigation: Preparation and implementation of an erosion control plan for construction sites less than one acre (Hyd-2A); and implementation of site design and treatment control design measures to reduce pollutants of concern in runoff (Hyd-2B).

Significance Before Mitigation: Potentially significant

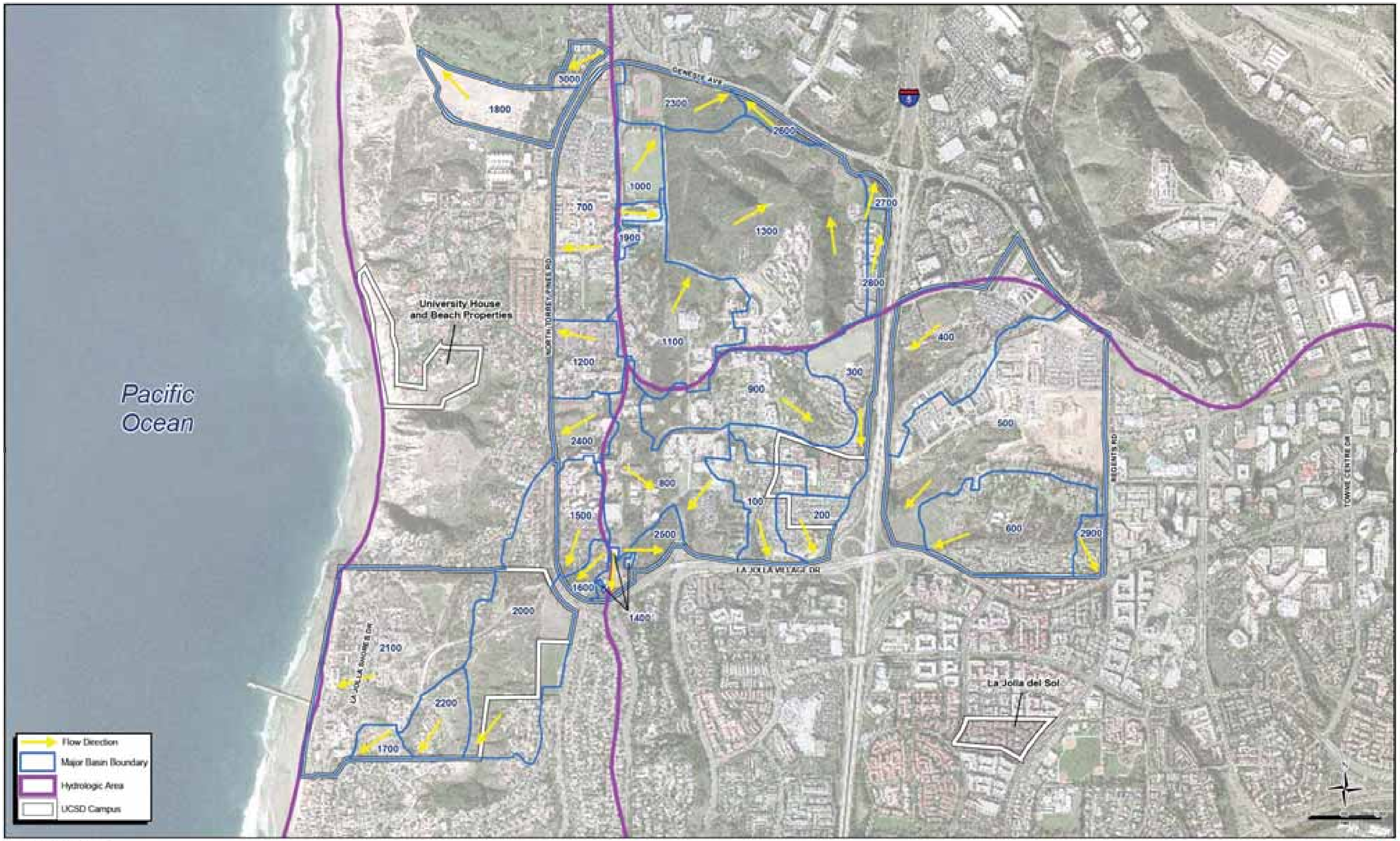
Significance After Mitigation: Less than significant

Standards of Significance

Based on Appendix G of the CEQA Guidelines, implementation of the 2004 LRDP may have a significant adverse impact if it would violate any water quality standards or waste discharge requirements, or otherwise substantially degrade water quality. Waste discharge requirements are requirements that are developed as part of permits issued by the SWRCB or RWQCB.

Impact Analysis

Applicable water quality standards developed by the SWRCB or RWQCB for storm water are set forth in applicable storm water permits (which also serve as waste discharge requirements). Storm water permits that are applicable to UCSD and the 2004 LRDP include the General Construction Storm Water Permit, the General Industrial Storm Water Permit, the General Small MS4s Storm Water Permit; and an individual



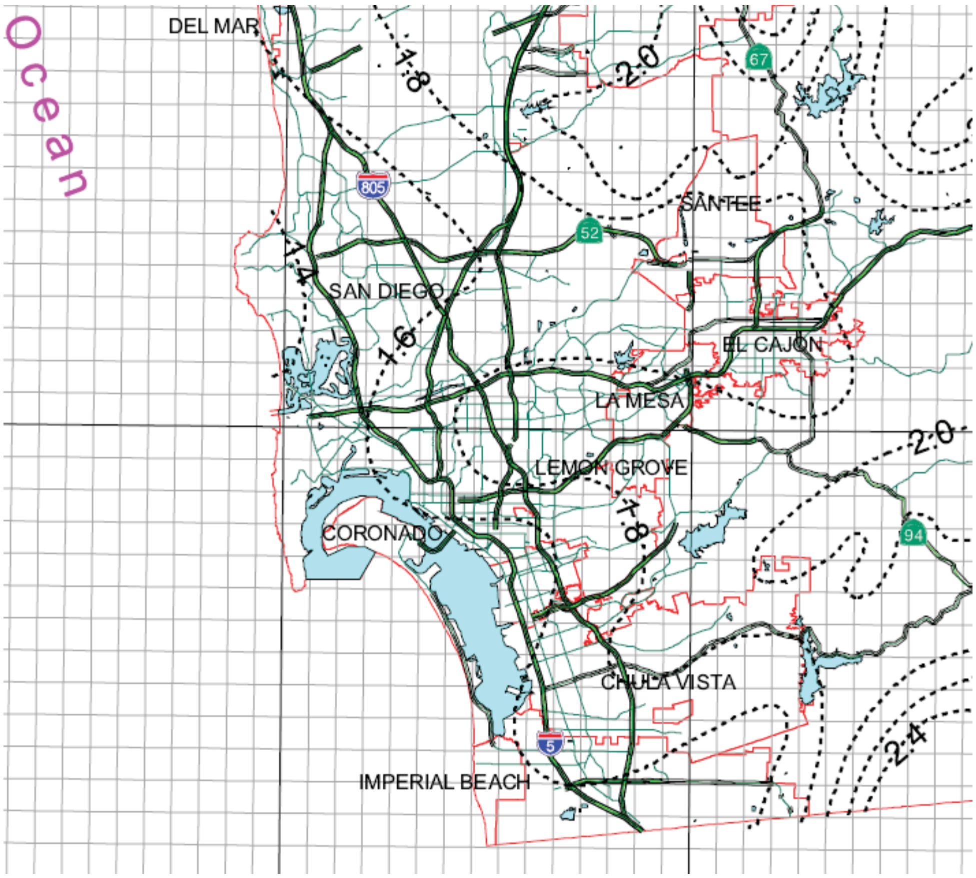
Source: Landiscor, January 2003

PBSJ

Drainage basins where not delineated for the La Jolla del Sol, University House, and beach properties because development under the 2004 LRDP is not anticipated to result in substantial new impervious surfaces on these properties.

MAJOR UCSD DRAINAGE BASINS

FIGURE 4.7-2

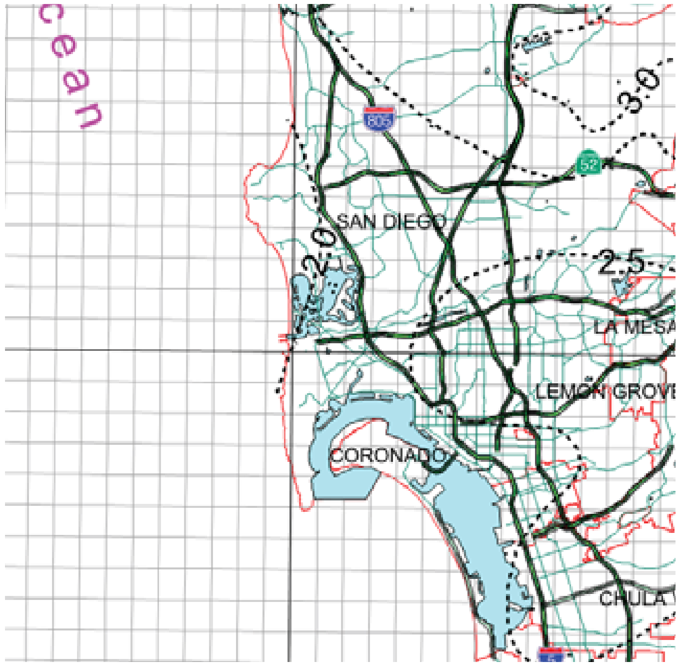


County of San Diego Hydrology Manual

Rainfall Isopluvials

10 Year Rainfall Event - 6 Hours

--------	Isopluvial (inches)

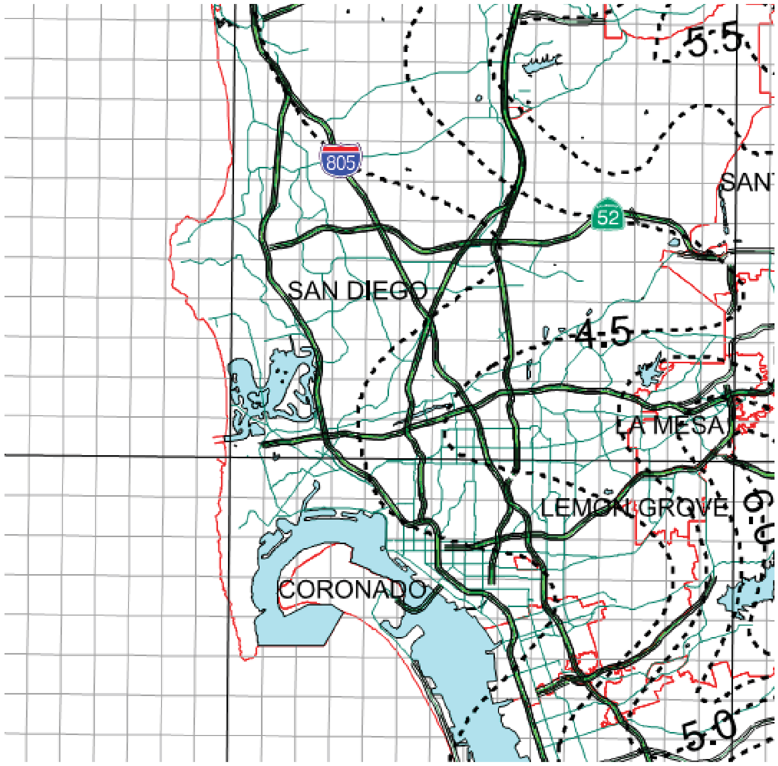


County of San Diego Hydrology Manual

Rainfall Isopluviais

100 Year Rainfall Event - 6 Hours

········ Isopluvial (inches)



County of San Diego Hydrology Manual

Rainfall Isopluviais

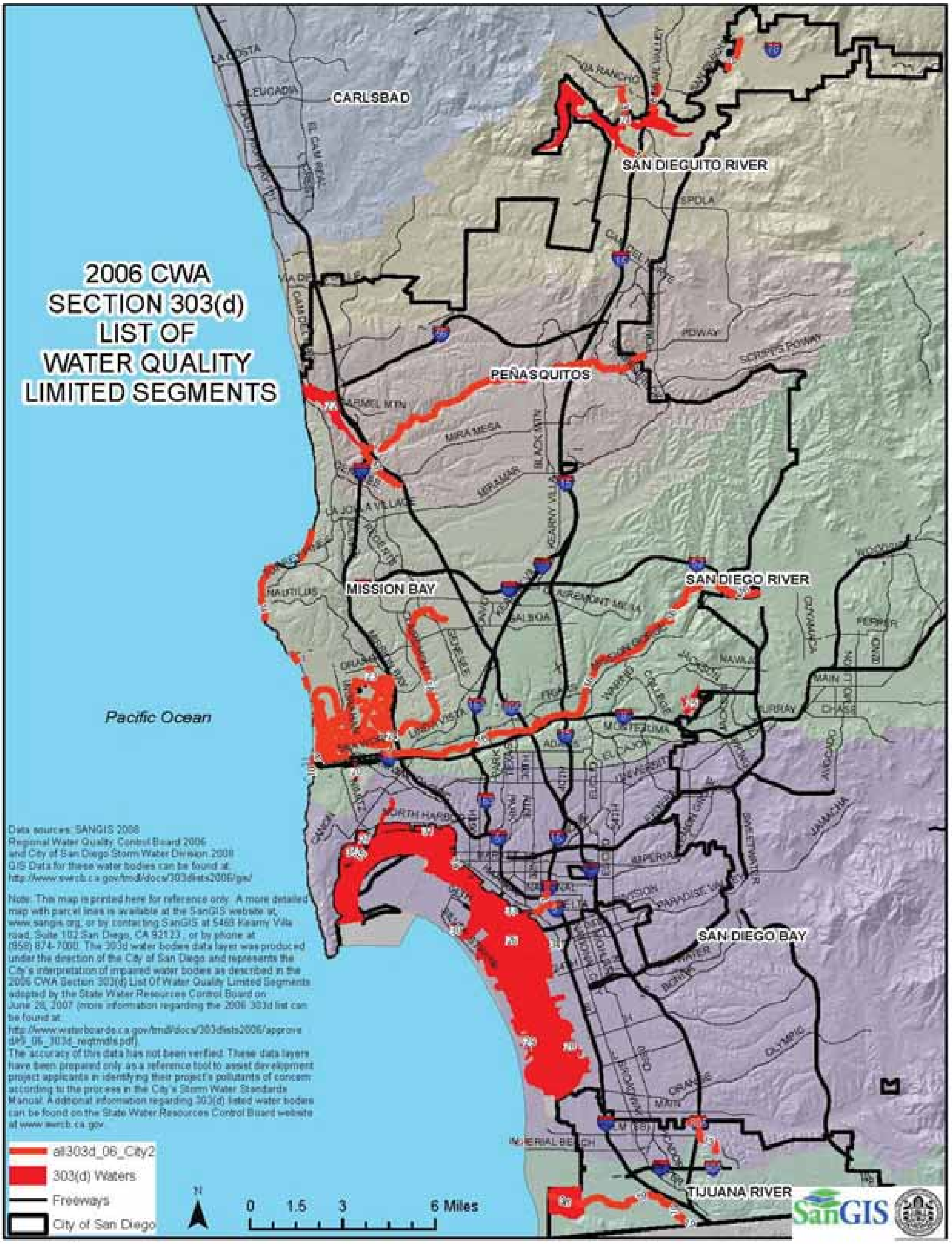
100 Year Rainfall Event - 24 Hours

-------- Isopluvial (inches)

APPENDIX E:

303(d) Impaired Waters Information

Note: ID numbers denoting "2006 CWA Section 303(d) List of Water Quality Segments" are illustrated on the following map. These ID numbers may be cross-referenced with the tables following the map.



				• Selenium ○ Source Unknown	12 Miles	2010	5A	2019
				• Total Dissolved Solids ○ Source Unknown	12 Miles	2006	5A	2019
				• Total Nitrogen as N ○ Source Unknown	12 Miles	2010	5A	2019
				• Toxicity ○ Unknown Nonpoint Source ○ Unknown Point Source ○ Urban Runoff/Storm Sewers	12 Miles	2010	5A	2021
9	Los Penasquitos Lagoon	Estuary	90610000 / 18070304	• Sedimentation/Siltation ○ Nonpoint Source ○ Point Source	469 Acres	1992	5A	2019
9	Loveland Reservoir	Lake & Reservoir	90931000 / 18070304	• Aluminum ○ Source Unknown	420 Acres	2006	5A	2019
				• Manganese ○ Source Unknown	420 Acres	2006	5A	2019
				• Oxygen, Dissolved ○ Source Unknown	420 Acres	2006	5A	2019
				• pH ○ Source Unknown	420 Acres	2006	5A	2019
				This listing was made by USEPA for 2006.				
9	Miramar Reservoir	Lake & Reservoir	90610000 / 18070304	• Total Nitrogen as N ○ Source Unknown	138 Acres	2010	5A	2019
9	Mission Bay (area at mouth of Rose Creek only)	Bay & Harbor	90640000 / 18070304	• Eutrophic ○ Highway/Road/Bridge Runoff ○ Landfills ○ Nonpoint Source ○ Nurseries ○ Point Source ○ Urban Runoff/Storm Sewers	9.2 Acres	1996	5A	2019
				• Lead ○ Highway/Road/Bridge Runoff	9.2 Acres	1996	5A	2019

9	Santa Ysabel Creek (above Sutherland Reservoir)	River & Stream	90553000 / 18070304	• Toxicity ○ Unknown Nonpoint Source	12 Miles	2010	5A	2021
9	Segunda Deshecha Creek	River & Stream	90130000 / 18070301	• Phosphorus ○ Unknown Nonpoint Source ○ Unknown Point Source ○ Urban Runoff/Storm Sewers	0.92 Miles	2002	5A	2019
				• Toxicity ○ Unknown Nonpoint Source ○ Unknown Point Source ○ Urban Runoff/Storm Sewers	0.92 Miles	2010	5A	2021
				• Turbidity ○ Channelization ○ Construction/Land Development ○ Flow Regulation/Modification ○ Unknown Nonpoint Source ○ Unknown Point Source ○ Urban Runoff/Storm Sewers	0.92 Miles	2002	5A	2019
9	Soledad Canyon	River & Stream	90610000 / 18070304	• Sediment Toxicity ○ Unknown Nonpoint Source ○ Unknown Point Source	1.7 Miles	2002	5A	2019
				• Selenium ○ Source Unknown ○ Unknown Nonpoint Source ○ Urban Runoff/Storm Sewers	1.7 Miles	2010	5A	2021
9	Sutherland Reservoir	Lake & Reservoir	90553000 / 18070304	• Color ○ Unknown Nonpoint Source ○ Unknown Point Source ○ Urban Runoff/Storm Sewers	561 Acres	2002	5A	2019
				• Iron ○ Source Unknown	561 Acres	2010	5A	2021
				• Manganese ○ Source Unknown	561 Acres	2006	5A	2019
				• Total Nitrogen as N ○ Natural Sources	561 Acres	2010	5A	2021

				○ Source Unknown ○ Unknown Nonpoint Source ○ Urban Runoff/Storm Sewers				
9	Pacific Ocean Shoreline, Lower San Juan HSA, at North Doheny State Park Campground	Coastal & Bay Shoreline	90130000 / 18070301	• Enterococcus ○ Natural Sources ○ Source Unknown ○ Unknown Nonpoint Source ○ Urban Runoff/Storm Sewers	0.03 Miles	2010	5A	2021
				• Total Coliform ○ Unknown Nonpoint Source ○ Unknown Point Source ○ Urban Runoff/Storm Sewers	0.03 Miles	2010	5A	2021
9	Pacific Ocean Shoreline, Lower San Juan HSA, at San Juan Creek	Coastal & Bay Shoreline	90120000 / 18070301	• Enterococcus ○ Natural Sources ○ Source Unknown ○ Unknown Nonpoint Source ○ Urban Runoff/Storm Sewers	0.03 Miles	1998	5A	2021
				• Fecal Coliform ○ Natural Sources ○ Source Unknown ○ Unknown Nonpoint Source ○ Urban Runoff/Storm Sewers	0.03 Miles	1998	5A	2021
				• Total Coliform ○ Natural Sources ○ Source Unknown ○ Unknown Nonpoint Source ○ Urban Runoff/Storm Sewers	0.03 Miles	1998	5A	2021
9	Pacific Ocean Shoreline, Lower San Juan HSA, at South Doheny State Park Campground	Coastal & Bay Shoreline	90130000 / 18070301	• Enterococcus ○ Natural Sources ○ Source Unknown ○ Unknown Nonpoint Source ○ Urban Runoff/Storm Sewers	0.03 Miles	2010	5A	2021
9	Pacific Ocean Shoreline, Miramar Reservoir HA, at Los Penasquitos River mouth	Coastal & Bay Shoreline	90610000 / 18070304	• Total Coliform ○ Unknown Nonpoint Source ○ Unknown Point Source ○ Urban Runoff/Storm Sewers	0.39 Miles	2010	5A	2019

APPENDIX F:

BMP Design Calculations

Post-Construction Stormwater Management Checklist* (5,000 SF or Greater)

Applicability: Required for projects that create and/or replace 5,000 square feet or greater of impervious surface (i.e. asphalt roads, concrete structures, building area, sidewalks, etc.). Impervious surfaces are those that water cannot infiltrate/soak into.

**This form must be filled out during the planning stages of the project to ensure that all required Best Management Practices are implemented in accordance with UC San Diego's Phase II Small MS4 General Permit 2013-0001-DWQ. All BMPs that will be implemented for projects will be reported to the State Water Quality Control Board on an annual basis by UC San Diego.*

Exemptions: The following projects are exempt from the Phase II Small MS4 permit storm water site design measures and low impact design requirements:

1. Projects completed before July 1, 2014.
2. Regulated projects that have been designed, approved, and funded prior to July 1, 2014.
3. Interior remodels.
4. Routine maintenance or repair projects such as:
    a. Maintenance, repair, and replacement work on existing underground utilities such as sanitary sewer lines or other utilities.
    b. Exterior wall surface replacement.
    c. Roof replacement.
    d. Pavement or asphalt resurfacing within the existing footprint.
    e. Sidewalk replacement within an existing footprint to replace concrete that is causing a trip hazard.
    f. routine replacement/repair of damaged pavement/asphalt such as pothole repair.
5. Bicycle lanes or pedestrian ramps on existing roads or sidewalks within existing footprint (e.g., no new impervious area).
6. Sidewalks built as a part of new streets or roads and built to direct storm water runoff to adjacent vegetated areas.
7. Bicycle lanes that are built as part of new streets or roads that direct storm water runoff to adjacent vegetated areas.
8. Impervious trails build to direct storm water runoff to adjacent vegetated areas, or other non-erodible permeable areas.
9. Sidewalks, bicycle lanes or trails constructed with permeable surfaces.

*****If your project meets the exemption requirements, do NOT fill out this form.**

Project Name:			**Project #:**	
Street Address:		**Cross Streets:**		
Project Watershed (circle): See Attached Map if unsure which watershed your project lies within.	Scripps	Miramar Reservoir	Miramar	Other:________________
Project Type: (Circle)	New Development / Retrofit	Re-Development	Road / Utility	Landscaping / Other: ______________________

Post-Construction Stormwater Management Checklist* (5,000 SF or Greater)

Description of Project:

Post-construction stormwater mangement is required because the site creates or replaces more than 5,000 sf of impervious area. The project area is analyzed as single basin as described below for Post-Construction Stormwater Management purpose.

•Voigt Parking Structure: The project is comprised of construction of a parking structure, improvements along Voigt Drive & Engineer Lane, and paths from Warren Mall to Hopkins Lane. Associated improvement work also includes proposed paths between Warren Mall and the Price Center. Proposed improvements include a 1.75 acre Parking Structure, adjacent and rooftop pedestrian paths, improvements along Engineer Lane, and pedestrian and bicycle paths extending from Warren Mall to Hopkins Lane. Approximately 70% of the Parking Structure's will be covered by a green roof. The runoff originating from the roof area is directed to planter areas located on the fourth floor and at the ground level within the light well area. Seven planters including two within the light well areas are utilized for flow control purpose. Site meets the water balance requirement therefore, treatment control BMPs are not required.

Areas (in square feet)

Total: 293,158 Disturbed: 266,151 New Impervious: 39,204 Replaced Impervious: 78,408

Will more than 50% of Impervious Surface be Replaced?* ☒ Yes ☐ No

*If Yes then runoff from the entire project consisting of all existing, new, and/or replaced impervious surface must be included in the storm water treatment and design calculations

For projects that are Redevelopment or Road Widening Projects

Total pre-project impervious surface area: 78,408 SF Total post-project impervious area: 117,612 SF

Status of Project

Application Date:_________ Application Deemed Complete Date:_____________ Project approval Date:__________

Post-Construction Stormwater Management Checklist* (5,000 SF or Greater)

PART A - SITE DESIGN MEASURES: Which site design measures have been implemented to reduce project site runoff? Applicant must select one or more of the following options below (check all that apply). In addition, the State Water Board's SMARTS Post-Construction Calculator (or equivalent) must be used to quantify the runoff reduction resulting from implementation of any site design measures specified below and attach the calculations to this checklist. If post-construction water balance cannot be achieved with site design measures only, then additional storm water treatment BMPs must be designed for the project as described in PART B below. An electronic copy of the Post-Construction Calculator is available on the UC San Diego Storm Water Management Program website: **http://stormwater.ucsd.edu** or request an electronic copy from EH&S Environmental Affairs at: **ehsea@ucsd.edu**

☐	**Stream Setbacks and Buffers** (A vegetated area including trees, shrubs, and herbaceous vegetation, that exists or is established to protect a stream system, lake reservoir, or coastal estuarine area)
☒	**Soil Quality Improvement and Maintenance** (improvements and maintenance through soil amendments and creation of microbial community)
☒	**Tree Planting and Preservation** (planting and preservation of healthy established trees that include both evergreens and deciduous, as applicable)
☒	**Rooftop and Impervious Area Disconnection** (Rerouting of rooftop drainage pipes to drain rainwater to rain barrels, cisterns, or permeable areas instead of to the storm water system)
☐	**Porous Pavement** (Pavement that allows runoff to pass through it, thereby reducing the runoff from a site and surrounding areas and filtering pollutants)
☒	**Green Roofs** (a vegetative layer grown on a roof (rooftop garden))
☐	**Vegetated Swales** (A vegetated, open-channel management practice designed specifically to treat and attenuate storm water runoff)
☐	**Rain Barrels and Cisterns** (system that collects and stores storm water runoff from a roof or other impervious surface)

Description of Site Design Measures Implemented for Project:
-The new landscaped areas will include amended soils which will support microbial community.
-Tree planting and preservation are implemented throughout the site to the maximum extent feasible.
-Rooftop and impervious areas are disconnected by directing the flow into landscaped areas.
-A Green Roof is provided for the Voigt Parking Structure

Volume of runoff that will be treated:

Size of area that will drain to BMP:

Pollutants that will be captured by BMP: (check all that apply) ☒ Trash/Litter ☒ Sediment ☒ Dry weather flows (e.g. irrigation runoff) ☐ Other

Post-Construction Stormwater Management Checklist* (5,000 SF or Greater)

PART B - SOURCE CONTROL MEASURES: All projects that are creating and/or replacing 5000 sf of impervious area or greater and that have pollutant generating sources are required to implement sources control BMPs as applicable. Check all pollutant generating activities that apply to your project below. The source controls below are from UC San Diego's Storm Water Management Program and are posted at http://stormwater.ucsd.edu. Alternatively, source control measures may be designed consistent with the CASQA Stormwater BMP Handbook for New Development and Redevelopment (https://www.casqa.org/resources/bmp-handbooks/new-development-redevelopment-bmp-handbook).

- ☐ **Housekeeping for outdoor material storage and outdoor work areas**
- ☒ **Spill control and cleanup for outdoor spills or leaks**
- ☐ **Marine activities**
- ☐ **Loading dock management**
- ☐ **Outdoor washing/ cleaning**
- ☐ **Fueling operations**
- ☒ **Maintenance on equipment containing water (e.g., eyewash showers, boiler drain lines, condensate drain lines, rooftop equipment, and drainage sumps**
- ☐ **Equipment, vehicle, and boat maintenance**
- ☒ **Trash management**
- ☐ **Hazardous materials management**
- ☐ **Hazardous waste management**
- ☒ **Potable water system flushing**
- ☒ **Fire sprinkler and hydrant testing/flushing**
- ☒ **Landscape management: irrigation runoff, erosion, green waste**
- ☐ **Food service management**
- ☐ **Sanitary sewer overflows/ line blockages**
- ☐ **Onsite transportation of materials/waste**
- ☐ **Surface cleaning/ pressure washing**
- ☒ **Outdoor painting and sandblasting**
- ☒ **Storm water conveyance system management to prevent improper discharge into storm drains**
- ☒ **Non-storm water discharges**
- ☒ **Integrated pest management**
- ☐ **Building repairs and remodeling**
- ☒ **Parking lot and storage area management**
- ☐ **Pools, decorative fountains, and other water features**

Describe the source control BMPs that will be implemented for the project for all pollutant generating activities checked above:

Post-Construction Stormwater Management Checklist* (5,000 SF or Greater)

PART C - STORM WATER TREATMENT/BASELINE HYDROMODIFICATION MEASURES: Only required if site design measures listed above cannot fully meet Permit requirements (i.e.. Calculations on SMARTS calculator show that post-construction water balance is not achieved). All stormwater treatment BMPs shall be designed based on the flow-based or volume-based criteria specified in Section F.5.g.2.b (Numeric Sizing Criteria) of the Permit. Treatment BMPs must be designed for each Drainage Management Area (DMA). Bioretention facilities are preferred for treatment but alternative treatment BMPs can be used if the proper documentation and supporting calculations are provided and attached to this checklist. If Alternative BMPs are selected then all sizing and calculations should be prepared by a Registered Civil Engineer.

STEP 1: Calculating What is Required for Treatment BMPs:

If you have a concept plan or design drawings for the proposed project which clearly define impervious and pervious areas you will be able to calculate the amount of area, volume, or flow that is required to be treated by stormwater treatment/hydromodification measures. If your project has more than one discharge point then you will need to divide your project into individual drainage management areas (DMA's) and calculate the required treatment for each DMA. If Bioretention is specified as the treatment control BMP of choice then skip to the Step 2 below for sizing BMPs. If alternative BMPs (BMPs other than bioretention) are utilized then depending on the type of BMP that will be designated for each DMA either volume-based or flow-based calculations should be performed to determine the required treatment volumes or rates. These calculations should be performed by a Registered Civil Engineer. The following sizing criteria should be used when determining volumes and rates for BMPs:

Volume-Based BMP Sizing Criteria:
a) The maximized stormwater capture volume for the tributary are based on historical rainfall records and determined in accordance with Urban Runoff Quality Management, WEF Manual of Practice No. 23/ASCE Manual of Practice No. 87 (1998), pages 175-178 (the 85th percentile, 24-hour storm event) **OR:** b.) The volume of annual runoff required to achieve 80 percent or more capture, determined in accordance with CASQA's Stormwater BMP Handbook for New and Redevelopment (2003) using local rainfall.

Flow-Based BMP Sizing Criteria:
a) The flow of runoff produced from a rain event equal to at least 0.2 inches per hour intensity **OR**: b) The flow of runoff produced from a rain event equivalent to at least 2 time the 85th percentile hourly rainfall intensity as determined from local rainfall records.

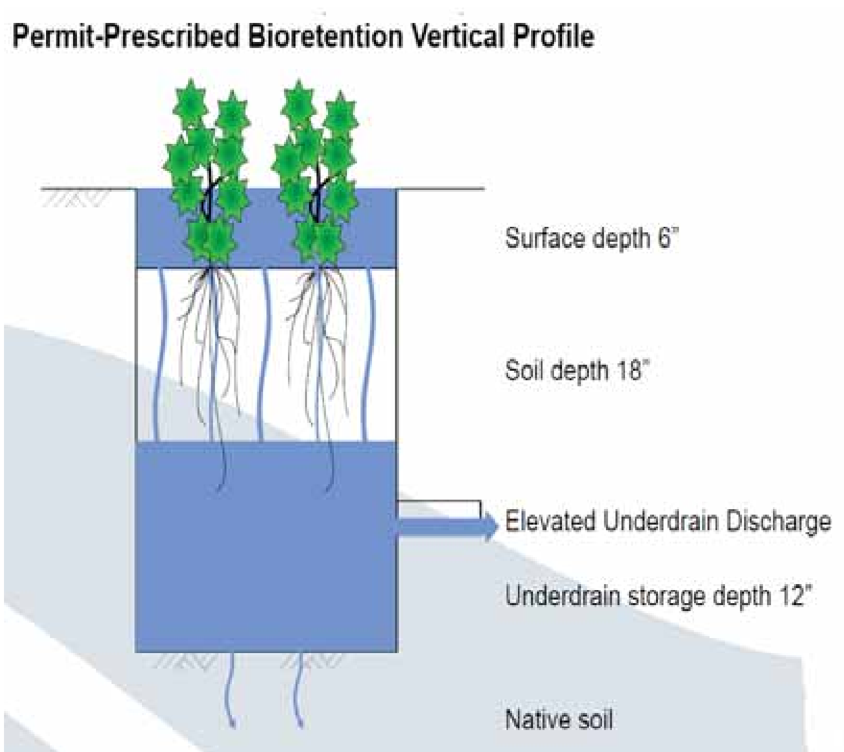
Treatment Rate or Volume Required for Project:
(If multiple DMA's please attach additional calculations to this checklist) ____________ ft^3 or ft./s

Post-Construction Stormwater Management Checklist* (5,000 SF or Greater)

STEP 2: Selecting Treatment/Hydromodification BMPs

☐ **Bioretention Facilities or Flow-Through Planters (Suggested BMP by Permit)**

Vegetated areas that can be designed as swales, basins, or flow-through planters. Bioretention facilities should be sized based on 4% of the total impervious tributary area to the bioretention facility and in accordance with the typical section below:



Additional Design Requirements for Bioretention:

-Bioretention facilities located in areas with highly infiltrative soils or high groundwater tables may omit the underdrain.

-The 18' Soil layer (Planting layer) shall be comprised of a mixture of sand (60-70%) and compost (30-40%) and shall meet ASTM C33 Standards. -

The 12" Storage layer shall be comprised of gravel and underdrain shall be placed near the top of this layer.

- No liners or other barriers shall be used unless there is a structure or other geotechnical hazard located within 10 feet of facility.

- The appropriate plant palette should be selected based on the soil type and max. available water use.

Total Bioretention Area Required (based on 4% of impervious area) _________ ft^2 Total Bioretention Area Provided: ______ ft^2

If the Total Bioretention Area is less than the area required please explain why in the space below:

☒ **Other BMPs as listed below (check all that apply)**

☒ **Extended Detention Basin**

☐ **Infiltration Basin or Infiltration Trench**

☐ **High-Rate Biofilters (e.g. Tree wells or other)** *(1)*

☐ **High-Rate Media Filter (e.g. Vault unit with replaceable cartridges)** *(1)*

☐ **Other equally effective as bioretention BMP** ______________________________

(1) High-rate Biofilters or Media Filters are only allowed if bioretention or equivalent facility is proven to be infeasible for the project and if the following conditions apply: 1) project is creating or replacing an acre or less and is located in an area that has at least 85% of the site covered by permanent structures; 2) The proposed facility is receiving runoff solely from existing (pre-project) impervious areas.

Post-Construction Stormwater Management Checklist* (5,000 SF or Greater)

Has the Excel File for the State Water Boards SMARTS Post-Construction Calculator been completed and attached to the back of this document for all Site Design Measures (Part A)?

☒ Yes ☐ No

Has all documentation for any source control measure that will be implemented on project been attached to this checklist (e.g.. CASQA Fact Sheets)?

☐ Yes ☒ No

Have all calculations for design of Storm water Treatment Facilities (bioretention facilities, etc.) been performed and attached to this report? Draft preliminary calcs are provided.

☒ Yes ☐ No

PART D - POST- CONSTRUCTION BMP FOLLOW-UP (to be completed after construction)

Where was the post-construction storm water treatment system installed (Circle all that apply): Onsite Joint storm water treatment facility Offsite

O&M Responsibility of the Site Design and Treatment BMPs for the life of the project:

☐ **HDH** ☐ **FM** ☐ **Contractor** **Other:** ______________________________

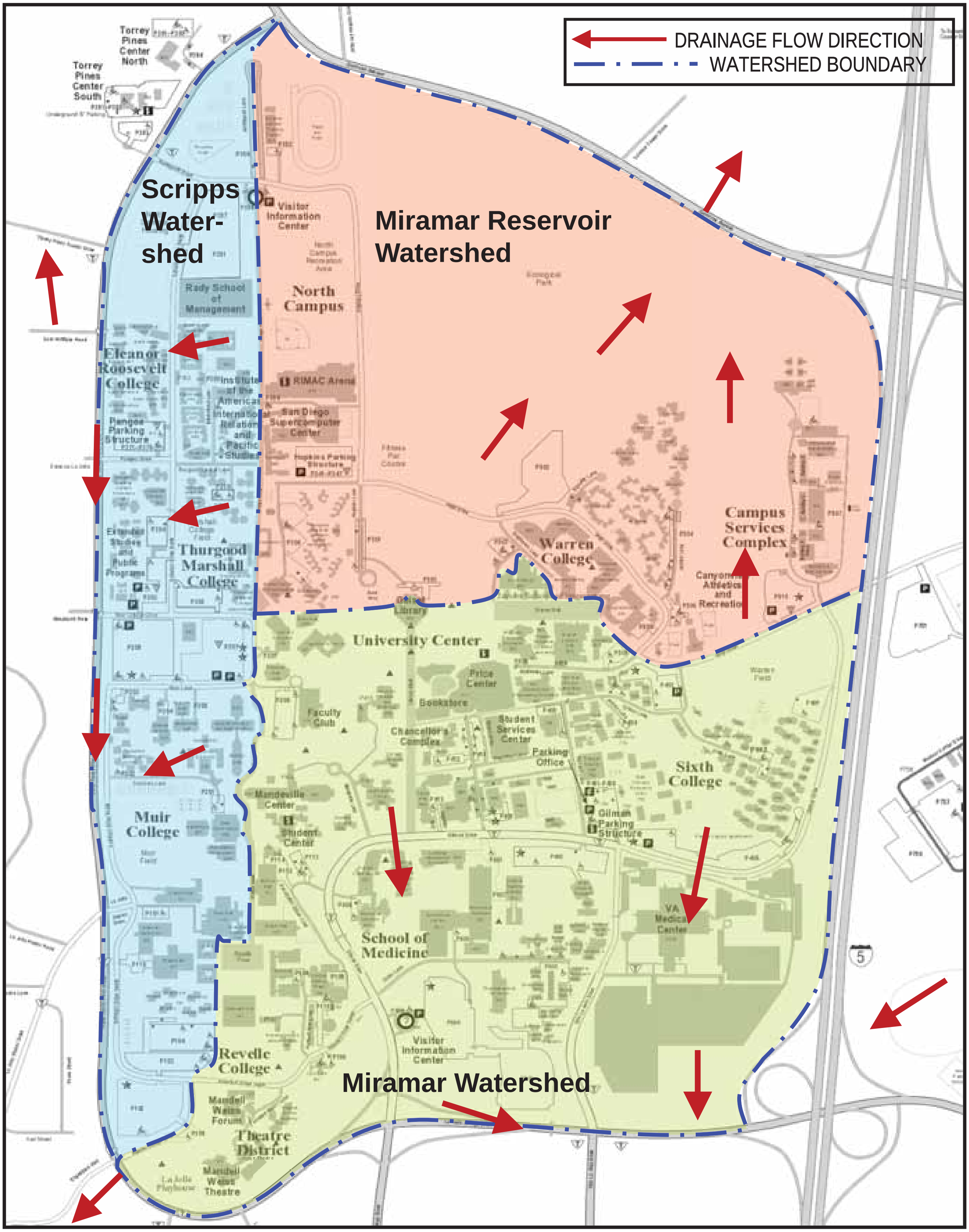
BMP O&M procedures/guidance provided to UC San Diego? ☐ **Yes** ☐ **No**

Date of Installation:

Date of post-construction inspection: **Inspected by:**

Proper Installation? ☐ **Yes** ☐ **No** **Corrective actions needed:**

Figure 1. UCSD West Campus Drainage Map



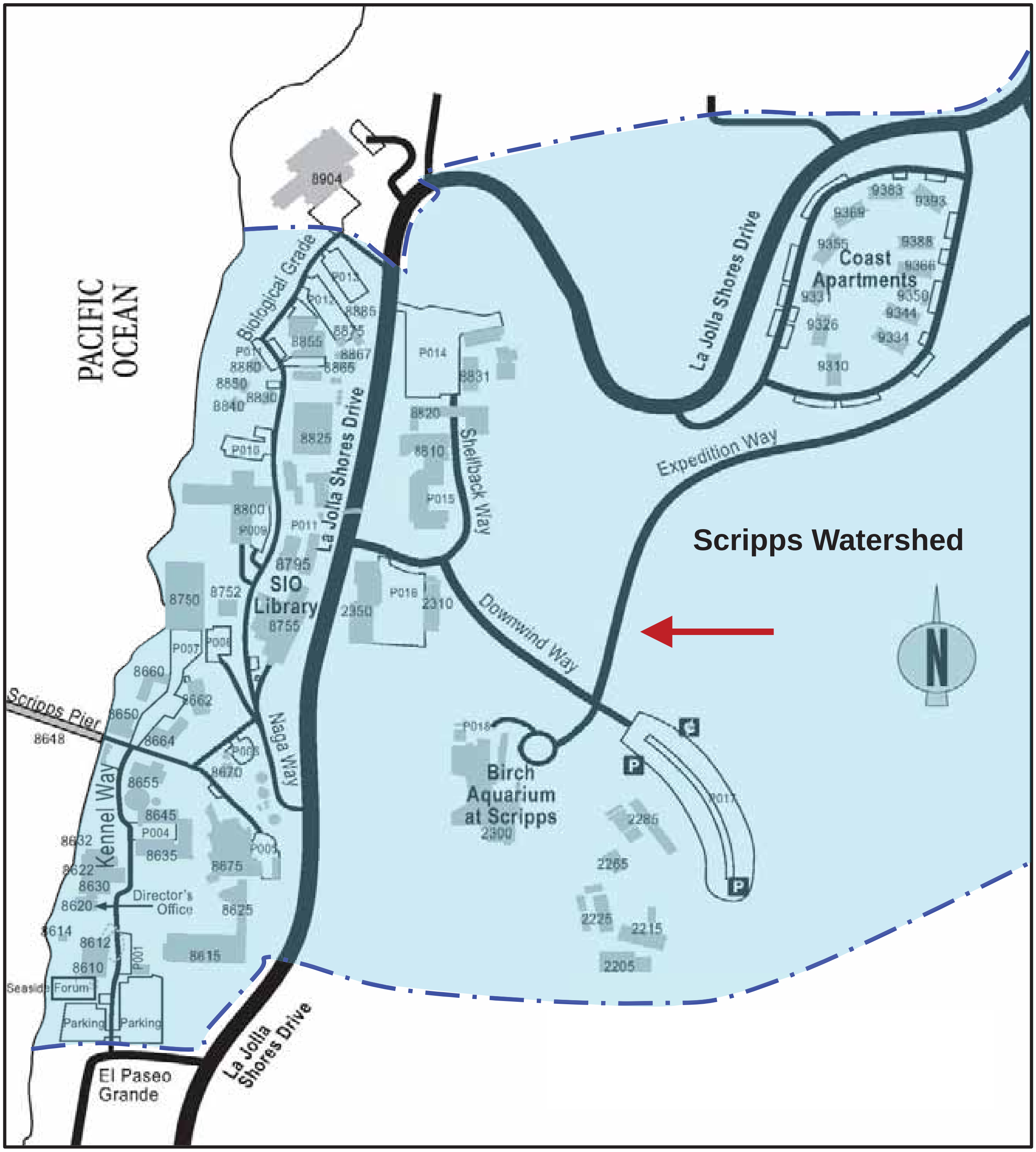
Note: UCSD West Campus drainage flows towards Pacific Ocean, Los Penesquitos Creek, Los Penesquitos Lagoon, Rose Canyon Creek, and Mission Bay.

Figure 2: UCSD East Campus Drainage Map

Note: UCSD East Campus drainage flows towards Rose Canyon Creek and Mission Bay.

DRAINAGE FLOW DIRECTION
WATERSHED BOUNDARY

Scripps Institution of Oceanography Drainage Map



Note: Scripps Institution of Oceanography (SIO) drainage flows towards Pacific Ocean.

← (red arrow)	DRAINAGE FLOW DIRECTION
— · — (blue dash-dot line)	WATERSHED BOUNDARY

Post-Construction Water Balance Calculator

User may make changes from any cell that is orange or brown in color (similar to the cells to the immediate right). Cells in green are calculated for you.

(Step 1a) If you know the 85th percentile storm event for your location enter it in the box below

(Step 1b) If you can not answer 1a then select the county where the project is located (click on the cell to the right for drop-down): This will determine the average 85th percentile 24 hr. storm event for your site, which will appear under precipitation to left. — *SAN_DIEGO*

(Step 1c) If you would like a more percise value select the location closest to your site. If you do not recgonize any of these locations, leave this drop-down menu at location. The average value for the County will be used. — **SAN DIEGO WSO AIRPORT**

Project Information	
Project Name:	*Voigt Parking Structure*
Waste Discharge Identification (WDID):	*Optional*
Date:	*Jul-17*
Sub Drainage Area Name (from map):	*Optional*

Runoff Curve Numbers	
Existing Runoff Curve Number	80
Proposed Development Runoff Curve Number	88

Design Storm		
Based on the County you indicated above, we have included the 85 percentile average 24 hr event - P85 (in)^ for your area.	0.49	in
The Amount of rainfall needed for runoff to occur (Existing runoff curve number -P from existing RCN (in)^)	0.51	In
P used for calculations (in) (the greater of the above two criteria)	0.51	In
[^Available at www.cabmphandbooks.com](www.cabmphandbooks.com)		

Pre-Project Runoff Volume (cu ft)	0.88	Cu.Ft.
Project-Related Runoff Volume Increase w/o credits (cu ft)	775	Cu.Ft.
Project-Related Volume Increase with Credits (cu ft)	0	Cu.Ft.

You have achieved your minimum requirements

Runoff Calculations

(Step 2) Indicate the Soil Type (dropdown menu to right):	*Group D Soils*	**Very low infiltration. Clay loam, silty clay loam, sandy clay, silty clay, or clay. Infiltration rate 0 to 0.05 inch/hr when wet.**
(Step 3) Indicate the existing **dominant** non-built land Use Type (dropdown menu to right):	*Brush: >75% ground cover*	
(Step 4) Indicate the proposed **dominant** non-built land Use Type (dropdown menu to right):	*A mix of lawn, grass, pasture and tress covering more than 75% of the open space*	

	Complete Either		
	Sq Ft	Acres	Acres
(Step 5) Total Project Site Area:		6.11	6.11
(Step 6) Sub-watershed Area:		6.11	6.11
Percent of total project :	100%		

(Step 7) Sub-watershed Conditions	Complete Either		Calculated Acres
Sub-watershed Area (acres)	Sq Ft	Acres	6.11
Existing Rooftop Impervious Coverage		0	0.00
Existing Non-Rooftop Impervious Coverage		1.80	1.80
Proposed Rooftop Impervious Coverage		1.73	1.73
Proposed Non-Rooftop Impervious Coverage		1.28	1.28

Credits	Acres	Square Feet
Porous Pavement	0.00	0
Tree Planting	0.47	20,473
Downspout Disconnection	0.87	37,897
Impervious Area Disconnection	0.00	0
Green Roof	1.21	52,708
Stream Buffer	0.00	0
Vegetated Swales	0.00	0
Subtotal	2.55	111,078
Subtotal Runoff Volume Reduction Credit	324 Cu. Ft.	

(Step 9) Impervious Volume Reduction Credits	Volume (cubic feet)
Rain Barrels/Cisterns	0 Cu. Ft.
Soil Quality	460 Cu. Ft.
Subtotal Runoff Volume Reduction	460 Cu. Ft.
Total Runoff Volume Reduction Credit	784 Cu. Ft.

Tree Planting Credit Worksheet

Please fill out a tree canopy credit worksheet for each project sub-watershed.

Tree Canopy Credit Criteria	Number of Trees Planted	Area Credit (acres)
Number of proposed evergreen trees to be planted (credit = number of trees x 0.005)*	0	0.00
Number of proposed deciduous trees to be planted (credit = number of trees x 0.0025)*	186	0.47
	Square feet Under Canopy	
Square feet under an existing tree canopy, that will remain on the property, with an average diameter at 4.5 ft above grade (i.e., diameter at breast height or DBH) is LESS than 12 in diameter.	0	0.00
Square feet under an existing tree canopy that will remain on the property, with an average diameter at 4.5 ft above grade (i.e., diameter at breast height or DBH) is 12 in diameter or GREATER.	0	0.00
Please describe below how the project will ensure that these trees will be maintained.		

Return to Calculator

* credit amount based on credits from Stormwater Quality Design Manual for the Sacramento and South Placer Regions

Downspout Disconnection Credit Worksheet

Please fill out a downspout disconnection credit worksheet for each project subwatershed. If you answer yes to all questions, all rooftop area draining to each downspout will be subtracted from your proposed rooftop impervious coverage.

Downspout Disconnection Credit Criteria		
Do downspouts and any extensions extend at least six feet from a basement and two feet from a crawl space or concrete slab?	○Yes	◉No
Is the area of rooftop connecting to each disconnected downspout 600 square feet or less?	○Yes	◉No
Is the roof runoff from the design storm event fully contained in a raised bed or planter box or does it drain as sheet flow to a landscaped area large enough to contain the roof runoff from the design storm event?	○Yes	◉No
The Stream Buffer and/or Vegetated Swale credits **will not** be taken in this sub-watershed area?	◉Yes	○No
Percentage of existing 0 Acre(s) of rooftop surface that have disconnected downspouts	0	
Percentage of the proposed 1.73 Acre(s) of rooftop surface that have disconnected downspouts	100	
	Return to Calculator	

Impervious Area Disconnection Credit Worksheet

Please fill out an impervious area disconnection credit worksheet for each project sub-watershed. If you answer yes to all questions, all non-rooftop impervious surface area will be subtracted from your proposed non-rooftop impervious coverage.

Non-Rooftop Disconnection Credit Criteria	Response
Is the maximum contributing impervious flow path length less than 75 feet or, if equal or greater than 75 feet, is a storage device (e.g. French drain, bioretention area, gravel trench) implemented to achieve the required disconnection length?	○ Yes ◉ No
Is the impervious area to any one discharge location less than 5,000 square feet?	○ Yes ◉ No
The Stream Buffer credit **will not** be taken in this sub-watershed area?	◉ Yes ○ No

Percentage of existing 1.8 Acre(s) of non-rooftop surface area disconnected	0	
Percentage of the proposed 1.28 Acre(s) of non-rooftop surface area disconnected	50	%

Return to Calculator

Stream Buffer Credit Worksheet

Please fill out a stream buffer credit worksheet for each project sub-watershed. If you answer yes to all questions, you may subtract all impervious surface draining to each stream buffer that has not been addressed using the Downspout and/or Impervious Area Disconnection credits.

Stream Buffer Credit Criteria	Response
Does runoff enter the floodprone width* or within 500 feet (whichever is larger) of a stream channel as sheet flow**?	○ Yes ◉ No
Is the contributing overland slope 5% or less, or if greater than 5%, is a level spreader used?	○ Yes ◉ No
Is the buffer area protected from vehicle or other traffic barriers to reduce compaction?	○ Yes ◉ No
Will the stream buffer be maintained in an ungraded and uncompacted condition and will the vegetation be maintained in a natural condition?	○ Yes ◉ No
Percentage of existing 1.8 Acre(s) impervious surface area draining into a stream buffer	
Percentage of the proposed 3.01 Acre(s) impervious surface area that will drain into a stream buffer	
Please describe below how the project will ensure that the buffer areas will remain in ungraded and uncompacted condition and that the vegetation will be maintained in a natural condition.	

Return to Calculator

* floodprone width is the width at twice the bankfull depth.
** the maximum contributing length shall be 75 feet for impervious area

Please fill out a soil quality worksheet for each project sub-watershed.

	Response
Will the soils used for landscaping meet the ideal bulk densities listed in Table 1 below?[1]	(●) Yes ( ) No
If you answered yes to the question above, and you know the area-weighted bulk density within the top 12 inches for soils used for landscaping (in g/cm^3)* , fill in the cell to the right and skip to cell G11. If not select from the drop-down menu in G10.	
If you answered yes to the question above, but you do not know the exact bulk density, which of the soil types in the drop down menu to the right best describes the top 12 inches for soils used for landscaping (in g/cm^3).	Sandy clay loams, loams, clay loams
What is the average depth of your landscaped soil media meeting the above criteria (inches)?	12
What is the total area of the landscaped areas meeting the above criteria (in acres)?	0.044

Return to Calculator

Credit (cu ft) 459.9936

Table 1

Sands, loamy sands	<1.6
Sandy loams, loams	<1.4
Sandy clay loams, loams, clay loams	<1.4
Silts, silt loams	<1.3
Silt loams, silty clay loams	<1.1
Sandy clays, silty clays, some clay loams (35-45% clay)	<1.1
Clays (>45% clay)	<1.1

[1] USDA NRCS. "Soil Quality Urban Technical Note No.2-Urban Soil Compaction". March 2000.
http://soils.usda.gov/sqi/management/files/sq_utn_2.pdf

* To determine how to calculate density see:
http://www.globe.gov/tctg/bulkden.pdf?sectionID=94

APPENDIX G:

BMPs Fact Sheets

Design Considerations

- Soil for Infiltration
- Tributary Area
- Slope
- Aesthetics
- Environmental Side-effects

Description

The bioretention best management practice (BMP) functions as a soil and plant-based filtration device that removes pollutants through a variety of physical, biological, and chemical treatment processes. These facilities normally consist of a grass buffer strip, sand bed, ponding area, organic layer or mulch layer, planting soil, and plants. The runoff's velocity is reduced by passing over or through buffer strip and subsequently distributed evenly along a ponding area. Exfiltration of the stored water in the bioretention area planting soil into the underlying soils occurs over a period of days.

California Experience

None documented. Bioretention has been used as a stormwater BMP since 1992. In addition to Prince George's County, MD and Alexandria, VA, bioretention has been used successfully at urban and suburban areas in Montgomery County, MD; Baltimore County, MD; Chesterfield County, VA; Prince William County, VA; Smith Mountain Lake State Park, VA; and Cary, NC.

Advantages

- Bioretention provides stormwater treatment that enhances the quality of downstream water bodies by temporarily storing runoff in the BMP and releasing it over a period of four days to the receiving water (EPA, 1999).

- The vegetation provides shade and wind breaks, absorbs noise, and improves an area's landscape.

Limitations

- The bioretention BMP is not recommended for areas with slopes greater than 20% or where mature tree removal would

Targeted Constituents

☑	Sediment	■
☑	Nutrients	▲
☑	Trash	■
☑	Metals	■
☑	Bacteria	■
☑	Oil and Grease	■
☑	Organics	■

Legend *(Removal Effectiveness)*

● Low ■ High

▲ Medium

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be required since clogging may result, particularly if the BMP receives runoff with high sediment loads (EPA, 1999).

- Bioretention is not a suitable BMP at locations where the water table is within 6 feet of the ground surface and where the surrounding soil stratum is unstable.
- By design, bioretention BMPs have the potential to create very attractive habitats for mosquitoes and other vectors because of highly organic, often heavily vegetated areas mixed with shallow water.
- In cold climates the soil may freeze, preventing runoff from infiltrating into the planting soil.

Design and Sizing Guidelines

- The bioretention area should be sized to capture the design storm runoff.
- In areas where the native soil permeability is less than 0.5 in/hr an underdrain should be provided.
- Recommended minimum dimensions are 15 feet by 40 feet, although the preferred width is 25 feet. Excavated depth should be 4 feet.
- Area should drain completely within 72 hours.
- Approximately 1 tree or shrub per 50 ft^2 of bioretention area should be included.
- Cover area with about 3 inches of mulch.

Construction/Inspection Considerations

Bioretention area should not be established until contributing watershed is stabilized.

Performance

Bioretention removes stormwater pollutants through physical and biological processes, including adsorption, filtration, plant uptake, microbial activity, decomposition, sedimentation and volatilization (EPA, 1999). Adsorption is the process whereby particulate pollutants attach to soil (e.g., clay) or vegetation surfaces. Adequate contact time between the surface and pollutant must be provided for in the design of the system for this removal process to occur. Thus, the infiltration rate of the soils must not exceed those specified in the design criteria or pollutant removal may decrease. Pollutants removed by adsorption include metals, phosphorus, and hydrocarbons. Filtration occurs as runoff passes through the bioretention area media, such as the sand bed, ground cover, and planting soil.

Common particulates removed from stormwater include particulate organic matter, phosphorus, and suspended solids. Biological processes that occur in wetlands result in pollutant uptake by plants and microorganisms in the soil. Plant growth is sustained by the uptake of nutrients from the soils, with woody plants locking up these nutrients through the seasons. Microbial activity within the soil also contributes to the removal of nitrogen and organic matter. Nitrogen is removed by nitrifying and denitrifying bacteria, while aerobic bacteria are responsible for the decomposition of the organic matter. Microbial processes require oxygen and can result in depleted oxygen levels if the bioretention area is not adequately aerated. Sedimentation occurs in the swale or ponding area as the velocity slows and solids fall out of suspension.

The removal effectiveness of bioretention has been studied during field and laboratory studies conducted by the University of Maryland (Davis et al, 1998). During these experiments, synthetic stormwater runoff was pumped through several laboratory and field bioretention areas to simulate typical storm events in Prince George's County, MD. Removal rates for heavy metals and nutrients are shown in Table 1.

Table 1 Laboratory and Estimated Bioretention Davis et al. (1998); PGDER (1993)

Pollutant	Removal Rate
Total Phosphorus	70-83%
Metals (Cu, Zn, Pb)	93-98%
TKN	68-80%
Total Suspended Solids	90%
Organics	90%
Bacteria	90%

Results for both the laboratory and field experiments were similar for each of the pollutants analyzed. Doubling or halving the influent pollutant levels had little effect on the effluent pollutants concentrations (Davis et al, 1998).

The microbial activity and plant uptake occurring in the bioretention area will likely result in higher removal rates than those determined for infiltration BMPs.

Siting Criteria

Bioretention BMPs are generally used to treat stormwater from impervious surfaces at commercial, residential, and industrial areas (EPA, 1999). Implementation of bioretention for stormwater management is ideal for median strips, parking lot islands, and swales. Moreover, the runoff in these areas can be designed to either divert directly into the bioretention area or convey into the bioretention area by a curb and gutter collection system.

The best location for bioretention areas is upland from inlets that receive sheet flow from graded areas and at areas that will be excavated (EPA, 1999). In order to maximize treatment effectiveness, the site must be graded in such a way that minimizes erosive conditions as sheet flow is conveyed to the treatment area. Locations where a bioretention area can be readily incorporated into the site plan without further environmental damage are preferred. Furthermore, to effectively minimize sediment loading in the treatment area, bioretention only should be used in stabilized drainage areas.

Additional Design Guidelines

The layout of the bioretention area is determined after site constraints such as location of utilities, underlying soils, existing vegetation, and drainage are considered (EPA, 1999). Sites with loamy sand soils are especially appropriate for bioretention because the excavated soil can be backfilled and used as the planting soil, thus eliminating the cost of importing planting soil.

The use of bioretention may not be feasible given an unstable surrounding soil stratum, soils with clay content greater than 25 percent, a site with slopes greater than 20 percent, and/or a site with mature trees that would be removed during construction of the BMP.

Bioretention can be designed to be off-line or on-line of the existing drainage system (EPA, 1999). The drainage area for a bioretention area should be between 0.1 and 0.4 hectares (0.25 and 1.0 acres). Larger drainage areas may require multiple bioretention areas. Furthermore, the maximum drainage area for a bioretention area is determined by the expected rainfall intensity and runoff rate. Stabilized areas may erode when velocities are greater than 5 feet per second (1.5 meter per second). The designer should determine the potential for erosive conditions at the site.

The size of the bioretention area, which is a function of the drainage area and the runoff generated from the area is sized to capture the water quality volume.

The recommended minimum dimensions of the bioretention area are 15 feet (4.6 meters) wide by 40 feet (12.2 meters) long, where the minimum width allows enough space for a dense, randomly-distributed area of trees and shrubs to become established. Thus replicating a natural forest and creating a microclimate, thereby enabling the bioretention area to tolerate the effects of heat stress, acid rain, runoff pollutants, and insect and disease infestations which landscaped areas in urban settings typically are unable to tolerate. The preferred width is 25 feet (7.6 meters), with a length of twice the width. Essentially, any facilities wider than 20 feet (6.1 meters) should be twice as long as they are wide, which promotes the distribution of flow and decreases the chances of concentrated flow.

In order to provide adequate storage and prevent water from standing for excessive periods of time the ponding depth of the bioretention area should not exceed 6 inches (15 centimeters). Water should not be left to stand for more than 72 hours. A restriction on the type of plants that can be used may be necessary due to some plants' water intolerance. Furthermore, if water is left standing for longer than 72 hours mosquitoes and other insects may start to breed.

The appropriate planting soil should be backfilled into the excavated bioretention area. Planting soils should be sandy loam, loamy sand, or loam texture with a clay content ranging from 10 to 25 percent.

Generally the soil should have infiltration rates greater than 0.5 inches (1.25 centimeters) per hour, which is typical of sandy loams, loamy sands, or loams. The pH of the soil should range between 5.5 and 6.5, where pollutants such as organic nitrogen and phosphorus can be adsorbed by the soil and microbial activity can flourish. Additional requirements for the planting soil include a 1.5 to 3 percent organic content and a maximum 500 ppm concentration of soluble salts.

Soil tests should be performed for every 500 cubic yards (382 cubic meters) of planting soil, with the exception of pH and organic content tests, which are required only once per bioretention area (EPA, 1999). Planting soil should be 4 inches (10.1 centimeters) deeper than the bottom of the largest root ball and 4 feet (1.2 meters) altogether. This depth will provide adequate soil for the plants' root systems to become established, prevent plant damage due to severe wind, and provide adequate moisture capacity. Most sites will require excavation in order to obtain the recommended depth.

Planting soil depths of greater than 4 feet (1.2 meters) may require additional construction practices such as shoring measures (EPA, 1999). Planting soil should be placed in 18 inches or greater lifts and lightly compacted until the desired depth is reached. Since high canopy trees may be destroyed during maintenance the bioretention area should be vegetated to resemble a terrestrial forest community ecosystem that is dominated by understory trees. Three species each of both trees and shrubs are recommended to be planted at a rate of 2500 trees and shrubs per hectare (1000 per acre). For instance, a 15 foot (4.6 meter) by 40 foot (12.2 meter) bioretention area (600 square feet or 55.75 square meters) would require 14 trees and shrubs. The shrub-to-tree ratio should be 2:1 to 3:1.

Trees and shrubs should be planted when conditions are favorable. Vegetation should be watered at the end of each day for fourteen days following its planting. Plant species tolerant of pollutant loads and varying wet and dry conditions should be used in the bioretention area.

The designer should assess aesthetics, site layout, and maintenance requirements when selecting plant species. Adjacent non-native invasive species should be identified and the designer should take measures, such as providing a soil breach to eliminate the threat of these species invading the bioretention area. Regional landscaping manuals should be consulted to ensure that the planting of the bioretention area meets the landscaping requirements established by the local authorities. The designers should evaluate the best placement of vegetation within the bioretention area. Plants should be placed at irregular intervals to replicate a natural forest. Trees should be placed on the perimeter of the area to provide shade and shelter from the wind. Trees and shrubs can be sheltered from damaging flows if they are placed away from the path of the incoming runoff. In cold climates, species that are more tolerant to cold winds, such as evergreens, should be placed in windier areas of the site.

Following placement of the trees and shrubs, the ground cover and/or mulch should be established. Ground cover such as grasses or legumes can be planted at the beginning of the growing season. Mulch should be placed immediately after trees and shrubs are planted. Two to 3 inches (5 to 7.6 cm) of commercially-available fine shredded hardwood mulch or shredded hardwood chips should be applied to the bioretention area to protect from erosion.

Maintenance

The primary maintenance requirement for bioretention areas is that of inspection and repair or replacement of the treatment area's components. Generally, this involves nothing more than the routine periodic maintenance that is required of any landscaped area. Plants that are appropriate for the site, climatic, and watering conditions should be selected for use in the bioretention cell. Appropriately selected plants will aide in reducing fertilizer, pesticide, water, and overall maintenance requirements. Bioretention system components should blend over time through plant and root growth, organic decomposition, and the development of a natural soil horizon. These biologic and physical processes over time will lengthen the facility's life span and reduce the need for extensive maintenance.

Routine maintenance should include a biannual health evaluation of the trees and shrubs and subsequent removal of any dead or diseased vegetation (EPA, 1999). Diseased vegetation should be treated as needed using preventative and low-toxic measures to the extent possible. BMPs have the potential to create very attractive habitats for mosquitoes and other vectors because of highly organic, often heavily vegetated areas mixed with shallow water. Routine inspections for areas of standing water within the BMP and corrective measures to restore proper infiltration rates are necessary to prevent creating mosquito and other vector habitat. In addition, bioretention BMPs are susceptible to invasion by aggressive plant species such as cattails, which increase the chances of water standing and subsequent vector production if not routinely maintained.

In order to maintain the treatment area's appearance it may be necessary to prune and weed. Furthermore, mulch replacement is suggested when erosion is evident or when the site begins to look unattractive. Specifically, the entire area may require mulch replacement every two to three years, although spot mulching may be sufficient when there are random void areas. Mulch replacement should be done prior to the start of the wet season.

New Jersey's Department of Environmental Protection states in their bioretention systems standards that accumulated sediment and debris removal (especially at the inflow point) will normally be the primary maintenance function. Other potential tasks include replacement of dead vegetation, soil pH regulation, erosion repair at inflow points, mulch replenishment, unclogging the underdrain, and repairing overflow structures. There is also the possibility that the cation exchange capacity of the soils in the cell will be significantly reduced over time. Depending on pollutant loads, soils may need to be replaced within 5-10 years of construction (LID, 2000).

Cost

Construction Cost

Construction cost estimates for a bioretention area are slightly greater than those for the required landscaping for a new development (EPA, 1999). A general rule of thumb (Coffman, 1999) is that residential bioretention areas average about $3 to $4 per square foot, depending on soil conditions and the density and types of plants used. Commercial, industrial and institutional site costs can range between $10 to $40 per square foot, based on the need for control structures, curbing, storm drains and underdrains.

Retrofitting a site typically costs more, averaging $6,500 per bioretention area. The higher costs are attributed to the demolition of existing concrete, asphalt, and existing structures and the replacement of fill material with planting soil. The costs of retrofitting a commercial site in Maryland, Kettering Development, with 15 bioretention areas were estimated at $111,600.

In any bioretention area design, the cost of plants varies substantially and can account for a significant portion of the expenditures. While these cost estimates are slightly greater than those of typical landscaping treatment (due to the increased number of plantings, additional soil excavation, backfill material, use of underdrains etc.), those landscaping expenses that would be required regardless of the bioretention installation should be subtracted when determining the net cost.

Perhaps of most importance, however, the cost savings compared to the use of traditional structural stormwater conveyance systems makes bioretention areas quite attractive financially. For example, the use of bioretention can decrease the cost required for constructing stormwater conveyance systems at a site. A medical office building in Maryland was able to reduce the amount of storm drain pipe that was needed from 800 to 230 feet - a cost savings of $24,000 (PGDER, 1993). And a new residential development spent a total of approximately $100,000 using bioretention cells on each lot instead of nearly $400,000 for the traditional stormwater ponds that were originally planned (Rappahanock,). Also, in residential areas, stormwater management controls become a part of each property owner's landscape, reducing the public burden to maintain large centralized facilities.

Maintenance Cost

The operation and maintenance costs for a bioretention facility will be comparable to those of typical landscaping required for a site. Costs beyond the normal landscaping fees will include the cost for testing the soils and may include costs for a sand bed and planting soil.

References and Sources of Additional Information

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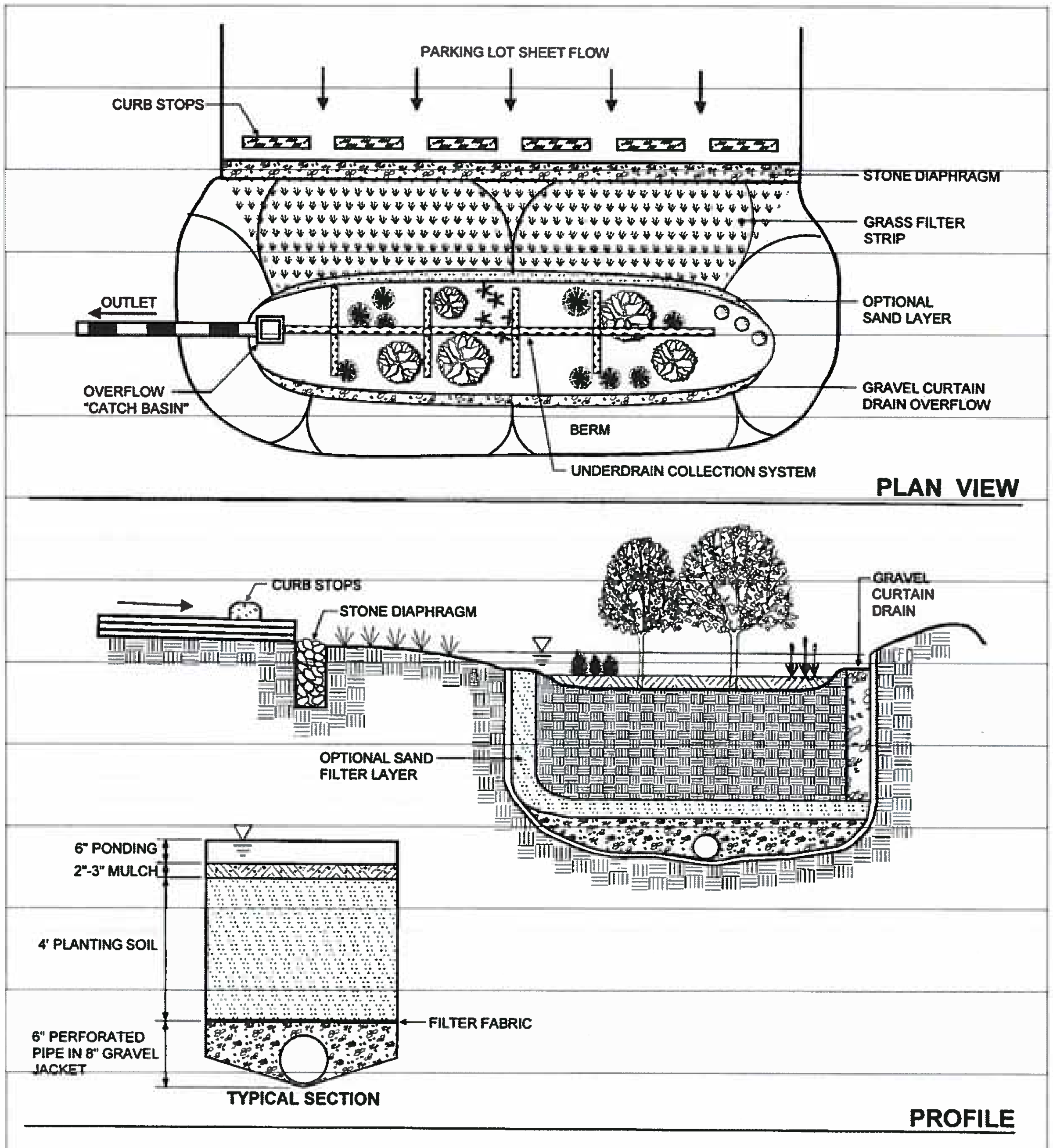

Schematic of a Bioretention Facility (MDE, 2000)