Dist-County-Route: 05-MON-218
Post Mile Limits: 0.0 / 0.9
Type of Work: Multi-Use Trail and Pedestrian Undercrossing
Project ID (EA): 05200000029 (051M570)
Program Identification: _____

Phase: ☐ PID ☐ PA/ED ☒ PS&E

Regional Water Quality Control Board(s): Central Coast, Region 3

Total DSA: 4.0 acres PCTA: _____ NIS: _____

Alternative Compliance (acres) N/A ATA 2 (50% Rule)? Yes ☐ No ☐

Estimated Const. Start Date: 8/28/2023 Estimated Const. Completion Date: 4/24/2024

Risk Level: RL 1 ☒ RL 2 ☐ RL 3 ☐ WPCP ☐ Other: ____

Is MWELO applicable? Yes ☒ No ☐

Does Project require a Rapid Stability Assessment? Yes ☐ No ☒

Is the Project within a TMDL/STGA area where Caltrans is a named stakeholder? Yes ☐ No ☒

TMDL Compliance Units (acres) _____

Notification of ADL reuse (if yes, provide date): Yes ☐ Date: _____ No ☒

This Report has been prepared under the direction of the following Licensed Person. The Licensed Person attests to the technical information contained herein and the date upon which recommendations, conclusions, and decisions are based. Professional Engineer or Landscape Architect stamp required at PS&E.

Nathaniel Milam, Registered Civil Engineer — *4/26/2023* Date

I have reviewed the stormwater quality design issues and find this report to be complete, current and accurate:

REGISTERED PROFESSIONAL ENGINEER
NATHANIEL DAVID MILAM
No. 76451
CIVIL
STATE OF CALIFORNIA

(Stamp Required for PS&E only)

Jackson Ho, Project Manager — *Date*

Enrique Castillo-Ramirez, Designated Maintenance Representative — *Date*

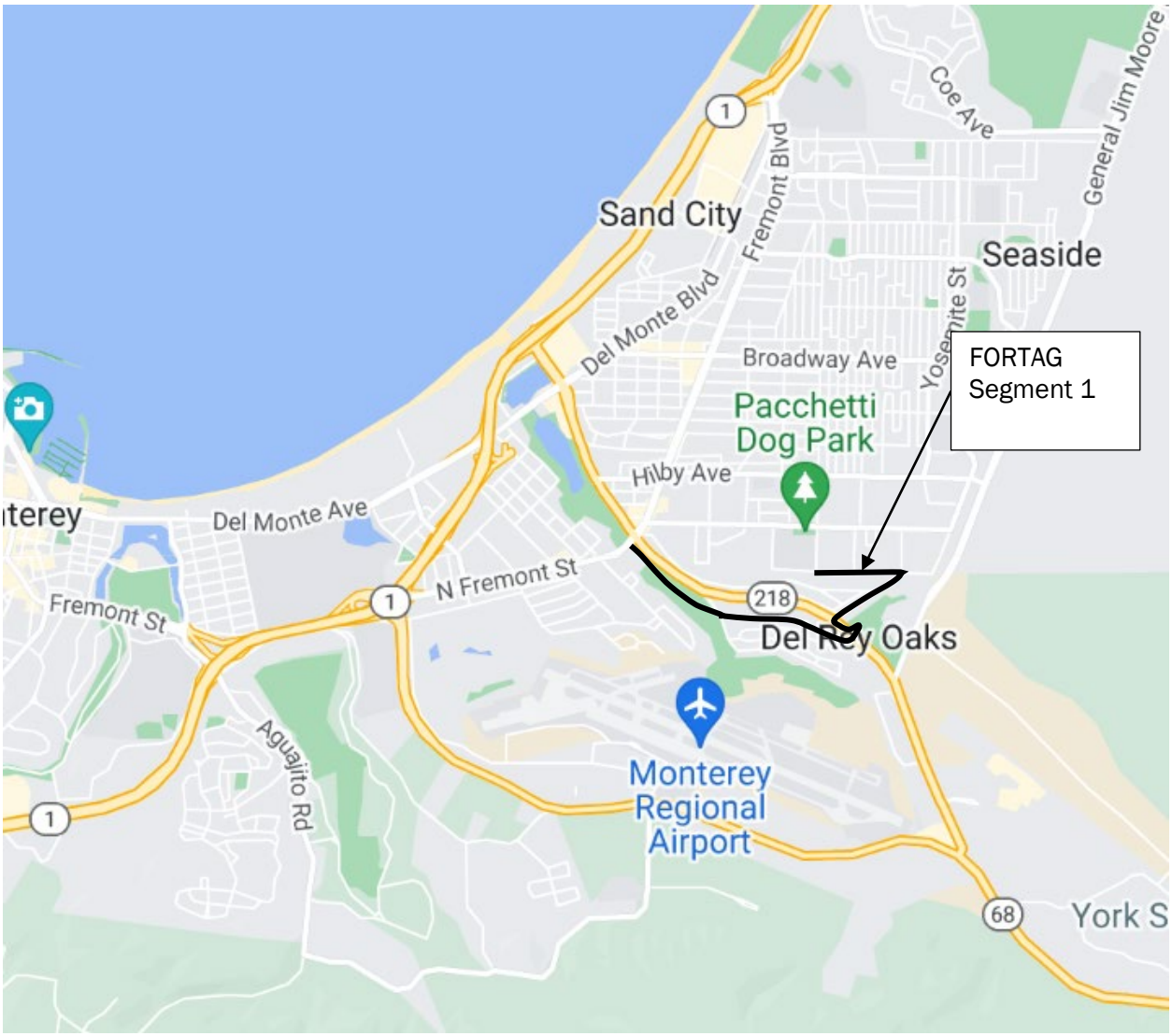
Corby Kilmer, Designated Landscape Architect Representative — *Date*

Karl Mikel, SW Coordinator or Designee — *Date*

STORM WATER DATA INFORMATION

1. Project Description

The **Transportation Agency for Monterey County (TAMC) Fort Ord Trail and Greenway (FORTAG) – Phase 1** project entails development of a 1.7-mile long paved multi-use trail within the cities of Del Rey Oaks and Seaside in Monterey County.



The work will mostly occur outside the State right-of-way, but does include work at two locations on State Route 218:

- PM 0.0 to PM 0.1: Construct 12'-wide multi-use trail along the southwestern side of State Route 218 from Fremont Boulevard to Work Memorial Park (a Del Rey Oaks city park). Work also includes adjustment/relocation of electric (PG&E) and telecommunications (AT&T) utilities; grading; storm drainage improvements; intersection improvements at Fremont Boulevard including traffic signal modifications, curb ramps and curb bulb-outs; and driveway modifications and curb bult-out adjacent to the Safeway parcel.

- PM 0.9: Construct a pedestrian undercrossing under State Route 218 approximately 200' southeast of Carlton Drive. Construct 12'-wide multi-use trail from Del Rey Park (a Del Rey Oaks city park) to the Frog Pond Wetland Preserve (a Monterey Peninsula Regional Parks District park) under State Route 218, then along the northeastern side of State Route 218 to Carlton Drive (City of Del Rey Oaks). Work also includes relocation of water (Cal-Am), gas (PG&E), electric (PG&E) and telecommunications (AT&T) utilities; retaining walls; grading; storm drainage improvements; and intersection improvements at Carlton Drive including curb ramps, bus stop and curb bulb-outs.

Table E-1, below, provides a summary of the project areas.

Table E-1. Summary of Project Areas

	CT ROW (acres)	Off CT ROW (acres)
Disturbed Soil Area	0.9	4.0
Pre-project Impervious Area	4.6[3]	1.5
Post-project Impervious Area	4.7	3.3
New Impervious (NNI) Area	0.1	1.8
Replaced Impervious Surface (RIS) Area	0.5	1.5
Total New Plus Replaced Impervious Surfaces (NNI + RIS)	0.6	3.3
Total Site Area	9.6[1]	4.0[2]

[1] Total Site Area, Caltrans ROW: Highway right-of-way from beginning to end of improvements, PM 0.00 to 0.93

[2] Since the project crosses multiple parcels and rights of way, for purposes herein the Project's Disturbed Soil Area is used for the Total Site Area, Off Caltrans ROW.

[3] Pre-Project impervious Area, Caltrans ROW: 5,000 LF x 40'

2. Site Data and Storm Water Quality Design Issues

- The project area drains to Canyon del Rey Creek (CalWater 3309500401, USGS HUC 18060012).
    - The project area within State Route 218, PM 0.0 to 0.1, drains to existing drain inlets located within highway adjacent to the project area. Runoff collected by these drain inlets enters the storm drain system which discharges into Canyon del Rey Creek.
    - The project area within State Route 218, PM 0.9, drains directly to Canyon del Rey Creek. The creek is located immediately south of the project area on the southwest side of State Route 218. The "Frog Pond" (a storm water detention pond) is located approximately 50 feet southeast of the project area on the north side of State Route 218.
- Canyon del Rey Creek is not a 303(d) listed water body.
- The project is not located in a moderate or high Significant Trash Generating Area, STGA.
- The following permits, reviews, and approvals are required for project construction:

Table E-2. Summary of Permits

Agency	Permit/Approval	Status
Central Coast Regional Water Quality Control Board	Section 401 Certification for impacts to waters of the United States	To be obtained before construction
United States Army Corps of Engineers	Section 404 Permit for impacts to wetlands and waters of the United States	To be obtained before construction
California Department of Fish and Wildlife	Section 1602 Agreement for Streambed Alteration impacts to Canyon del Rey Creek	To be obtained before construction
National Marine Fisheries Service	Biological Opinion for South Central Coast Steelhead Trout	To be obtained prior to approval of the Final Environmental Document
State Water Resources Control Board	Construction General Permit	To be obtained before construction
City of Seaside	Encroachment Permit and Grading Permit; includes SWCP approval	To be obtained before construction
City of Seaside	Coastal Development Permit, or Exemption	To be obtained before construction
City of Del Rey Oaks	Encroachment Permit and Grading Permit; includes SWCP approval	To be obtained before construction
Monterey Peninsula Regional Parks District	Encroachment Permit for work within Frog Pond Wetland Preserve	To be obtained before construction
Caltrans	Encroachment Permit	To be obtained before advertising for construction

- There are no Drinking Water Reservoirs and/or Recharge Facilities within the project limit
- There are no RWQCB special requirements/concerns
- The cities of Del Rey Oaks and Seaside have not provided storm water requirements other than compliance with their MS4 Permit requirements.
- Permanent erosion control will be provided on all disturbed soils. No permanent BMPs are proposed within the highway right-of-way.
- Soils within the highway right-of-way are classified as Baywood Sand (map symbol BbC). Baywood sand is classified as Hydrologic Soil Group (HSG) “A” and has an estimated saturated hydraulic conductivity of 6 to 20 in/hr. Immediately to the south of the highway right-of-way, along Canyon del Rey Creek, soils are classified as Rindge muck (symbol Rb), which is classified as HSG “D”.
- The project does not propose to reuse soil containing Aerially Deposited Lead (ADL).
- There are no existing Caltrans Treatment BMPs within the project limits.

- There are no existing permanent Caltrans Maintenance facilities within the project limits.

3. Temporary Construction Site BMPs to be used on Project

- This project proposes to create **4 acres** of DSA. Therefore this project will require a Storm Water Pollution Prevention Plan (SWPPP) and coverage under the Construction General Permit.
- A preliminary project risk level assessment has determined this project to be a risk level 1. See the attached risk level assessment for more information.
    - The Latitude/Longitude for this project is 36.5955 / -121.8439
    - The R-Factor is- 47.92
    - The K-Factor is- 0.1
    - The LS Factor is- 1.74
    - The sediment risk is Low (8.33 ton/acre)
    - The Receiving Water Risk is Low
- The cost of construction site BMPs is estimated at 2% of the total construction cost (see "Percentage Total Cost" method described in Appendix F of the Project Planning and Design Guide.)
- **4 acres** will be used in the calculation to determine Construction General Permit (CGP) NOI/NOT fees.

    1 Number of FYs of construction schedule
    1 Additional year for vegetation period or other NOT requirements
    2 Total years
    $704 Storm Water Construction Annual Fees
    $1408 Total NOI/NOT Stormwater CGP fees

- During construction, effective combinations of temporary and permanent erosion and sediment controls will be used. Storm water management for the site will be coordinated through the contractor with Caltrans construction personnel to effectively manage erosion from the DSA's by implementing a Storm Water Pollution Prevention Plan (SWPPP). Selected BMP's that will be included but not limited to the SWPPP/WPCP for the project are defined as follows:

Temporary Soil Stabilization

- Minimize active DSA's during the rainy season utilizing scheduling techniques.
- Preserve existing vegetation to the maximum extent feasible.
- Implement temporary protective cover/erosion control on all non-active DSA's and soil stockpiles.
- Control erosive forces of storm water runoff with effective storm flow management such as temporary concentrated flow conveyance devices, earthen dikes, drainage swales, lined ditches, outlet protection/velocity dissipation devices, and slope drains as determined feasible.

Temporary Sediment Controls

- Implement linear sediment controls such as fiber rolls, check dams, or gravel bag berms on all active and non-active DSA's during the rainy season.
- To further help prevent sediment discharge stabilized construction site entrances, temporary drainage inlet protection, and street sweeping and vacuuming will be necessary.

- Implement appropriate wind erosion controls year round.

Non Storm Water Management

- The appropriate non-storm water BMP's will be implemented year-round as follows:
- Water conservation practices are implemented on all construction sites and wherever water is used.
- The project area includes areas defined by a high groundwater elevation. Multiple earthwork and excavation operations will potentially encounter groundwater during construction activities. Dewatering BMP's will need to be implemented.
- Paving and Grinding procedures are implemented where paving, surfacing, resurfacing, grinding, or saw cutting may pollute storm water runoff or discharge to the storm drain system or watercourses.
- Procedures and practices designed for construction contractors to recognize illicit connections or illegally dumped or discharged materials on a construction site and report incidents to the Resident Engineer.
- The following activities must be performed at least 100 feet from concentrated flows of storm water, drainage courses, and inlets if within the floodplain and at least 50 feet if outside of the floodplain; stockpiling materials, storing equipment and liquid waste containers, washing vehicles or equipment, fueling and maintaining vehicles and equipment.
- Pile driving operations will be part of the construction activities.
- Concrete curing will be used in the construction of structures such as bridges and retaining walls. Concrete curing includes the use of both chemical and water methods. Proper procedures will minimize pollution of runoff during concrete curing.
- The following construction site BMPs are anticipated to be bid items for this project:
    - Temporary Facilities and Controls
    - Job Site Management
    - Prepare Stormwater Pollution Prevention Plan
    - Stormwater Annual Report
    - Move In/Move Out (Temporary Erosion Control)
    - Temporary Check Dam
    - Temporary Inlet Protection
    - Temporary Fiber Roll
    - Temporary Construction Entrance (Type 2)
    - Street Sweeping
    - Temporary Concrete Washout
    - Temporary High Visibility Fencing (ESA)

TAMC-Furnished Items

- Annual Construction General Permit Fee

- Concurrence from Construction regarding the temporary Construction Site BMP implementation strategy and associated quantities was given by TAMC, CSWC, in January 2023.

4. Maintenance BMPs

Not applicable.

5. Regional Water Quality Control Board Agreements, PLACs, and Other Water Quality Requirements

Not applicable.

6. Permanent BMPs

Design Pollution Prevention (DPP) BMP Strategy

Slope/Surface Protection Systems

- Cut and fill slopes will be created by the work. Existing slopes are generally gentle, except that the existing embankment slope on the north side of State Route 218 at the proposed pedestrian undercrossing is steeper than 2H:1V. A maximum slope of 3H:1V is used for all proposed slopes.
- The following permanent erosion control strategies will be implemented with this project: plants, rock and wood mulch and establishment periods
- This project complies with the Model Water Efficient Landscape Ordinance (MWELO) as it seeks to minimize erosion, limit soil compaction, minimize stormwater runoff, maximize infiltration, encourage healthy plant growth, and use irrigation water efficiently.
- The following hard surfaces are proposed:
    - Stamped concrete is proposed for the trail shoulder between the trail and road curb where the trail is parallel to and near the road curb.
    - Slope paving is proposed for the 1.5H:1V slopes on both sides of the proposed multi-use trail where it crosses under the proposed pedestrian undercrossing.

Preservation of Existing Vegetation

- The limits of grading will be cleared and grubbed.
- Environmentally Sensitive Areas (ESAs) will be demarcated (fenced) as shown on the Plans.
- The project requires limited work within ESAs. The project was designed to minimize impacts to ESAs to the maximum extent practicable.

Treatment BMP Strategy

Not applicable.

Permanent Storm Water Control Measures (SCMs) are provided outside the highway right-of-way per the City of Seaside and City of Del Rey Oaks MS4 permits. Work outside the highway right-of-way is described in the project's Storm Water Control Plan (SWCP) and submitted to the Cities of Del Rey Oaks and Seaside.

Highway Drainage

- The following drainage systems are proposed within the highway:

  - System 1, Trail Sta 50+00, PM 0.11, plan sheet C-104: a new Type G3 drain inlet, 15" storm drain and RSP outlet protection are proposed on the southwest side of State Route 218, southeast of Wilson Drive. This drain inlet is added primarily to remove roadway drainage upstream of the new curb ramp; runoff currently flows around the curb return, exiting the highway ROW to Wilson Drive. The drain inlet's tributary area is 0.4 ac, and the storm drain will discharge into Work Memorial Park. Project Storm Water Control Measure (SCM) #2.1 (bioretention pond) is located downstream of this drainage system.
  - System 5, Trail Sta 202+00, PM 0.92, plan sheet C-104: a new Type G0 drain inlet, 15" storm drain and RSP outlet protection are proposed on the northeast side of State Route 218. The drain inlet's tributary area is 0.8 ac, and the storm drain will discharge into the Frog Pond Wetland Preserve.
  - System 6, Trail Sta 202+60 to 205+70, PM 0.88 to 0.93, plan sheets C-111, C-112 and C-113: runoff from 21 acres within the Cities of Del Rey Oaks and Seaside collects at the intersection of Carlton Drive, Work Avenue and State Route 218. Currently this drainage is collected by an asphalt gutter on the northeast side of State Route 218 and conveys the flow into a 15" CMP over-side drain at PM 0.91. The project proposes to bulb-out the curb returns on the northeast side of State Route 218 at Carlton Drive, thus reducing the water spread width on the northeast side of the highway to 5 feet. (The highway is superelevated at this location, so if water spread exceeds 5 feet, water will sheet across the highway.) Type GOL drain inlets are therefore proposed on Carlton Drive and on Work Avenue, to maximize the removal of local street runoff prior to it reaching the highway. A 24"-diameter storm drain is proposed to convey collected runoff through the highway right-of-way to the Frog Pond Wetland Preserve.

- Water spread was checked at the two proposed drain inlets on the highway, and at the proposed bulb-out on the south side of State Route 218 at PM 0.87.
  - Drain inlet 1a (PM 0.11) meets the water spread criteria (shoulder plus ½ of outer lane). A spread of 5.0 feet is calculated, and 16 feet is allowed.
  - Drain inlet 5a (PM 0.92): Water spread is limited to 5 feet (shoulder width) due to the highway superelevation. Four Type GOL drain inlets are proposed on Work Avenue and Carlton Drive just north of the highway to minimize the amount of local street runoff arriving at the highway. A spread of 5.0 feet is calculated.
  - The bulb-out at PM 0.87 meets the selected water spread criteria (shoulder plus ½ of outer vehicular lane). A spread of 7.0 feet is calculated, and 12 feet is allowed.

Pedestrian Undercrossing Drainage

- Canyon del Rey Creek currently crosses under State Route 218 via a 6'-wide x 8'-tall RCB culvert at PM 0.96. The existing RCB has an upstream flowline elevation of 76.5'.
- The low point on the Highway crown (the elevation at which the highway is overtopped) is approximately elevation 83.4'. (The low point is approximately 170' southeast of the existing RCB culvert).
- The proposed PUC will be constructed approximately 200 feet northwest of the existing RCB culvert. The PUC is located as far west as possible to maximize the existing highway elevation. Also the bridge type was selected to minimize the structure depth.
- The proposed trail profile grade on the north (upstream) side of State Route 218 is 78.0'. This trail grade is driven by the existing highway grade, the bridge deck depth, and the required trail clear height.

- The FEMA Flood Insurance Study for Monterey County (2017) provides 10- and 100-year flood elevations on the north side of the highway (in the Frog Pond Wetland Preserve) of 92.5' and 95', respectively.
- Monterey County's Canyon del Rey Master Drainage Plan (Balance Hydrologics, 2014) provides estimated 10- and 100-year flood elevations of 83' and 85', respectively.
- The PDT discussed potential design mitigations for flooding of the PUC with Caltrans at our regularly scheduled PDT meeting in June 2022. It was agreed that an earthen berm be constructed to elevation to reduce the frequency that floodwaters in the Frog Pond can enter the PUC. This berm elevation would still allow an accessible trail connection between the proposed FORTAG Trail and the existing trail network around the Frog Pond, which is a key project component..

Attachments

1. Evaluation Documentation Form (EDF)
2. SWDR Attachment for SMARTS Input
3. Checklist SW-1, Site Data Sources
4. Vicinity Map
5. Risk Level Determination Documentation
6. Hydrologic and Hydraulic Calculations
7. Landscape MWELO Documentation

APPENDIX E

Evaluation Documentation Form

DATE: 12/12/2022

Project ID / EA: 05200000029 (051M570)

No.	Criteria	Yes ✓	No ✓	Supplemental Information for Evaluation
1.	Begin Project evaluation regarding requirement for implementation of Treatment BMPs	✓		See Figure 4-1, Project Evaluation Process for Consideration of Permanent Treatment BMPs. Continue to 2.
2.	Is the scope of the Project to install Treatment BMPs (e.g., Alternative Compliance, TMDL, Trash Amendment Compliance)?		✓	If **Yes**, go to 8. If **No**, continue to 3.
3.	Is there a direct or indirect discharge to surface waters?	✓		If **Yes**, continue to 4. If **No**, go to 9.
4.	As defined in the WQAR, does the Project have: 1. Areas of Special Biological Significance (ASBS), 2. A TMDL area where Caltrans is named stakeholder, or 3. Other Pollution Control Requirements for surface waters within the project limits?		✓ ✓ ✓	If **Yes to any**, contact the District/Regional Stormwater Coordinator to discuss the Department's obligations, go to 8 or 5. _____*(Dist./Reg. SW Coordinator initials*) If **No**, continue to 5.
5.	Are any existing Treatment BMPs partially or completely removed? (ATA condition #1, See PPDG Section 4.4.1)		✓	If **Yes**, go to 8 **AND** continue to 6. If **No**, continue to 6.
6.	Is this a Routine Maintenance Project?		✓	If **Yes**, continue to 9. If **No**, go to 7.
7.	Does the project result in one acre or more of new impervious surface (NIS)?		✓	If **Yes**, go to 8. _____*ac NIS (NIS=NNI+ RIS)* If **No**, continue to 9.
8.	Project is required to implement Treatment BMPs.	Complete Checklist T-1, Part 1.		
9.	Project is not required to implement Treatment BMPs. _____ *(Dist. /Reg. SW Coord. Initials)* _____*(Project Engineer Initials)* _____ *(Date)*	Document for Project Files by completing this form and attaching it to the SWDR.		

The following information is based on the PS&E design plans and specifications. If contract amendments or change orders are made after the design is complete, then the information should be updated by construction, as appropriate.

Project ID (EA): 05200000029 (051M570)

Enter the following data into the CGP SMARTS Notice of Intent-Site Information page.

1. **Total site size** (acres); for project area use Caltrans R/W x post mile limits (begin-end) on plan sheets.

Total site size 4.0 acres *(using the disturbed area as the "site size", since project spans multiple jurisdictions, rights of way and parcels. This does not affect the Risk Level calculation.)*

2. Enter **latitude and longitude** in decimal degrees to 5 significant figures. Use a location from the center of the project. This information can be obtained from Survey information, GPS units, Google earth, CT Earth, or other mapping software.

Latitude: 36.5955

Longitude: -121.8439

3. **Total Area to be Disturbed** (total Disturbed Soil Area (DSA)): This information is already calculated and can be taken from SWDR Section 1. It is should be described in acres.

DSA 4.0 acres

4. **Imperviousness before Construction (percentage)** - This is calculated as the total impervious area of the project area divided by the total project area (see total site size), multiplied by 100. The impervious area is all paved areas or hard surfaces within the project limits.

Impervious area before construction 42%

5. **Percent of total disturbed (percentage)**; This should be calculated by dividing the total disturbed soil area by the total project area and multiply by 100.

Percent of Total disturbed area 100%

6. **Imperviousness after Construction (percentage)**, This should be calculated by adding all impervious area paved and hard surfaces based on the final design within project limits from above and dividing by the total project area from above multiply by 100.

Impervious area after construction 76%

7. **Mile Post Marker**, enter the approximate post mile at the center of the project or take the average of the "begin" and "end" post mile markers from the title sheet.
Mile post Marker 0.5

8. **Is the construction site part of a larger common plan of development**? No.

9. **Name of development.**

Name of plan or development: N/A

10. **Estimated Construction Commencement Date**,

Estimated Construction Commencement Date, 08/28/2023.

11. **Estimated Complete Grading Date/Complete Project Date**;

Estimated Complete Grading Date/Complete Project: 04/24/2024. Use the same date for both inputs, unless instructed otherwise.

12. **Does the Stormwater from the construction site discharge directly or indirectly into waters of the United States.**

Indirect discharge _Y__ - If yes, list name(s) of receiving water(s) __Canyon del Rey Creek_____

Direct discharge _Y__ - If yes, list name(s) of receiving water(s) __Canyon del Rey Creek_____

13. **Risk Level**; the combined project risk level is calculated using the sediment risk factor and the water body risk factor to give one overall project risk level. Use the Caltrans risk level determination guidance, (see the Stormwater design web page). Attach all risk calculations.

R factor value __47.92____

K factor value___0.1____

LS factor value__1.74____

High receiving water risk _No__

14. Provide electronic copy of plan sheets in .pdf format that can be loaded to SMARTS, burn a CD for the RE to use for the project. The Title sheet can be used as the site map.

15. Methodology for obtaining the CGP NOT decided by the PDT, see SWDR Section 4 text for methodology text and computational proof as appropriate, circle one. See SWRCB bulletin for details: http://www.waterboards.ca.gov/water_issues/programs/stormwater/docs/bulletin_2013_1.pdf

a. 70% final cover method

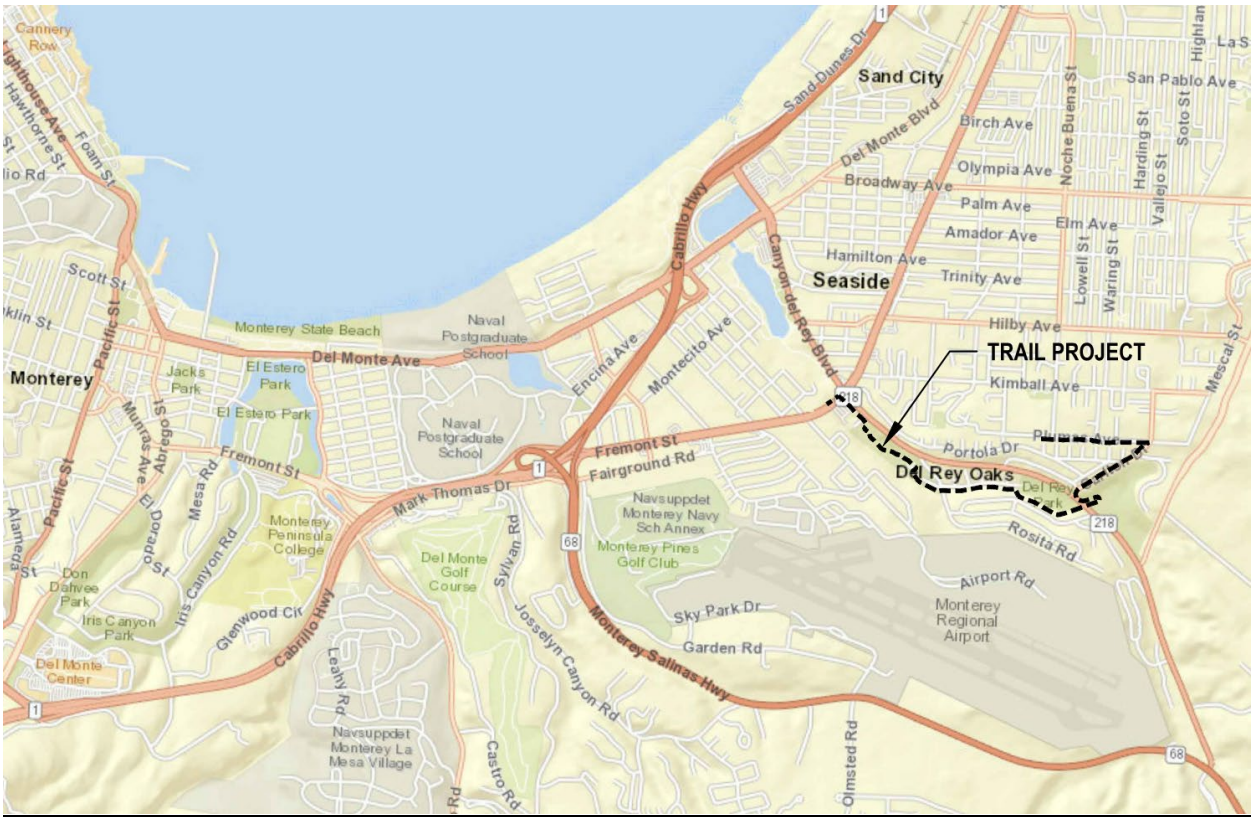
Checklist SW-1, Site Data Sources

Prepared by: N. Milam Date: 12/12/22 District-Co-Route: 05-MON-218
PM : 0.0 / 0.9 Project ID (EA): 05200000029 (051M570) RWQCB: Central Coast

Information for the following data categories should be obtained, reviewed and referenced as necessary throughout the project planning phase. Collect any available documents pertaining to the category and list them and reference your data source. For specific examples of documents within these categories, refer to Section 5.5 of this document. Example categories have been listed below; add additional categories, as needed. Summarize pertinent information in Section 2 of the SWDR.

DATA CATEGORY/SOURCES	Date
Topographic	
• Project topographic mapping	2020
• Project Plans (for proposed topography)	2022
•	
Hydraulic	
• FEMA Flood Insurance Study for Monterey County	2009
• Canyon del Rey Master Drainage Plan	2014
• Project Storm Water Control Plan	2022
Soils	
• NRCS Soil Survey- https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx	
• Project Geotechnical Data Report	2022
•	
Climatic	
• NOAA PFDS	
• EPA R-Factor Calculator- https://www.epa.gov/npdes/rainfall-erosivity-factor-calculator-small-construction-sites	
•	
Water Quality	
• Project Planning and Design Guide	
• Water Quality Planning Tool- http://www.owp.csus.edu/WQPT/wqpt.aspx	
•	
Other Data Categories	
•	
•	
•	

Vicinity Map



Start Date: 08/28/2023	**Latitude:** 36.5955
End Date: 04/28/2024	**Longitude:** -121.8439

Calculation Results

Rainfall erosivity factor (R Factor) = **47.92**

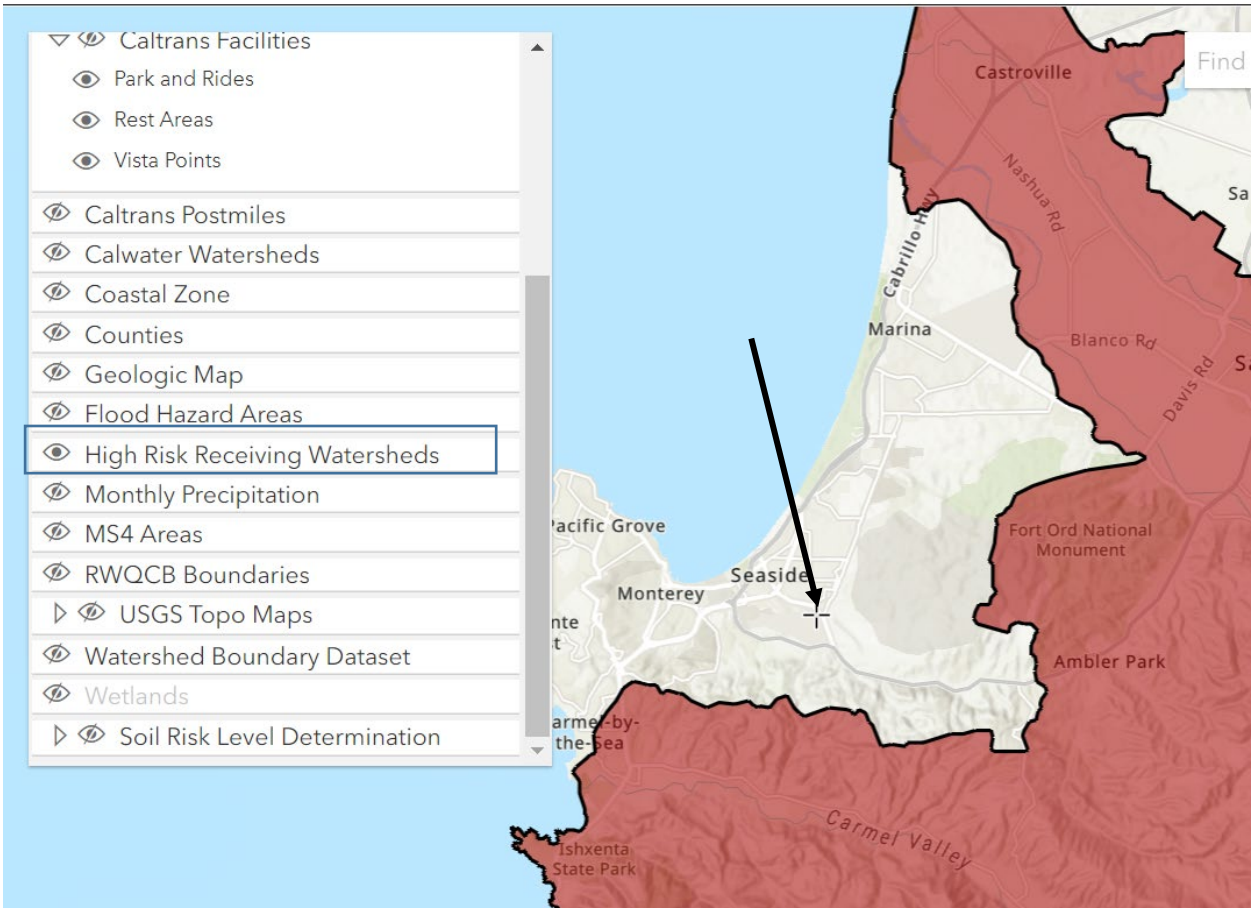
Source: https://lew.epa.gov/ accessed 12/13/2022

K = 0.1
Source: SWRCB GIS Data

LS = 1.74
Source: SWRCB GIS Data

Caltrans Water Quality Planning Tool

The Water Quality Planning Tool was created to help planners and designers comply with environmental permits. It uses a map a project's location. **This application is being updated for digital accessibility and will continue to function while update**



Receiving Water Risk = Low
Source: Caltrans WQ Planning Tool

Gutter Spread and Drain Inlet Calculations

Project: TAMC FORTAG Phase 1

Date: 4/7/2023

System ID:		**1a**	**5a**	**7c**	**8a**	**9a**	**10a**	**12c**	**Exist DI 252+50**	**Bulb-Out**	**Bulb-Out**	
Trail Station		50+10	201+50	244+30	244+00	244+50	252+30	252+30	252+50	13+00	N/A	
Route / Street		218	218	Carlton	Work	Carlton	Carlton	Carlton	Carlton	218	218	
PM		0.11	0.92	--	--	--	--	--	--	0.07	0.87	
Design Storm Frequency	year	10	10	10	10	10	10	10	10	10	10	HDM Table 831.3
Time of Concentration	minutes	5	5	10	10	10	10	10	10	5	5	Assumed per HDM 816.6
Precipitation Intensity "i"	in/hr	3.25	3.25	2.33	2.33	2.33	2.33	2.33	2.33	3.25	3.25	NOAA Atlas 14
Watershed Characteristics												
Imperv. Runoff Coefficient "Ci"	--	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	HDM Table 819.2B
Perv. Runoff Coefficient "Cp"	--	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	HDM Table 819.2A
Percent Impervious "imp"	--	80%	50%	60%	70%	60%	65%	65%	42%	100%	60%	
Frequency Factor "Cf"	--	1	1	1	1	1	1	1	1	1	1	HDM 819.2(1)
Composite "C"	--	*0.80*	*0.65*	*0.70*	*0.75*	*0.70*	*0.73*	*0.73*	*0.61*	*0.90*	*0.70*	*C = Cf (Ci * imp + Cp (1 - imp))*
Drainage Area "A"	acres	0.38	0.79	2.76	5.51	1.84	1.52	1.52	8.32	0.20	3.16	
Watershed Runoff	cfs	0.99	1.67	4.50	9.63	3.00	2.57	2.57	11.83	0.59	7.19	Q = C * i * A
Bypass flow from upstream	cfs		2.15			0.26		3.76				
Total Gutter Flow	cfs	0.99	3.82	4.50	9.63	3.26	2.57	6.32	11.83	0.59	7.19	
Water Spread												
Gutter present?		No	Yes							Yes	Yes	
Curb or dike present?		Dike	Curb							Curb	Curb	
Allowable Spread	ft	16	5							6	12	Shoulder plus one-half of outside lane
Calculated Spread	ft	5.0	5.0							4.8	6.9	see attached calculation sheet
Drain Inlet (On-Grade)												
Inlet Type		G3	G3	GOL (10')	GOL (10')	GOL (10')	GOL (7')	GOL (10')	City Std.			
Captured Flow	cfs	0.87	2.92	4.11	8.51	3.15	2.31	5.79	8.07			see attached calculation sheet
Bypass Flow	cfs	0.12	0.90	0.39	1.12	0.11	0.26	0.53	3.76			see attached calculation sheet
Bypass Flows To Structure				5a	5a	5a	9a	5a	12c			see attached calculation sheet

Rock Riprap Apron Sizing (HEC-14, Section 10.2)

Project: TAMC FORTAG Phase 1

Date: Dec 29, 2022

System ID:		1e	5c	6a
Trail Station:		50+10	201+50	202+70
Route:		218	218	Frog Pond
PM:		0.11	0.92	N/A

Inputs

Storm Drain Diameter "D"	ft	1.25	1.25	2	
Discharge "Q"	cfs	0.87	2.92	21.6	
Supercritical flow in culvert?		Yes	Yes	Yes	If yes, complete "yn" below
Normal (supercritical) depth "yn"	ft	0.17	0.35	1.21	See attached calculation

Constants

Gravitational acceleration "g"	fps^2	32.2	32.2	32.2	
Rock specific gravity	--	2.65	2.65	2.65	

Calculated Values

Tailwater Depth "TW"	ft	0.50	0.50	0.80	TW = 0.4D (conservative)
Adjusted Culvert Diameter D'	ft	0.71	0.8	1.605	if supercritical, D' = (D + yn) / 2 otherwise, D' = D
Riprap Size "D50"	ft	0.05	0.22	0.79	$D_{50} = 0.2\,D\left(\frac{Q}{\sqrt{g}D^{2.5}}\right)^{4/3}\left(\frac{D}{TW}\right)$

RSP Pad Dimensions:

Caltrans RSP Class		I	I	II	
Rock D50	in	6	6	9	
Apron Length	ft	5.00	5.00	13.30	See Table 10.1 (+ 3.3' if no FES)
Apron Thickness	ft	1.65	1.65	1.80	See Table 10.1
Apron Width, Upstream	ft	3.75	3.75	6	= 3D
Flared End Section?		Yes	Yes	No	
Apron Width, Downstream	ft	7.1	7.1	18.2	= 3D + 2/3 L (+ 3.3 feet if no FES)

Table 10.1. Example Riprap Classes and Apron Dimensions

Class	D_{50} (mm)	D_{50} (in)	Apron Length[1]	Apron Depth
1	125	5	4D	$3.5D_{50}$
2	150	6	4D	$3.3D_{50}$
3	250	10	5D	$2.4D_{50}$
4	350	14	6D	$2.2D_{50}$
5	500	20	7D	$2.0D_{50}$
6	550	22	8D	$2.0D_{50}$

[1]D is the culvert rise.

Rock Riprap Apron Sizing Calculation (HEC-14, Section 10.2)

Rock Gradation

Nominal RSP class by median particle diameter[b]		Nominal median particle weight W_{50}[c,d]	d_{15}[c] (in)		d_{50}[c] (in)		d_{100}[c] (in)	Placement
Class[a]	Diameter (in)		Min	Max	Min	Max	Max	Method
I	6	20 lb	3.7	5.2	5.7	6.9	12.0	B
II	9	60 lb	5.5	7.8	8.5	10.5	18.0	B
III	12	150 lb	7.3	10.5	11.5	14.0	24.0	B
IV	15	300 lb	9.2	13.0	14.5	17.5	30.0	B
V	18	1/4 ton	11.0	15.5	17.0	20.5	36.0	B
VI	21	3/8 ton	13.0	18.5	20.0	24.0	42.0	A or B
VII	24	1/2 ton	14.5	21.0	23.0	27.5	48.0	A or B
VIII	30	1 ton	18.5	26.0	28.5	34.5	48.0	A or B
IX	36	2 ton	22.0	31.5	34.0	41.5	52.8	A
X	42	3 ton	25.5	36.5	40.0	48.5	60.5	A
XI	46	4 ton	28.0	39.4	43.7	53.1	66.6	A

[a]For RSP Classes I–VIII, use Class 8 RSP fabric. For RSP Classes IX–XI, use Class 10 RSP fabric.
[b]Intermediate or B dimension (i.e., width) where A dimension is length and C dimension is thickness.
[c]d%, where % denotes the percentage of the total weight of the graded material.
[d]Values shown are based on the minimum and maximum particle diameters shown and an average specific gravity of 2.65. Weight will vary based on specific gravity of rock available for the project.

Table 10.1. Example Riprap Classes and Apron Dimensions

Class	D_{50} (mm)	D_{50} (in)	Apron Length[1]	Apron Depth
1	125	5	4D	$3.5D_{50}$
2	150	6	4D	$3.3D_{50}$
3	250	10	5D	$2.4D_{50}$
4	350	14	6D	$2.2D_{50}$
5	500	20	7D	$2.0D_{50}$
6	550	22	8D	$2.0D_{50}$

[1]D is the culvert rise.

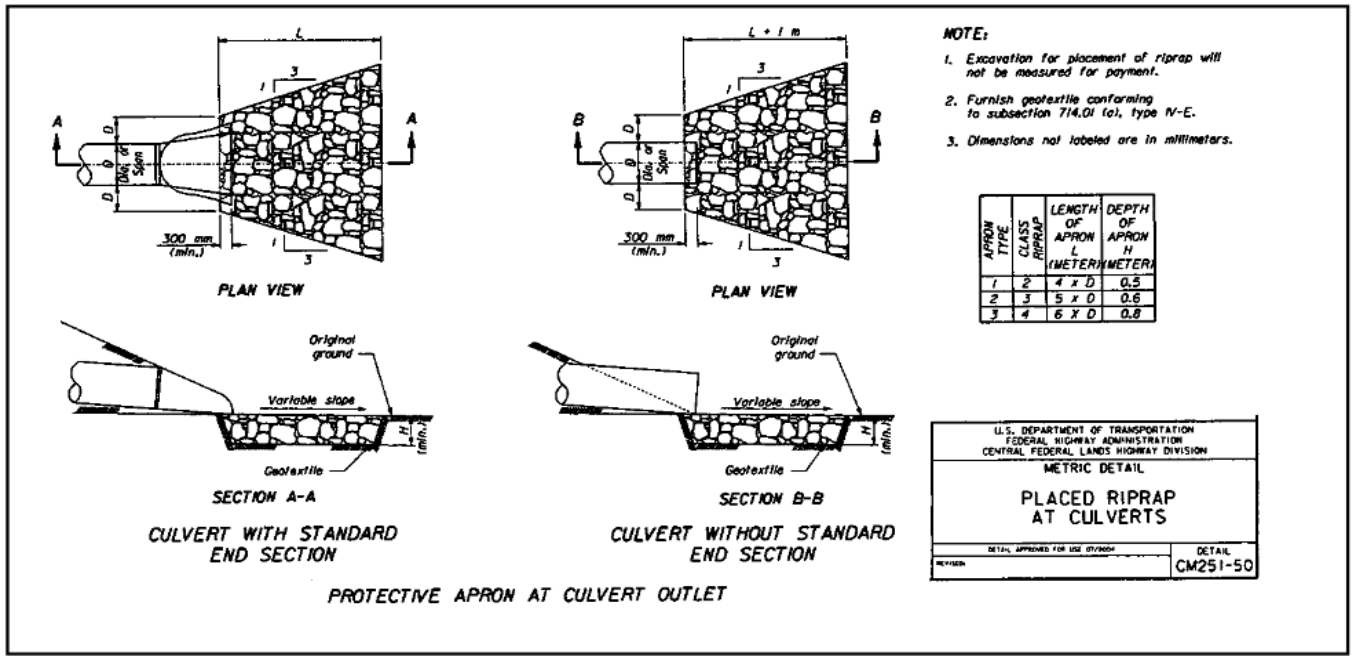


Figure 10.4. Placed Riprap at Culverts (Central Federal Lands Highway Division)

NOAA Atlas 14, Volume 6, Version 2
Location name: Monterey, California, USA*
Latitude: 36.5959°, Longitude: -121.8374°
Elevation: 152.43 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

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

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.144 (0.126-0.165)	0.178 (0.156-0.205)	0.227 (0.198-0.263)	0.271 (0.234-0.317)	0.338 (0.281-0.410)	0.394 (0.320-0.490)	0.457 (0.360-0.585)	0.527 (0.403-0.697)	0.633 (0.461-0.877)	0.724 (0.507-1.04)
10-min	0.206 (0.181-0.237)	0.255 (0.223-0.294)	0.325 (0.284-0.376)	0.389 (0.336-0.454)	0.484 (0.402-0.587)	0.565 (0.459-0.703)	0.655 (0.517-0.838)	0.756 (0.577-0.999)	0.907 (0.661-1.26)	1.04 (0.727-1.50)
15-min	0.249 (0.218-0.287)	0.308 (0.270-0.355)	0.393 (0.344-0.455)	0.470 (0.406-0.549)	0.585 (0.487-0.710)	0.683 (0.555-0.850)	0.792 (0.625-1.01)	0.914 (0.698-1.21)	1.10 (0.799-1.52)	1.25 (0.879-1.81)
30-min	0.359 (0.315-0.414)	0.444 (0.389-0.512)	0.568 (0.496-0.657)	0.678 (0.586-0.792)	0.844 (0.702-1.02)	0.986 (0.800-1.23)	1.14 (0.901-1.46)	1.32 (1.01-1.74)	1.58 (1.15-2.19)	1.81 (1.27-2.61)
60-min	0.443 (0.388-0.510)	0.547 (0.479-0.631)	0.699 (0.610-0.809)	0.835 (0.722-0.975)	1.04 (0.865-1.26)	1.21 (0.985-1.51)	1.41 (1.11-1.80)	1.62 (1.24-2.15)	1.95 (1.42-2.70)	2.23 (1.56-3.21)
2-hr	0.606 (0.532-0.698)	0.746 (0.654-0.861)	0.945 (0.825-1.09)	1.12 (0.968-1.31)	1.38 (1.14-1.67)	1.59 (1.29-1.98)	1.82 (1.44-2.33)	2.08 (1.59-2.74)	2.45 (1.78-3.40)	2.76 (1.94-3.99)
3-hr	0.737 (0.647-0.849)	0.909 (0.796-1.05)	1.15 (1.00-1.33)	1.36 (1.18-1.59)	1.66 (1.38-2.02)	1.92 (1.55-2.38)	2.18 (1.72-2.80)	2.48 (1.89-3.28)	2.91 (2.12-4.03)	3.26 (2.29-4.71)
6-hr	0.945 (0.829-1.09)	1.18 (1.03-1.36)	1.50 (1.31-1.73)	1.77 (1.53-2.07)	2.17 (1.80-2.63)	2.48 (2.02-3.09)	2.82 (2.23-3.61)	3.19 (2.43-4.21)	3.71 (2.70-5.14)	4.13 (2.90-5.96)
12-hr	1.11 (0.975-1.28)	1.42 (1.24-1.64)	1.84 (1.61-2.13)	2.19 (1.90-2.56)	2.70 (2.25-3.28)	3.11 (2.52-3.86)	3.53 (2.79-4.52)	3.99 (3.05-5.28)	4.64 (3.38-6.44)	5.17 (3.62-7.46)
24-hr	1.46 (1.34-1.63)	1.92 (1.75-2.14)	2.53 (2.31-2.83)	3.04 (2.76-3.43)	3.76 (3.32-4.36)	4.34 (3.76-5.11)	4.94 (4.19-5.94)	5.58 (4.62-6.87)	6.48 (5.18-8.26)	7.20 (5.59-9.46)
2-day	1.83 (1.67-2.04)	2.41 (2.20-2.69)	3.19 (2.91-3.56)	3.82 (3.47-4.31)	4.70 (4.15-5.45)	5.39 (4.67-6.35)	6.10 (5.17-7.33)	6.84 (5.66-8.42)	7.85 (6.28-10.0)	8.66 (6.73-11.4)
3-day	2.09 (1.91-2.33)	2.77 (2.53-3.09)	3.65 (3.33-4.08)	4.37 (3.96-4.92)	5.35 (4.72-6.20)	6.11 (5.29-7.20)	6.88 (5.84-8.28)	7.68 (6.36-9.46)	8.77 (7.01-11.2)	9.62 (7.47-12.6)
4-day	2.29 (2.10-2.55)	3.04 (2.78-3.39)	4.01 (3.65-4.48)	4.79 (4.34-5.40)	5.86 (5.16-6.78)	6.67 (5.78-7.86)	7.50 (6.36-9.02)	8.35 (6.92-10.3)	9.50 (7.60-12.1)	10.4 (8.07-13.6)
7-day	2.80 (2.57-3.12)	3.75 (3.43-4.19)	4.97 (4.54-5.56)	5.95 (5.39-6.70)	7.26 (6.40-8.40)	8.25 (7.15-9.72)	9.25 (7.85-11.1)	10.3 (8.51-12.6)	11.6 (9.31-14.8)	12.7 (9.85-16.7)
10-day	3.16 (2.90-3.52)	4.25 (3.89-4.75)	5.65 (5.15-6.31)	6.76 (6.12-7.61)	8.24 (7.26-9.53)	9.35 (8.10-11.0)	10.5 (8.88-12.6)	11.6 (9.61-14.3)	13.1 (10.5-16.7)	14.3 (11.1-18.7)
20-day	4.18 (3.82-4.65)	5.62 (5.14-6.27)	7.45 (6.80-8.33)	8.89 (8.05-10.0)	10.8 (9.50-12.5)	12.2 (10.5-14.3)	13.6 (11.5-16.3)	15.0 (12.4-18.4)	16.8 (13.4-21.4)	18.2 (14.1-23.9)
30-day	5.07 (4.64-5.65)	6.78 (6.20-7.56)	8.92 (8.14-9.98)	10.6 (9.60-11.9)	12.8 (11.3-14.8)	14.4 (12.5-16.9)	16.0 (13.5-19.2)	17.5 (14.5-21.6)	19.6 (15.7-25.0)	21.1 (16.4-27.7)
45-day	6.39 (5.85-7.12)	8.44 (7.72-9.42)	11.0 (10.0-12.3)	13.0 (11.8-14.6)	15.5 (13.7-18.0)	17.4 (15.1-20.5)	19.2 (16.3-23.1)	21.0 (17.4-25.9)	23.3 (18.7-29.8)	25.1 (19.5-32.9)
60-day	7.66 (7.01-8.53)	9.99 (9.13-11.1)	12.9 (11.7-14.4)	15.1 (13.7-17.0)	17.9 (15.8-20.8)	20.0 (17.3-23.6)	22.0 (18.7-26.5)	24.0 (19.9-29.6)	26.5 (21.2-33.9)	28.4 (22.1-37.3)

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

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

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical

NOAA Atlas 14, Volume 6, Version 2
Location name: Monterey, California, USA*
Latitude: 36.5959°, Longitude: -121.8374°
Elevation: 152.43 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

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

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**1.73** (1.51-1.98)	**2.14** (1.87-2.46)	**2.72** (2.38-3.16)	**3.25** (2.81-3.80)	**4.06** (3.37-4.92)	**4.73** (3.84-5.88)	**5.48** (4.32-7.02)	**6.32** (4.84-8.36)	**7.60** (5.53-10.5)	**8.69** (6.08-12.5)
10-min	**1.24** (1.09-1.42)	**1.53** (1.34-1.76)	**1.95** (1.70-2.26)	**2.33** (2.02-2.72)	**2.90** (2.41-3.52)	**3.39** (2.75-4.22)	**3.93** (3.10-5.03)	**4.54** (3.46-5.99)	**5.44** (3.97-7.55)	**6.22** (4.36-8.98)
15-min	**0.996** (0.872-1.15)	**1.23** (1.08-1.42)	**1.57** (1.38-1.82)	**1.88** (1.62-2.20)	**2.34** (1.95-2.84)	**2.73** (2.22-3.40)	**3.17** (2.50-4.05)	**3.66** (2.79-4.83)	**4.39** (3.20-6.08)	**5.02** (3.52-7.24)
30-min	**0.718** (0.630-0.828)	**0.888** (0.778-1.02)	**1.14** (0.992-1.31)	**1.36** (1.17-1.58)	**1.69** (1.40-2.05)	**1.97** (1.60-2.45)	**2.28** (1.80-2.92)	**2.64** (2.01-3.49)	**3.17** (2.31-4.39)	**3.62** (2.54-5.22)
60-min	**0.443** (0.388-0.510)	**0.547** (0.479-0.631)	**0.699** (0.610-0.809)	**0.835** (0.722-0.975)	**1.04** (0.865-1.26)	**1.21** (0.985-1.51)	**1.41** (1.11-1.80)	**1.62** (1.24-2.15)	**1.95** (1.42-2.70)	**2.23** (1.56-3.21)
2-hr	**0.303** (0.266-0.349)	**0.373** (0.327-0.430)	**0.472** (0.412-0.546)	**0.560** (0.484-0.654)	**0.688** (0.572-0.834)	**0.794** (0.644-0.988)	**0.910** (0.718-1.16)	**1.04** (0.792-1.37)	**1.22** (0.892-1.70)	**1.38** (0.968-1.99)
3-hr	**0.245** (0.215-0.283)	**0.303** (0.265-0.349)	**0.383** (0.335-0.443)	**0.453** (0.392-0.529)	**0.554** (0.461-0.673)	**0.638** (0.517-0.793)	**0.727** (0.574-0.931)	**0.826** (0.631-1.09)	**0.968** (0.705-1.34)	**1.09** (0.761-1.57)
6-hr	**0.158** (0.138-0.182)	**0.197** (0.172-0.227)	**0.250** (0.218-0.289)	**0.296** (0.256-0.346)	**0.362** (0.301-0.439)	**0.415** (0.337-0.516)	**0.471** (0.372-0.603)	**0.532** (0.406-0.703)	**0.619** (0.451-0.858)	**0.690** (0.484-0.996)
12-hr	**0.092** (0.081-0.106)	**0.118** (0.103-0.136)	**0.153** (0.133-0.177)	**0.182** (0.158-0.213)	**0.224** (0.186-0.272)	**0.258** (0.209-0.321)	**0.293** (0.231-0.375)	**0.331** (0.253-0.438)	**0.385** (0.281-0.534)	**0.429** (0.301-0.619)
24-hr	**0.061** (0.056-0.068)	**0.080** (0.073-0.089)	**0.105** (0.096-0.118)	**0.127** (0.115-0.143)	**0.157** (0.138-0.182)	**0.181** (0.157-0.213)	**0.206** (0.175-0.248)	**0.232** (0.193-0.286)	**0.270** (0.216-0.344)	**0.300** (0.233-0.394)
2-day	**0.038** (0.035-0.042)	**0.050** (0.046-0.056)	**0.066** (0.061-0.074)	**0.080** (0.072-0.090)	**0.098** (0.086-0.113)	**0.112** (0.097-0.132)	**0.127** (0.108-0.153)	**0.142** (0.118-0.175)	**0.164** (0.131-0.209)	**0.180** (0.140-0.237)
3-day	**0.029** (0.027-0.032)	**0.038** (0.035-0.043)	**0.051** (0.046-0.057)	**0.061** (0.055-0.068)	**0.074** (0.066-0.086)	**0.085** (0.073-0.100)	**0.096** (0.081-0.115)	**0.107** (0.088-0.131)	**0.122** (0.097-0.155)	**0.134** (0.104-0.175)
4-day	**0.024** (0.022-0.027)	**0.032** (0.029-0.035)	**0.042** (0.038-0.047)	**0.050** (0.045-0.056)	**0.061** (0.054-0.071)	**0.070** (0.060-0.082)	**0.078** (0.066-0.094)	**0.087** (0.072-0.107)	**0.099** (0.079-0.126)	**0.108** (0.084-0.142)
7-day	**0.017** (0.015-0.019)	**0.022** (0.020-0.025)	**0.030** (0.027-0.033)	**0.035** (0.032-0.040)	**0.043** (0.038-0.050)	**0.049** (0.043-0.058)	**0.055** (0.047-0.066)	**0.061** (0.051-0.075)	**0.069** (0.055-0.088)	**0.076** (0.059-0.099)
10-day	**0.013** (0.012-0.015)	**0.018** (0.016-0.020)	**0.024** (0.021-0.026)	**0.028** (0.026-0.032)	**0.034** (0.030-0.040)	**0.039** (0.034-0.046)	**0.044** (0.037-0.052)	**0.048** (0.040-0.060)	**0.055** (0.044-0.070)	**0.059** (0.046-0.078)
20-day	**0.009** (0.008-0.010)	**0.012** (0.011-0.013)	**0.016** (0.014-0.017)	**0.019** (0.017-0.021)	**0.022** (0.020-0.026)	**0.025** (0.022-0.030)	**0.028** (0.024-0.034)	**0.031** (0.026-0.038)	**0.035** (0.028-0.045)	**0.038** (0.029-0.050)
30-day	**0.007** (0.006-0.008)	**0.009** (0.009-0.010)	**0.012** (0.011-0.014)	**0.015** (0.013-0.017)	**0.018** (0.016-0.021)	**0.020** (0.017-0.024)	**0.022** (0.019-0.027)	**0.024** (0.020-0.030)	**0.027** (0.022-0.035)	**0.029** (0.023-0.039)
45-day	**0.006** (0.005-0.007)	**0.008** (0.007-0.009)	**0.010** (0.009-0.011)	**0.012** (0.011-0.014)	**0.014** (0.013-0.017)	**0.016** (0.014-0.019)	**0.018** (0.015-0.021)	**0.019** (0.016-0.024)	**0.022** (0.017-0.028)	**0.023** (0.018-0.030)
60-day	**0.005** (0.005-0.006)	**0.007** (0.006-0.008)	**0.009** (0.008-0.010)	**0.010** (0.009-0.012)	**0.012** (0.011-0.014)	**0.014** (0.012-0.016)	**0.015** (0.013-0.018)	**0.017** (0.014-0.021)	**0.018** (0.015-0.024)	**0.020** (0.015-0.026)

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

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

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical

816.6 Time of Concentration (Tc) and Travel Time (Tt)

Time of concentration is defined as the time required for storm runoff to travel from the hydraulically most remote point of the drainage basin to the point of interest.

An assumption made in some of the hydrologic methods for estimating peak discharge, such as the Rational and NRCS Methods (Index 819.2), is that maximum flow results when rainfall of uniform intensity falls over the entire watershed area and the duration of that rainfall is equal to the time of concentration. Time of concentration (T_C) is typically the cumulative sum of three travel times, including:

- Sheet flow
- Shallow concentrated flow
- Channel flow

For all-paved watersheds (e.g., parking lots, roadway travel lanes and shoulders, etc.) it is not necessary to calculate a separate shallow concentrated flow travel time segment. Such flows will typically transition directly from sheet flow to channel flow or be intercepted at inlets with either no, or inconsequential lengths of, shallow concentrated flow.

In many cases a minimum time of concentration will have to be assumed as extremely short travel times will lead to calculated rainfall intensities that are overly conservative for design purposes. For all-paved areas, slopes steeper than 10H:1V, or where there is a limited opportunity for surface storage, a minimum T_C of 5 minutes should be assumed. For rural or undeveloped areas, it is recommended that a minimum T_C of 10 minutes be used for most situations.

Designers should be aware that maximum runoff estimates are not always obtained using rainfall intensities determined by the time of concentration for the total area. Peak runoff estimates may be obtained by applying higher rainfall intensities from storms of short duration over a portion of the watershed.

(1) Sheet flow travel time. Sheet flow is flow of uniform depth over plane surfaces and usually occurs for some distance after rain falls on the ground. The maximum flow depth is usually less than 0.8 inches – 1.2 inches. For unpaved areas, sheet flow normally exists for a distance less than 80 feet – 100 feet. An upper limit of 300 feet is recommended for paved areas.

A common method to estimate the travel time of sheet flow is based on kinematic wave theory and uses the Kinematic Wave Equation:

$$T_t = \frac{0.93 L^{3/5} n^{3/5}}{i^{2/5} S^{3/10}}$$

where

Tt = Travel time in minutes.

L = Length of flow path in feet.

S = Slope of flow in feet per feet.

n = Manning's roughness coefficient for sheet flow (see Table 816.6A).

i = Design storm rainfall intensity in inches per hour.

frequency factor, C(f). Values of C(f) are given below. Under no circumstances should the product of C(f) times C exceed 1.0.

Frequency (yrs)	C(f)
25	1.1
50	1.2
100	1.25

(2) Regional Analysis Methods. Regional analysis methods utilize records for streams or drainage areas in the vicinity of the stream under consideration which would have similar characteristics to develop peak discharge estimates. These methods provide techniques for estimating annual peak stream discharge at any site, gaged or ungaged, for probability of recurrence from 50 percent (2years) to 1 percent (100 years). Application of these methods is convenient, but the procedure is subject to some limitations.

Regional Flood - Frequency equations developed by the U.S. Geological Survey for use in California are given in Table 819.2C and Table 819.7A. These equations are based on regional regression analysis of data from stream gauging stations. The equations in Table 819.2C were derived from data gathered and analyzed through 2006, while the regions covered by Table 819.7A are reflective of a 1994 study of the Southwestern U.S, which has been supplemented by a more recent 2007 Study of California Desert Region Hydrology. Information on use and development of this method may be found in "Methods for Determining Magnitude and Frequency of Floods in California Based on Data through Water Year 2006" by the U.S. Department of the Interior, Geological Survey.

The Regional Flood-Frequency equations are applicable only to sites within the flood-frequency regions for which they were derived and on streams with virtually natural flows. The equations are not directly applicable to streams in urban areas affected substantially by urban development. In urban areas the equations may be used to estimate peak discharge values under natural conditions and then by use of the techniques described in the publication or HDS No. 2, adjust the discharge values to compensate for urbanization. A method for directly estimating design discharges for some gaged and ungaged streams is also provided in HDS No. 2. The method is applicable to streams on or nearby those for which study data are available.

(3) Flood Frequency Analysis

(a) If there are two gaged sites with similar watershed characteristics but one has a short record and the other has a longer record of peak flows, a two-station comparison analysis can be conducted to extend the equivalent length of record at the shorter gaged site.

(b) Flood-frequency relations at sites near gaged sites on the same stream (or in a similar watershed) can be estimated using a ratio of drainage area for the ungaged and gaged sites.

(c) At a gaged site, weighted estimates of peak discharges based on the station flood-frequency relation and the regional regression equations are considered the best estimates of flood frequency and are used to reduce the time-sampling error that may occur in a station flood-frequency estimate.

Figure 819.2A

Runoff Coefficients for Undeveloped Areas Watershed Types

	Extreme	High	Normal	Low
Relief	.28 -.35 Steep, rugged terrain with average slopes above 30%	.20 -.28 Hilly, with average slopes of 10 to 30%	.14 -.20 Rolling, with average slopes of 5 to 10%	.08 -.14 Relatively flat land, with average slopes of 0 to 5%
Soil Infiltration	.12 -.16 No effective soil cover, either rock or thin soil mantle of negligible infiltration capacity	.08 -.12 Slow to take up water, clay or shallow loam soils of low infiltration capacity, imperfectly or poorly drained	.06 -.08 Normal; well drained light or medium textured soils, sandy loams, silt and silt loams	.04 -.06 High; deep sand or other soil that takes up water readily, very light well drained soils
Vegetal Cover	.12 -.16 No effective plant cover, bare or very sparse cover	.08 -.12 Poor to fair; clean cultivation crops, or poor natural cover, less than 20% of drainage area over good cover	.06 -.08 Fair to good; about 50% of area in good grassland or woodland, not more than 50% of area in cultivated crops	.04 -.06 Good to excellent; about 90% of drainage area in good grassland, woodland or equivalent cover
Surface Storage	.10 -.12 Negligible surface depression few and shallow; drainageways steep and small, no marshes	.08 -.10 Low; well defined system of small drainageways; no ponds or marshes	.06 -.08 Normal; considerable surface depression storage; lakes and pond marshes	.04 -.06 High; surface storage, high; drainage system not sharply defined; large floodplain storage or large number of ponds or marshes
Given	An undeveloped watershed consisting of; 1) rolling terrain with average slopes of 5%, 2) clay type soils, 3) good grassland area, and 4) normal surface depressions.		Solution: Relief 0.14 Soil Infiltration 0.08 Vegetal Cover 0.04 Surface Storage 0.06 C = 0.32	
Find	The runoff coefficient, C, for the above watershed.			

Estimated runoff coefficient for landscape areas:
0.20 + 0.05 + 0.07 + 0.08 = 0.40

Table 819.2B

Run off Coefficients for Developed Areas[1]

Type of Drainage Area	Runoff Coefficient	
Business:		
Downtown areas	0.70 - 0.95	
Neighborhood areas	0.50 - 0.70	
Residential:		
Single-family areas	0.30 - 0.50	
Multi-units, detached	0.40 - 0.60	
Multi-units, attached	0.60 - 0.75	
Suburban	0.25 - 0.40	
Apartment dwelling areas	0.50 - 0.70	
Industrial:		
Light areas	0.50 - 0.80	
Heavy areas	0.60 - 0.90	
Parks, cemeteries:	0.10 - 0.25	
Playgrounds:	0.20 - 0.40	
Railroad yard areas:	0.20 - 0.40	
Unimproved areas:	0.10 - 0.30	
Lawns:		
Sandy soil, flat, 2%	0.05 - 0.10	
Sandy soil, average, 2-7%	0.10 - 0.15	
Sandy soil, steep, 7%	0.15 - 0.20	
Heavy soil, flat, 2%	0.13 - 0.17	
Heavy soil, average, 2-7%	0.18 - 0.22	
Heavy soil, steep, 7%	0.25 - 0.35	
Streets:		
Asphaltic	0.70 - 0.95	C = 0.9
Concrete	0.80 - 0.95	
Brick	0.70 - 0.85	
Drives and walks	0.75 - 0.85	
Roofs:	0.75 - 0.95	

NOTES:
(1) From HDS No. 2.

Table 831.3

Desirable Roadway Drainage Guidelines

HIGHWAY Type/Category/Feature	DESIGN STORM		DESIGN WATER SPREAD		
	4% (25 yrs)	10% (10 yrs)	Shldr or Parking Lane	1/2 Outer Lane	Local Standard
FREEWAYS					
Through traffic lanes, branch connections, and other major ramp connections.	X	--	X	--	--
Minor ramps.	--	X	X	--	--
Frontage roads.	--	X	--	--	X
CONVENTIONAL HIGHWAYS					
High volume, multilane Speeds over 45 mph.	X	--	X	--	--
High volume, multilane Speeds 45 mph and under.	--	X	--	X	--
Low volume, rural Speeds over 45 mph.	X	--	X	--	--
Urban Speeds 45 mph and under.	--	X	--	X	X
ALL STATE HIGHWAYS					
Depressed Sections That Require Pumping: Use a 2% (50 yrs) design storm for freeways and conventional State highways. Design water spread at depressed sections should not exceed that of adjacent roadway sections. A 4% (25 yr) design storm may be used on local streets or road undercrossings that require pumping.					

Table 838.4

Minimum Pipe Diameter for Storm Drain Systems

Type of Drain	Minimum Diameter (in)
Trunk Drain	18
Trunk Laterals	15[(1)]
Inlet Laterals	15[(1)]

NOTE:

[(1)]18 minimum if wholly or partly under the roadbed.

Specific subjects for special consideration are:

- Bedding and Backfill. Bedding and backfill consideration are discussed under Index 829.2. Maximum height of cover tables are included in Chapter 850 and minimum thickness of cover is given in Table 856.5.
- Roughness Factor. The roughness factor, Manning's n value, generally assumes greater importance for storm drain design than it does for culverts. Suggested Manning's n values for various types of pipe materials are given in Table 852.1.

(6) Floating Trash. Except at pumping installations, every effort should be made to carry all floating trash through the storm drain system. Curb and wall opening inlets are well suited for this purpose. In special cases where it is necessary to exclude trash, as in pumping installations, a standard trash rack must be provided across all curb and wall openings of tributary inlets. See the Standard Plans for details.

(7) Median Flow. In estimating the quantity of flow in the median, consideration should be given to the effects of trash, weeds, and plantings.

838.5 Appurtenant Structures

(1) Manholes.

(a) General Notes. The purpose of a manhole is to provide access to a storm drain for inspection and maintenance. Manholes are usually constructed out of cast in place concrete, pre-cast concrete, or corrugated metal pipe. They are usually circular and approximately three or four feet in diameter to facilitate the movement of maintenance personnel.

There is no Caltrans Standard Plan for manholes. Relocation and reconstruction of existing storm drain facilities, owned by a city or county agency, is often necessary. Generally the local agency has adopted manhole design standard for use on their facilities. Use of the manhole design preferred by the responsible authority or owner is appropriate.

Commercial precast manhole shafts are effective and usually more economical than cast in place shafts. Brick or block may also be used, but only upon request and justification from the local agency or owner.

Table 851.2

Manning "n" Value for Alternative Pipe Materials[1]

Type of Conduit		Recommended Design Value	"n" Value Range
Corrugated Metal Pipe[2]			
(Annular and Helical)[3]			
2⅔" x ½"	corrugation	0.025	0.022 - 0.027
3" x 1"	"	0.028	0.027 - 0.028
5" x 1"	"	0.026	0.025 - 0.026
6" x 2"	"	0.035	0.033 - 0.035
9" x 2½"	"	0.035	0.033 - 0.037
Concrete Pipe			
Pre-cast		0.012	0.011 - 0.017
Cast-in-place		0.013	0.012 - 0.017
Concrete Box		0.013	0.012 - 0.018
Plastic Pipe			
Smooth Interior		0.012	0.010 - 0.013
Corrugated Interior		0.022	0.020 - 0.025
Spiral Rib Metal Pipe			
¾" (W) x 1" (D) @ 11½" o/c		0.013	0.011 - 0.015
¾" (W) x ¾" (D) @ 7½" o/c		0.013	0.012 - 0.015
¾" (W) x 1" (D) @ 8½" o/c		0.013	0.012 - 0.015
Composite Steel Spiral Rib Pipe		0.012	0.011 - 0.015
Steel Pipe, Ungalvanized		0.015	--
Cast Iron Pipe		0.015	--
Clay Sewer Pipe		0.013	--
Polymer Concrete Grated Line Drain		0.011	0.010 - 0.013

Notes:

[1] Tabulated n-values apply to circular pipes flowing full except for the grated line drain. See Note 5.

[2] For lined corrugated metal pipe, a composite roughness coefficient may be computed using the procedures outlined in the HDS No. 5, Hydraulic Design of Highway Culverts.

[3] Lower n-values may be possible for helical pipe under specific flow conditions (refer to FHWA's publication Hydraulic Flow Resistance Factors for Corrugated Metal Conduits), but in general, it is recommended that the tabulated n-value be used for both annular and helical corrugated pipes.

[4] For culverts operating under inlet control, barrel roughness does not impact the headwater. For culverts operating under outlet control barrel roughness is a significant factor. See Index 825.2 Culvert Flow.

[5] Grated Line Drain details are shown in Standard Plan D98G-D98J and described under Index 837.2(6) Grated Line Drains. This type of inlet can be used as an alternative at the locations described under Index 837.2(5) Slotted Drains. The carrying capacity is less than 18-inch slotted (pipe) drains.

(6) Critical Flow. A useful concept in hydraulic analysis is that of "specific energy". The specific energy at a given section is defined as the total energy, or total head, of the flowing water with respect to the channel bottom. For a channel of small slope;

$$E = d + \frac{V^2}{2g}$$

Table 866.3A

Average Values for Manning's Roughness Coefficient (n)

Type of Channel	n value
Unlined Channels:	
Clay Loam	0.023
Sand	0.020
Gravel	0.030
Rock	0.040
Lined Channels:	
Portland Cement Concrete	0.014
Air Blown Mortar (troweled)	0.012
Air Blown Mortar (untroweled)	0.016
Air Blown Mortar (roughened)	0.025
Asphalt Concrete	0.016-0.018
Sacked Concrete	0.025
Pavement and Gutters:	
Portland Cement Concrete	0.013-0.015
Hot Mix Asphalt Concrete	0.016-0.018
Depressed Medians:	
Earth (without growth)	0.016-0.025
Earth (with growth)	0.050
Gravel (d_{50} = 1 in. flow depth ≤ 6 in.)	0.040
Gravel (d_{50} = 2 in. flow depth ≤ 6 in.)	0.056

used n = 0.016

NOTES:

For additional values of n, see HEC No. 15, Tables 2.1 and 2.2, and "Introduction to Highway Hydraulics", Hydraulic Design Series No. 4, FHWA Table 14.

where:

E = Specific energy, in feet

d = Depth of flow, in feet

Inlet Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Dec 29 2022

DI 1a

Combination Inlet

Location	= On grade
Curb Length (ft)	= 3.00
Throat Height (in)	= 5.00
Grate Area (sqft)	= -0-
Grate Width (ft)	= 2.00
Grate Length (ft)	= 3.00

Gutter

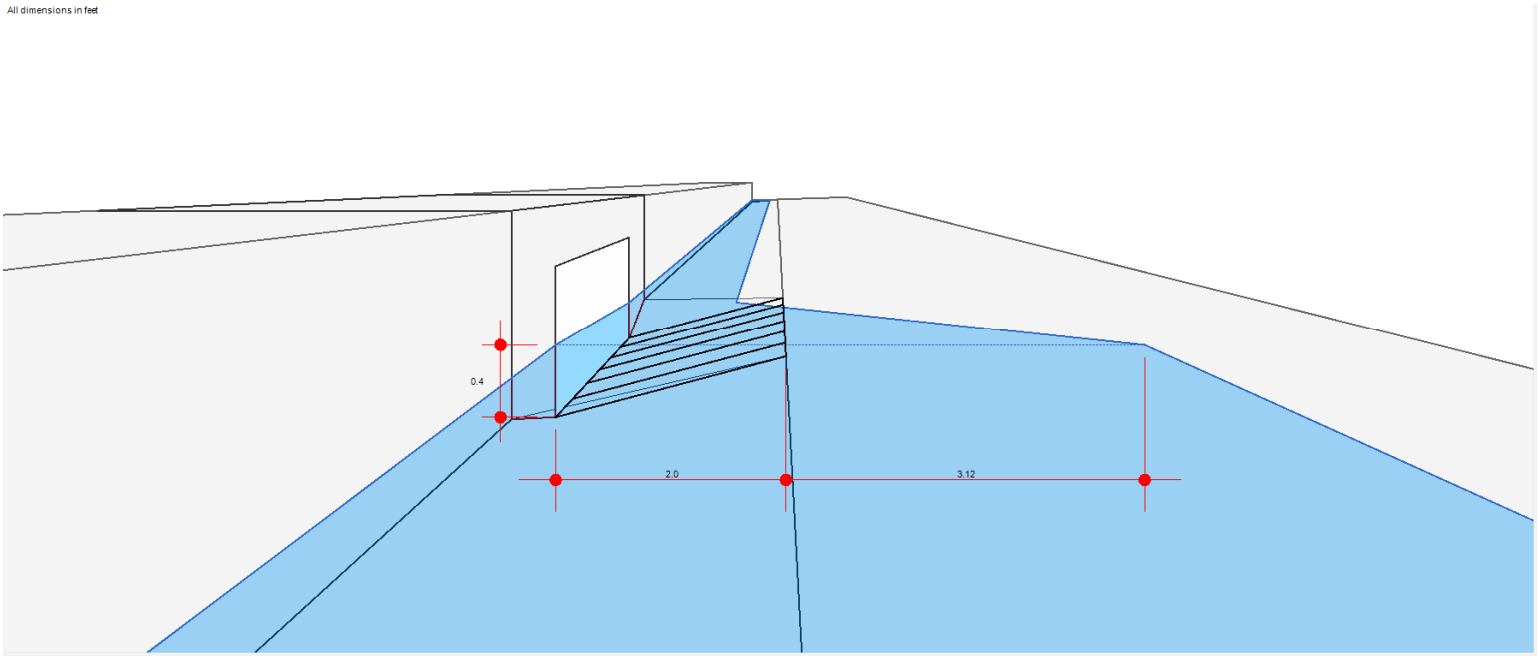
Slope, Sw (ft/ft)	= 0.063
Slope, Sx (ft/ft)	= 0.020
Local Depr (in)	= 2.50
Gutter Width (ft)	= 2.00
Gutter Slope (%)	= 2.40
Gutter n-value	= 0.018

Calculations

Compute by:	Known Q
Q (cfs)	= 0.99

Highlighted

Q Total (cfs)	= 0.99
Q Capt (cfs)	= 0.87
Q Bypass (cfs)	= 0.12
Depth at Inlet (in)	= 4.76
Efficiency (%)	= 88
Gutter Spread (ft)	= 5.12
Gutter Vel (ft/s)	= 2.85
Bypass Spread (ft)	= 1.39
Bypass Depth (in)	= 1.05



Inlet Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Dec 29 2022

DI 5a

Combination Inlet

Location	= On grade
Curb Length (ft)	= 3.00
Throat Height (in)	= 5.00
Grate Area (sqft)	= -0-
Grate Width (ft)	= 2.00
Grate Length (ft)	= 3.00

Gutter

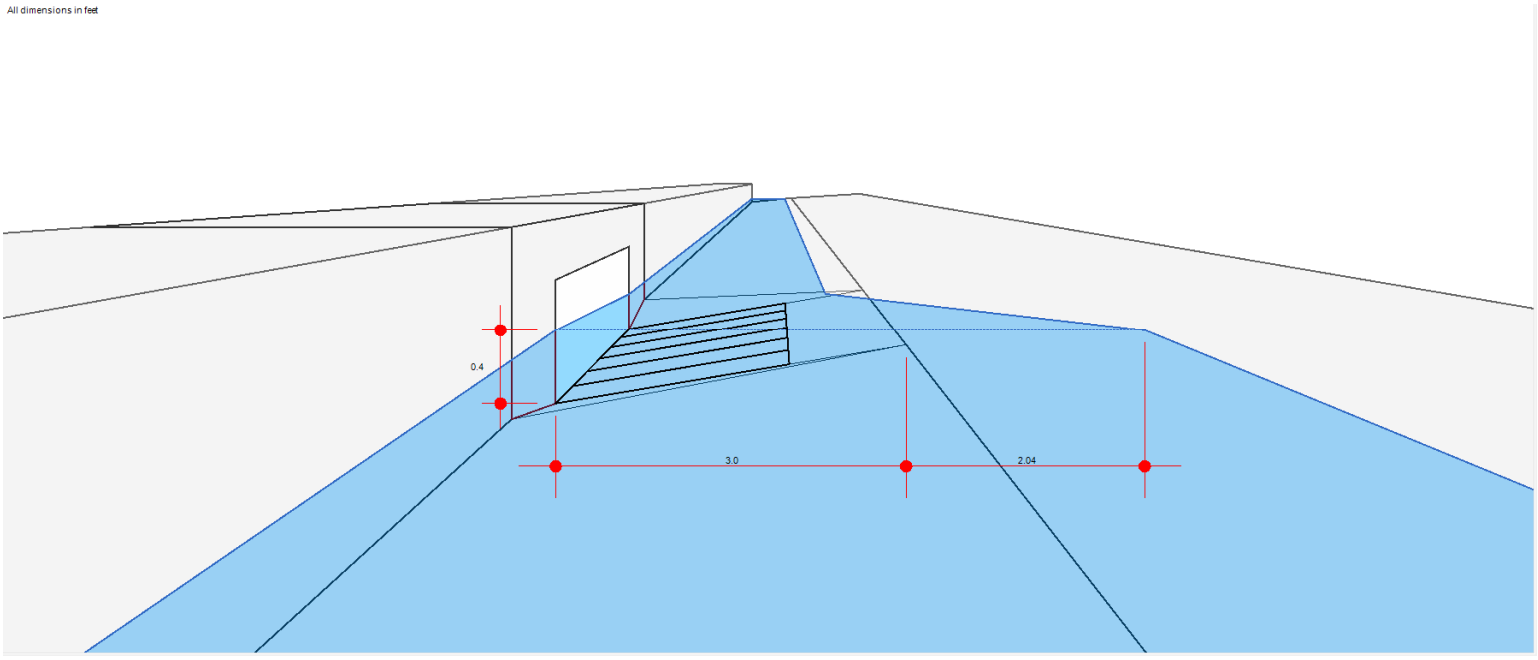
Slope, Sw (ft/ft)	= 0.063
Slope, Sx (ft/ft)	= 0.040
Local Depr (in)	= 1.60
Gutter Width (ft)	= 3.00
Gutter Slope (%)	= 4.80
Gutter n-value	= 0.016

Calculations

Compute by:	Known Q
Q (cfs)	= 3.82

Highlighted

Q Total (cfs)	= 3.82
Q Capt (cfs)	= 2.92
Q Bypass (cfs)	= 0.90
Depth at Inlet (in)	= 4.85
Efficiency (%)	= 77
Gutter Spread (ft)	= 5.04
Gutter Vel (ft/s)	= 6.24
Bypass Spread (ft)	= 2.52
Bypass Depth (in)	= 1.90



Inlet Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Dec 29 2022

DI 7c

Combination Inlet

Location	= On grade
Curb Length (ft)	= 10.00
Throat Height (in)	= 5.00
Grate Area (sqft)	= -0-
Grate Width (ft)	= 2.00
Grate Length (ft)	= 3.33

Gutter

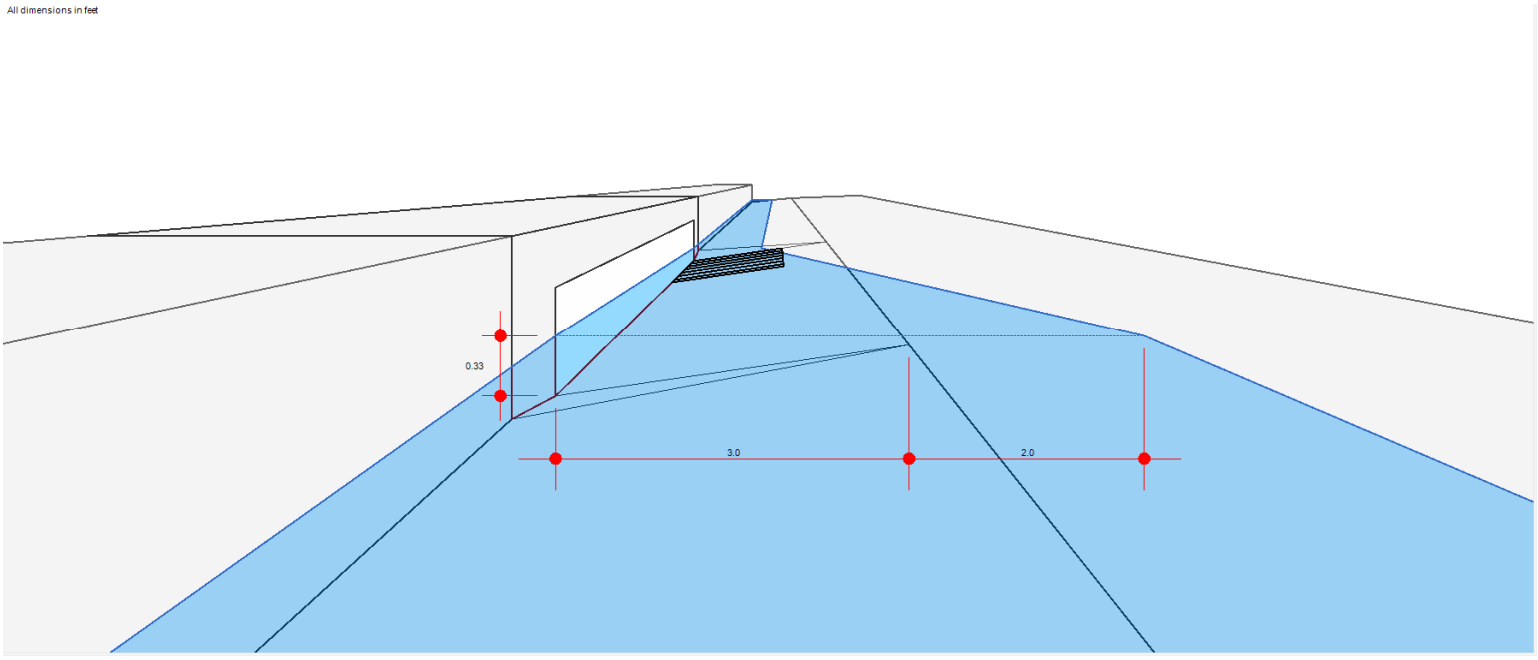
Slope, Sw (ft/ft)	= 0.063
Slope, Sx (ft/ft)	= 0.025
Local Depr (in)	= 1.10
Gutter Width (ft)	= 3.00
Gutter Slope (%)	= 13.00
Gutter n-value	= 0.016

Calculations

Compute by:	Known Q
Q (cfs)	= 4.50

Highlighted

Q Total (cfs)	= 4.50
Q Capt (cfs)	= 4.11
Q Bypass (cfs)	= 0.39
Depth at Inlet (in)	= 3.97
Efficiency (%)	= 91
Gutter Spread (ft)	= 5.00
Gutter Vel (ft/s)	= 9.32
Bypass Spread (ft)	= 1.53
Bypass Depth (in)	= 1.16



Inlet Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Dec 29 2022

DI 8a

Combination Inlet

Location	=	On grade
Curb Length (ft)	=	10.00
Throat Height (in)	=	6.00
Grate Area (sqft)	=	-0-
Grate Width (ft)	=	2.00
Grate Length (ft)	=	3.33

Gutter

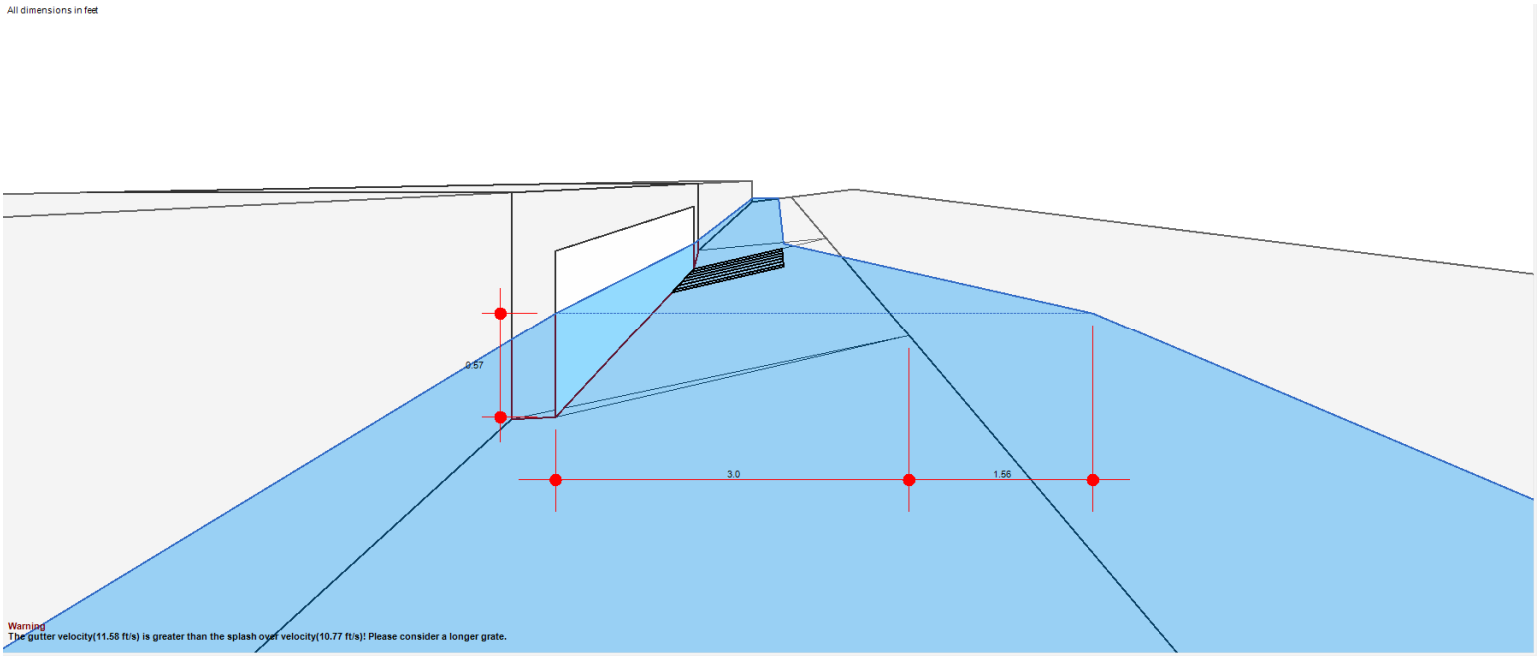
Slope, Sw (ft/ft)	=	0.080
Slope, Sx (ft/ft)	=	0.080
Local Depr (in)	=	2.50
Gutter Width (ft)	=	3.00
Gutter Slope (%)	=	10.50
Gutter n-value	=	0.016

Calculations

Compute by:	Known Q
Q (cfs)	= 9.63

Highlighted

Q Total (cfs)	= 9.63
Q Capt (cfs)	= 8.51
Q Bypass (cfs)	= 1.12
Depth at Inlet (in)	= 6.88
Efficiency (%)	= 88
Gutter Spread (ft)	= 4.56
Gutter Vel (ft/s)	= 11.58
Bypass Spread (ft)	= 2.03
Bypass Depth (in)	= 1.95



Inlet Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Dec 29 2022

DI 9a

Combination Inlet

Location	=	On grade
Curb Length (ft)	=	10.00
Throat Height (in)	=	5.00
Grate Area (sqft)	=	-0-
Grate Width (ft)	=	1.96
Grate Length (ft)	=	3.33

Gutter

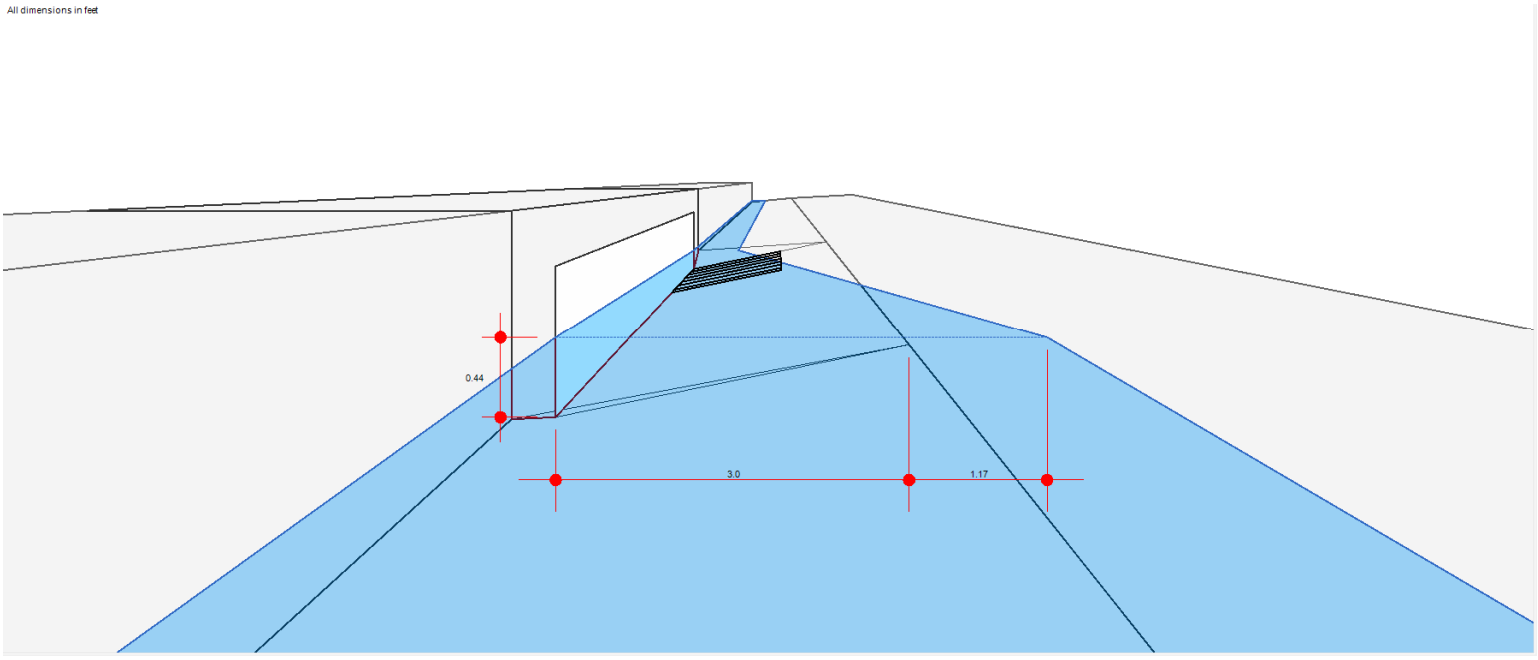
Slope, Sw (ft/ft)	=	0.063
Slope, Sx (ft/ft)	=	0.035
Local Depr (in)	=	2.50
Gutter Width (ft)	=	3.00
Gutter Slope (%)	=	8.60
Gutter n-value	=	0.016

Calculations

Compute by:		Known Q
Q (cfs)	=	3.26

Highlighted

Q Total (cfs)	=	3.26
Q Capt (cfs)	=	3.15
Q Bypass (cfs)	=	0.11
Depth at Inlet (in)	=	5.26
Efficiency (%)	=	97
Gutter Spread (ft)	=	4.17
Gutter Vel (ft/s)	=	7.57
Bypass Spread (ft)	=	1.02
Bypass Depth (in)	=	0.77



Inlet Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Dec 29 2022

DI 10a

Combination Inlet

Location	=	On grade
Curb Length (ft)	=	7.00
Throat Height (in)	=	5.00
Grate Area (sqft)	=	-0-
Grate Width (ft)	=	2.00
Grate Length (ft)	=	3.33

Gutter

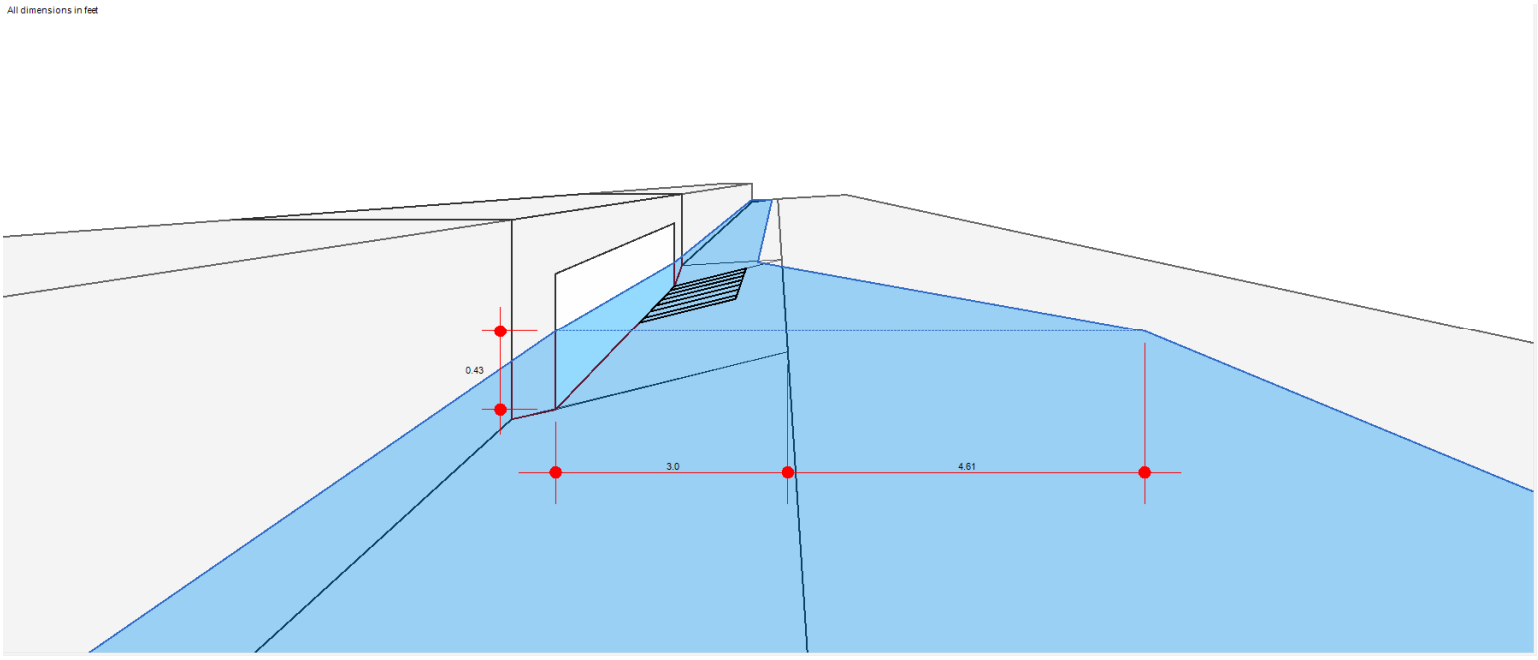
Slope, Sw (ft/ft)	=	0.050
Slope, Sx (ft/ft)	=	0.025
Local Depr (in)	=	2.00
Gutter Width (ft)	=	3.00
Gutter Slope (%)	=	1.30
Gutter n-value	=	0.016

Calculations

Compute by:		Known Q
Q (cfs)	=	2.57

Highlighted

Q Total (cfs)	=	2.57
Q Capt (cfs)	=	2.31
Q Bypass (cfs)	=	0.26
Depth at Inlet (in)	=	5.18
Efficiency (%)	=	90
Gutter Spread (ft)	=	7.61
Gutter Vel (ft/s)	=	3.07
Bypass Spread (ft)	=	2.33
Bypass Depth (in)	=	1.40



Inlet Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Dec 29 2022

DI 12c

Combination Inlet

Location	=	On grade
Curb Length (ft)	=	10.00
Throat Height (in)	=	6.00
Grate Area (sqft)	=	-0-
Grate Width (ft)	=	2.00
Grate Length (ft)	=	3.33

Gutter

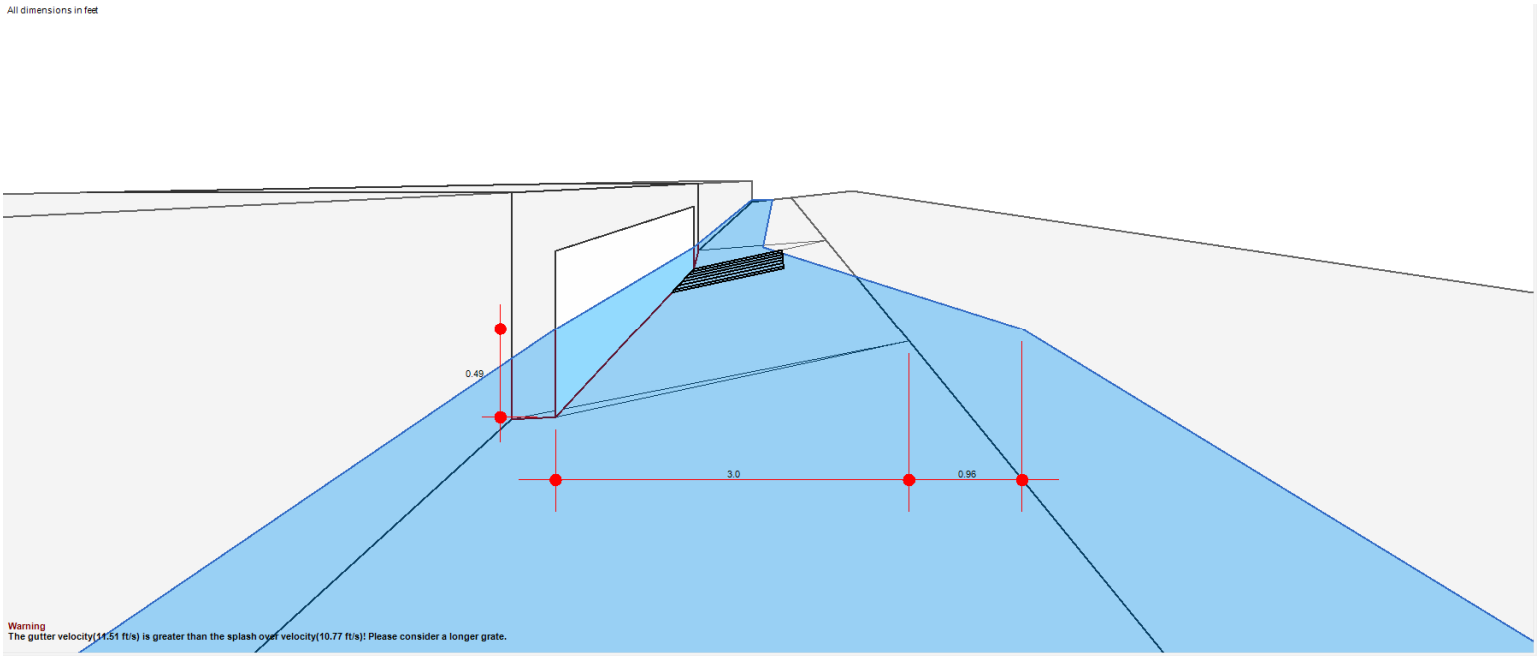
Slope, Sw (ft/ft)	=	0.070
Slope, Sx (ft/ft)	=	0.070
Local Depr (in)	=	2.50
Gutter Width (ft)	=	3.00
Gutter Slope (%)	=	15.00
Gutter n-value	=	0.016

Calculations

Compute by:	Known Q
Q (cfs)	= 6.32

Highlighted

Q Total (cfs)	= 6.32
Q Capt (cfs)	= 5.79
Q Bypass (cfs)	= 0.53
Depth at Inlet (in)	= 5.83
Efficiency (%)	= 92
Gutter Spread (ft)	= 3.96
Gutter Vel (ft/s)	= 11.51
Bypass Spread (ft)	= 1.57
Bypass Depth (in)	= 1.32



Inlet Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Dec 29 2022

Exist DI 252+50

Combination Inlet

Location	=	On grade
Curb Length (ft)	=	3.00
Throat Height (in)	=	6.00
Grate Area (sqft)	=	-0-
Grate Width (ft)	=	1.70
Grate Length (ft)	=	3.00

Gutter

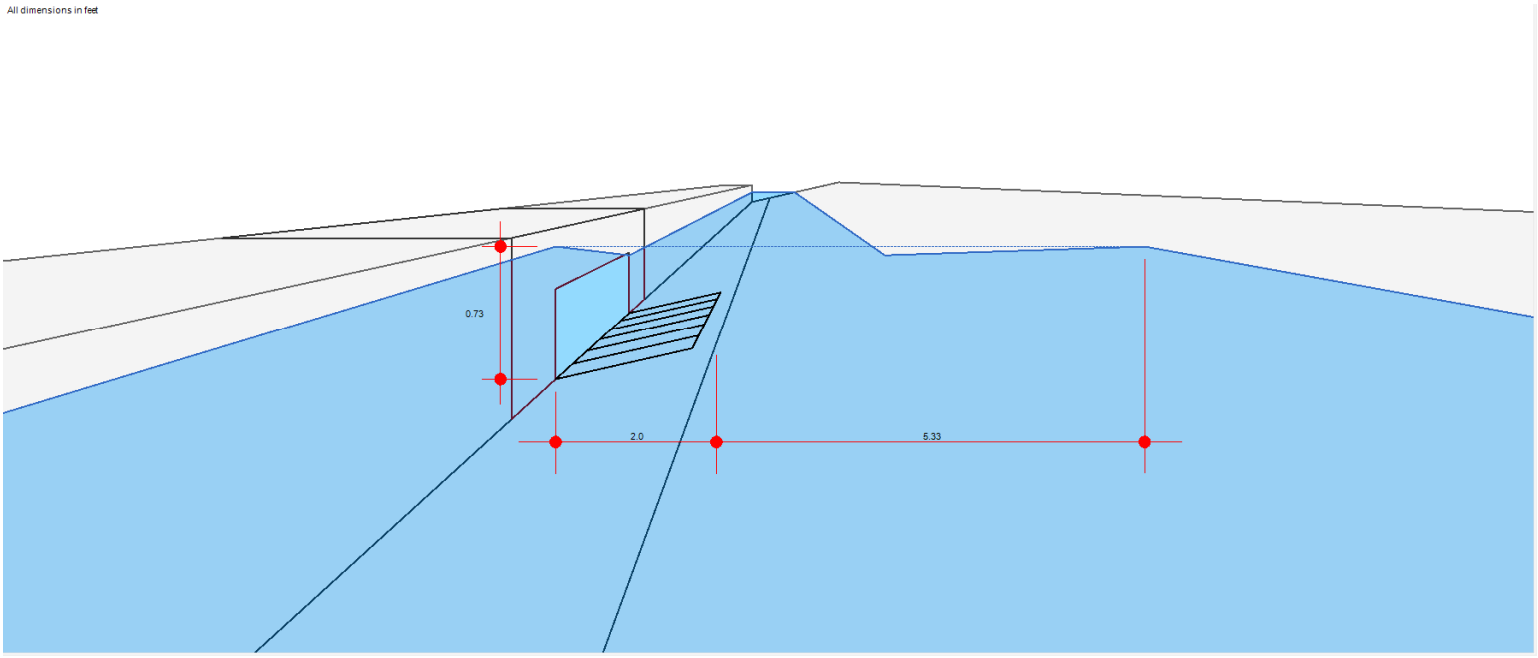
Slope, Sw (ft/ft)	=	0.100
Slope, Sx (ft/ft)	=	0.100
Local Depr (in)	=	-0-
Gutter Width (ft)	=	2.00
Gutter Slope (%)	=	0.60
Gutter n-value	=	0.016

Calculations

Compute by:		Known Q
Q (cfs)	=	11.83

Highlighted

Q Total (cfs)	=	11.83
Q Capt (cfs)	=	8.07
Q Bypass (cfs)	=	3.76
Depth at Inlet (in)	=	8.79
Efficiency (%)	=	68
Gutter Spread (ft)	=	7.33
Gutter Vel (ft/s)	=	4.41
Bypass Spread (ft)	=	4.77
Bypass Depth (in)	=	5.72



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Friday, Apr 7 2023

Curb bulb-out at PM 0.07

Gutter

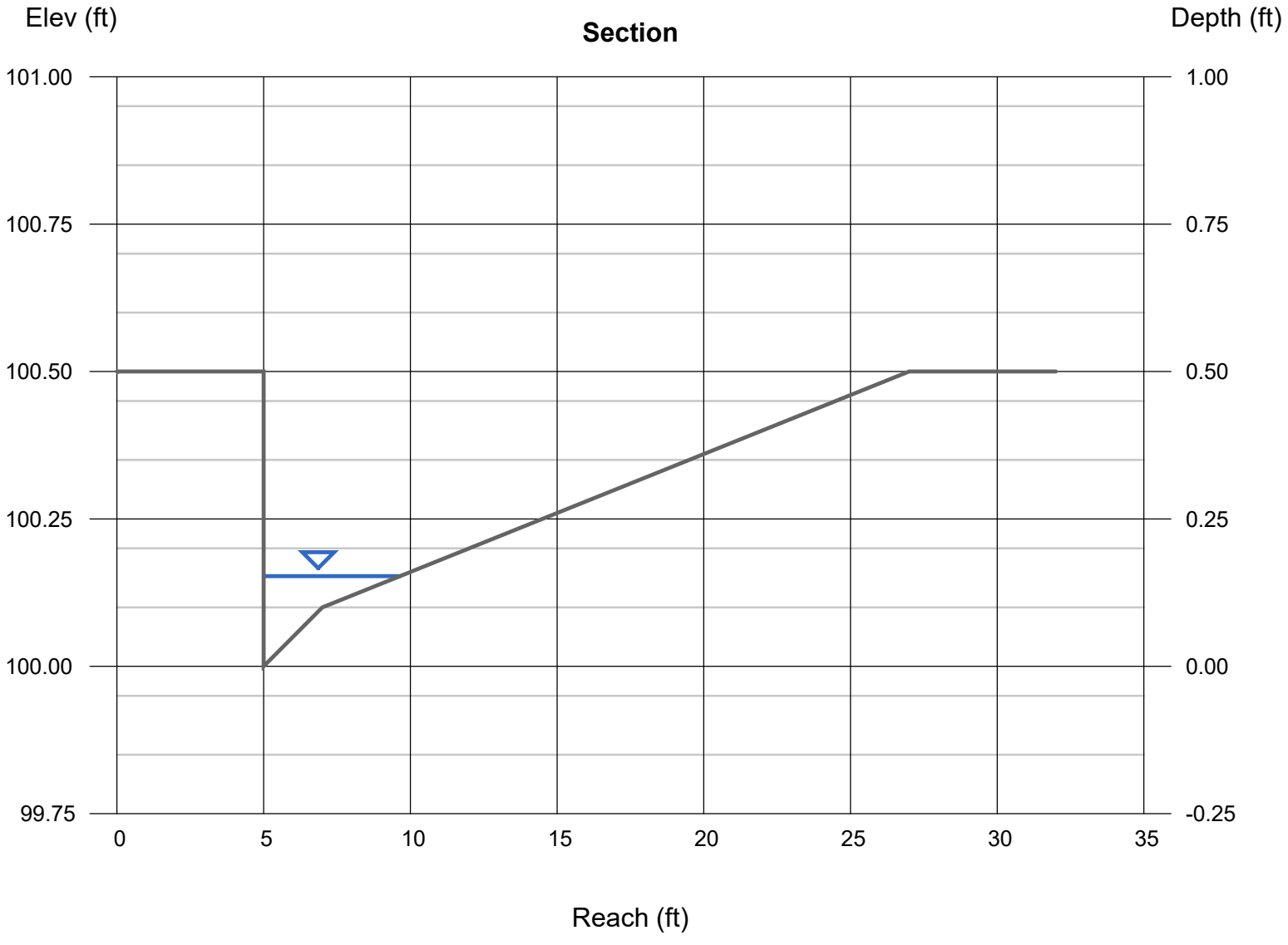
Cross Sl, Sx (ft/ft)	= 0.020
Cross Sl, Sw (ft/ft)	= 0.050
Gutter Width (ft)	= 2.00
Invert Elev (ft)	= 100.00
Slope (%)	= 1.40
N-Value	= 0.016

Calculations

Compute by:	Known Q
Known Q (cfs)	= 0.59

Highlighted

Depth (ft)	= 0.15
Q (cfs)	= 0.590
Area (sqft)	= 0.28
Velocity (ft/s)	= 2.14
Wetted Perim (ft)	= 4.81
Crit Depth, Yc (ft)	= 0.18
Spread Width (ft)	= 4.65
EGL (ft)	= 0.22



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Dec 29 2022

Curb bulb-out at PM 0.87

Gutter

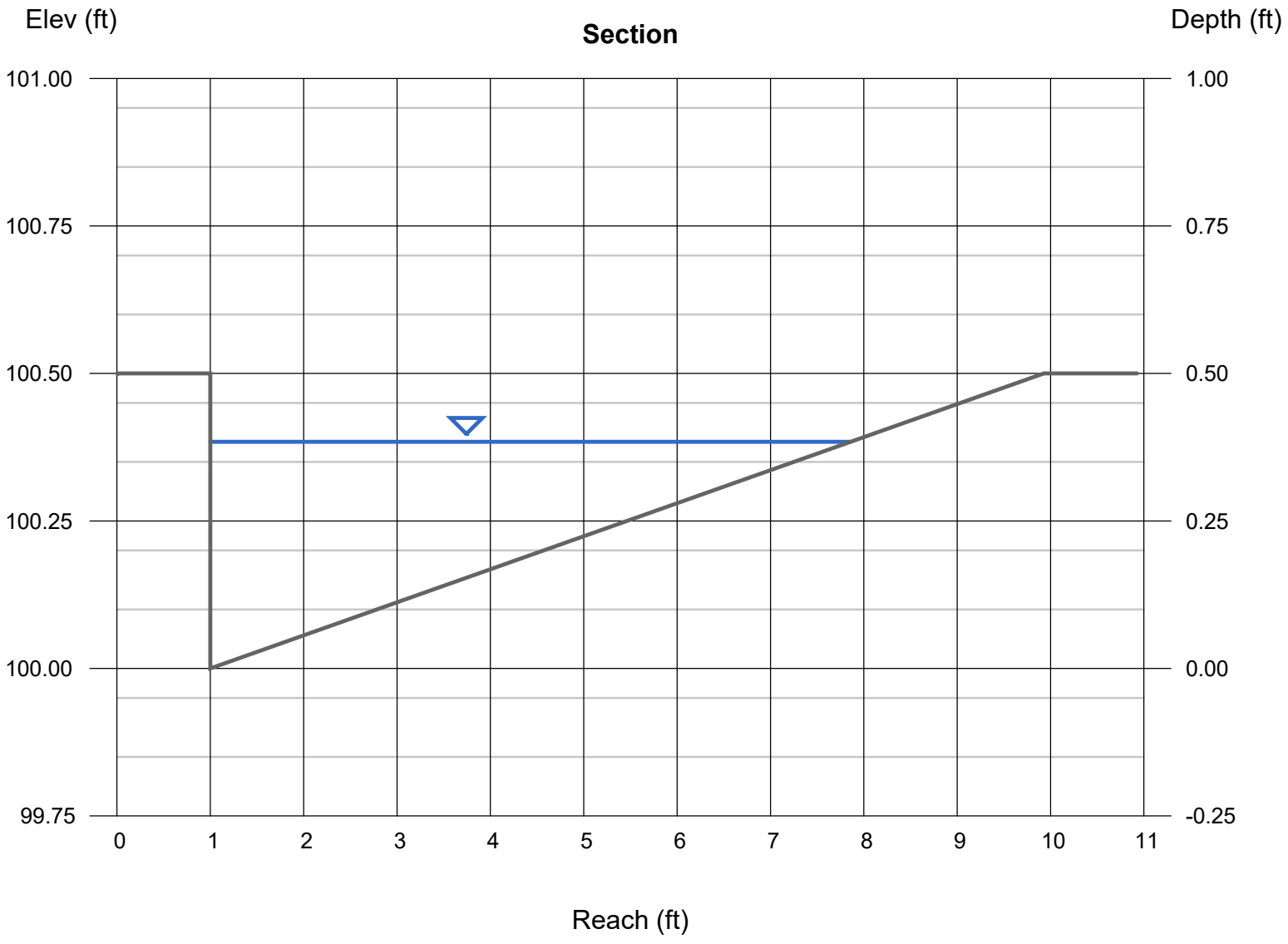
Cross Sl, Sx (ft/ft)	= 0.056
Cross Sl, Sw (ft/ft)	= 0.056
Gutter Width (ft)	= 2.00
Invert Elev (ft)	= 100.00
Slope (%)	= 2.20
N-Value	= 0.016

Calculations

Compute by:	Known Q
Known Q (cfs)	= 7.19

Highlighted

Depth (ft)	= 0.38
Q (cfs)	= 7.190
Area (sqft)	= 1.32
Velocity (ft/s)	= 5.46
Wetted Perim (ft)	= 7.25
Crit Depth, Yc (ft)	= 0.53
Spread Width (ft)	= 6.86
EGL (ft)	= 0.85



Channel Report

SD 1b

Circular

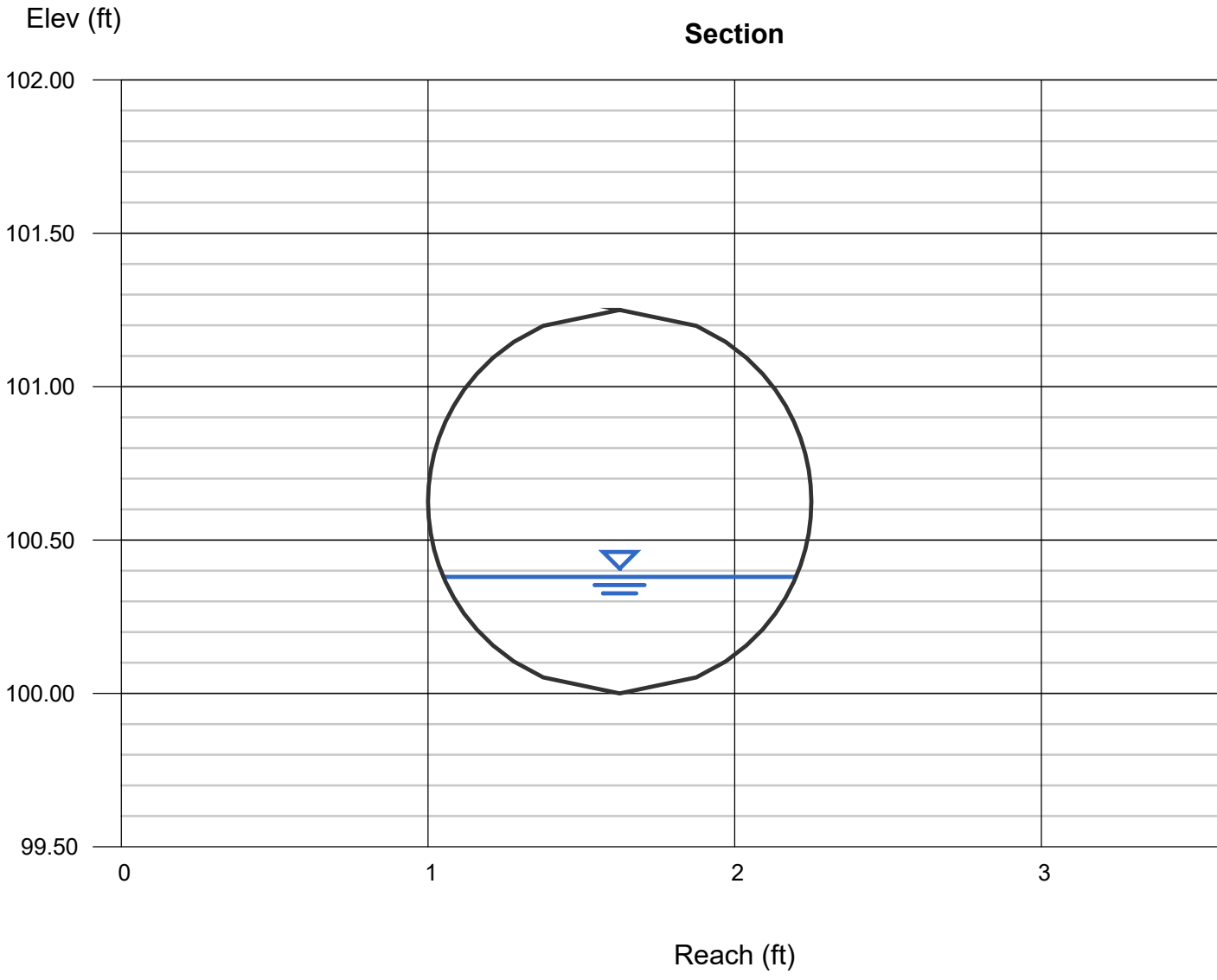
Diameter (ft)	= 1.25
Invert Elev (ft)	= 100.00
Slope (%)	= 1.76
N-Value	= 0.025

Calculations

Compute by:	Known Q
Known Q (cfs)	= 0.87

Highlighted

Depth (ft)	= 0.38
Q (cfs)	= 0.870
Area (sqft)	= 0.32
Velocity (ft/s)	= 2.75
Wetted Perim (ft)	= 1.46
Crit Depth, Yc (ft)	= 0.37
Top Width (ft)	= 1.15
EGL (ft)	= 0.50



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Dec 29 2022

SD 1c

Circular

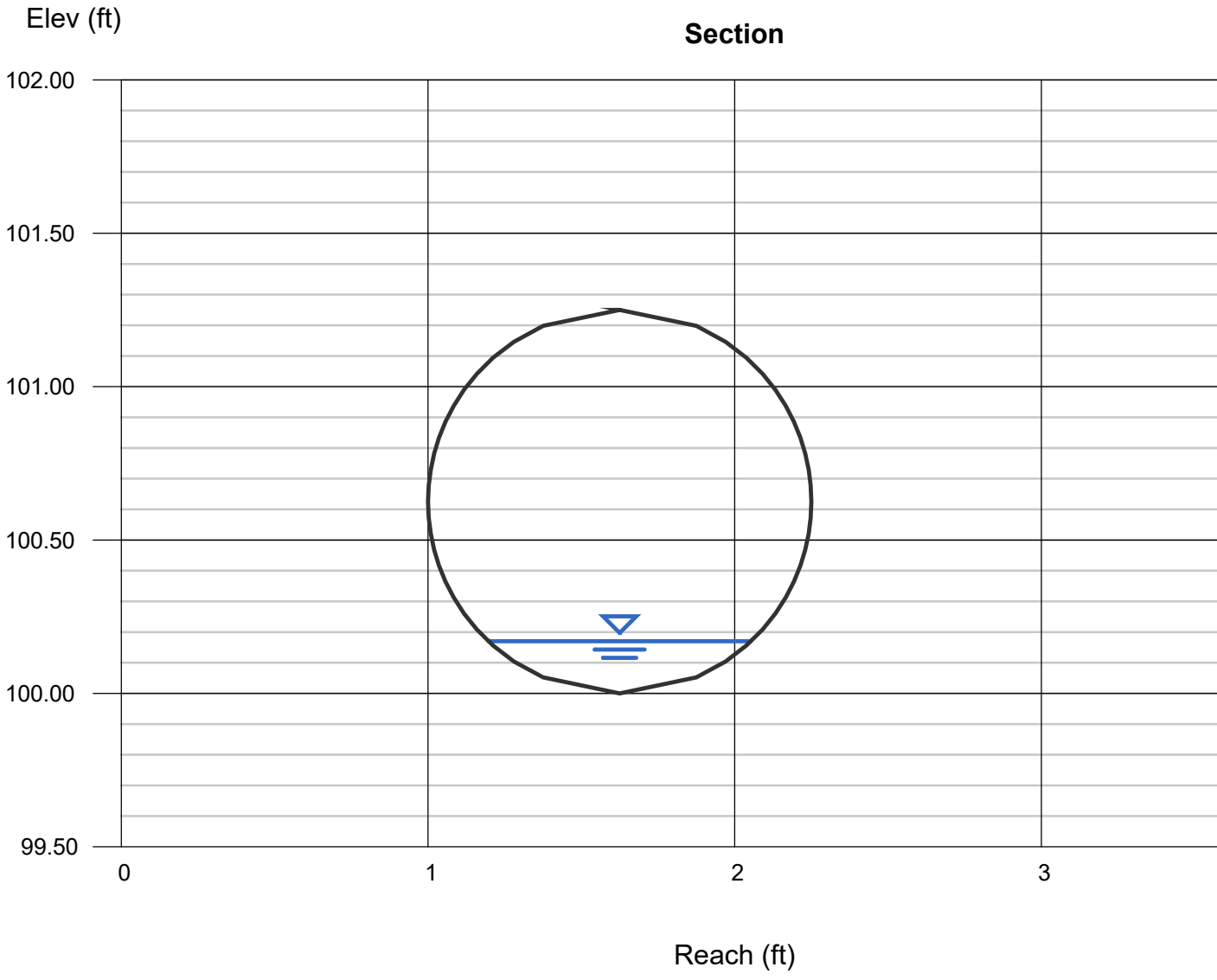
Diameter (ft)	= 1.25
Invert Elev (ft)	= 100.00
Slope (%)	= 50.00
N-Value	= 0.025

Calculations

Compute by:	Known Q
Known Q (cfs)	= 0.87

Highlighted

Depth (ft)	= 0.17
Q (cfs)	= 0.870
Area (sqft)	= 0.10
Velocity (ft/s)	= 8.54
Wetted Perim (ft)	= 0.95
Crit Depth, Yc (ft)	= 0.37
Top Width (ft)	= 0.86
EGL (ft)	= 1.31



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Dec 29 2022

SD 5b

Circular

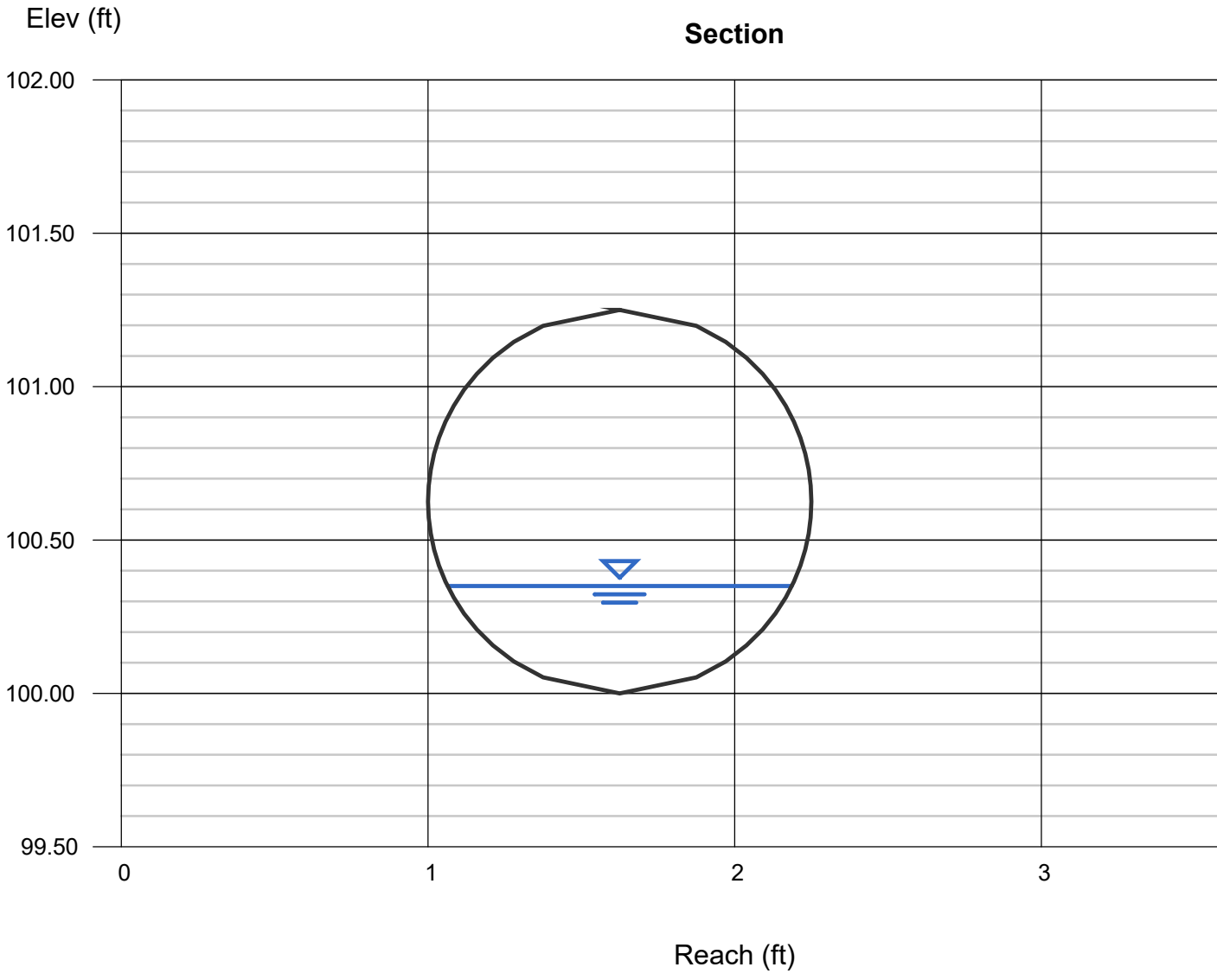
Diameter (ft)	= 1.25
Invert Elev (ft)	= 100.00
Slope (%)	= 25.06
N-Value	= 0.025

Calculations

Compute by:	Known Q
Known Q (cfs)	= 2.92

Highlighted

Depth (ft)	= 0.35
Q (cfs)	= 2.920
Area (sqft)	= 0.28
Velocity (ft/s)	= 10.27
Wetted Perim (ft)	= 1.40
Crit Depth, Yc (ft)	= 0.69
Top Width (ft)	= 1.13
EGL (ft)	= 1.99



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Dec 29 2022

SD 6b

Circular

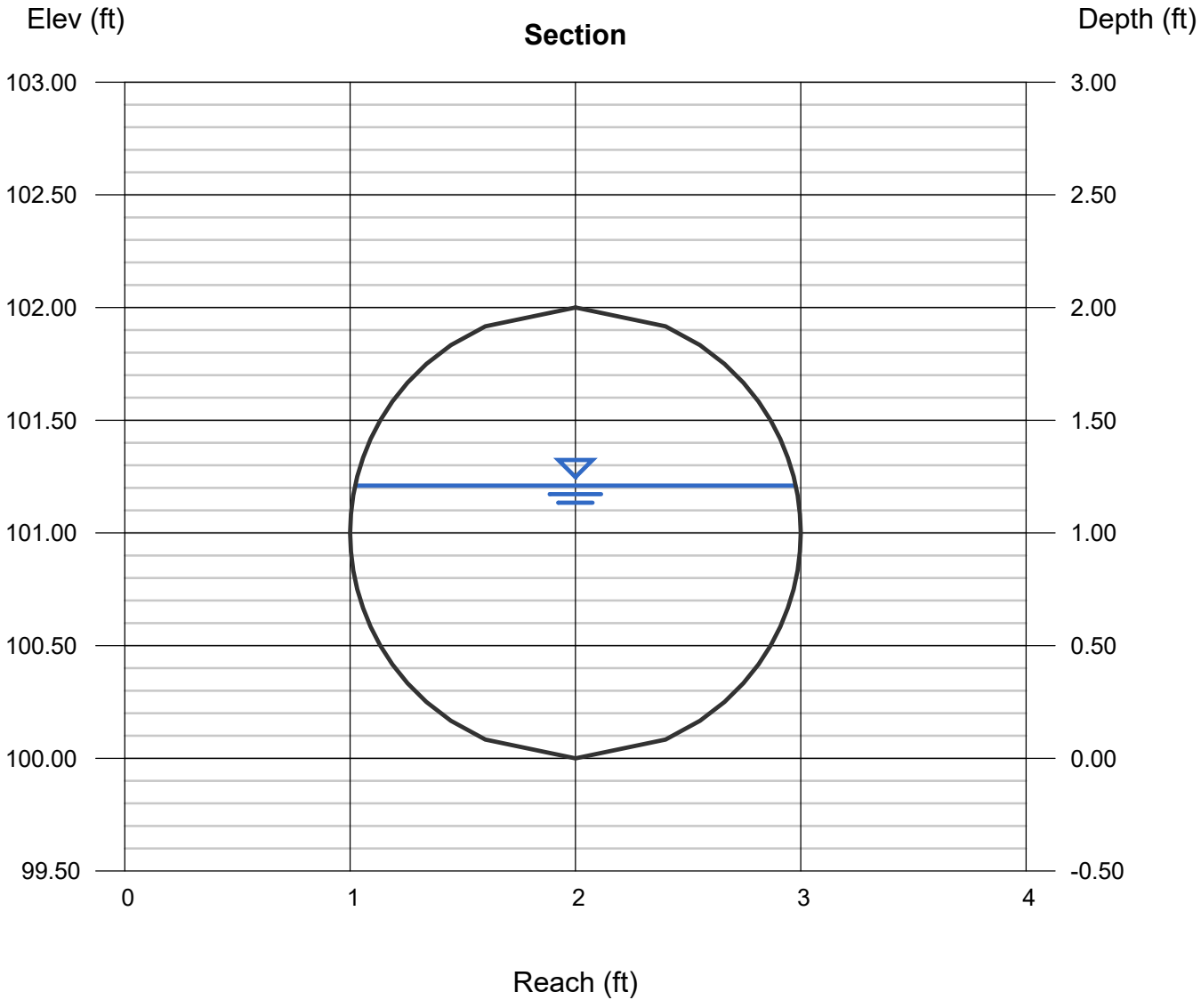
Diameter (ft)	= 2.00
Invert Elev (ft)	= 100.00
Slope (%)	= 2.00
N-Value	= 0.013

Calculations

Compute by:	Known Q
Known Q (cfs)	= 21.60

Highlighted

Depth (ft)	= 1.21
Q (cfs)	= 21.60
Area (sqft)	= 1.99
Velocity (ft/s)	= 10.84
Wetted Perim (ft)	= 3.57
Crit Depth, Yc (ft)	= 1.66
Top Width (ft)	= 1.95
EGL (ft)	= 3.04



MWELO DOCUMENTATION

Water Efficient Landscape Worksheet

ETWU (Estimated Total Water Use) Calculation (Eto x .62 x ETAF x Area)

REGULAR LANDSCAPE AREAS

Hydro Zone	Valve Zones	PF	Irr Method	IE	ETAF (PF/IE)	Landscape Area	ETAF x Area	ETWU (gal/yr)
Water Features	na	1	NA	1	1.00	0.00	0.00	0.00
Very Low	na	0.1	NA	0.81	0.12	0.00	0.00	0.00
Low (Shrubs)	A3,A6,A7, B1,B2,B5B,6	0.3	Drip	0.81	0.37	9,822.00	3,637.78	10,487.71
Medium (Trees)	A1,A2,A4,A5,A8,B3, B4	0.5	Bubblers	0.81	0.62	603.00	372.22	1,073.12
High		0.8	Rotors	0.81	0.99	0.00	0.00	0.00
					Totals	10,425.00	4,010.00	

SPECIAL LANDSCAPE AREAS

Pool and Spa					0	0	0.00	0.00
Turf Areas					0.45	0	0.00	0.00
					Totals	0.00	0.00	
							ETWU Total	11,560.83
							MAWA	13,524.87

(ETWU should be less than MAWA)

ETAF Calculations

Total Sitewide (ETAF x Area) / Total Area 0.38

Average ETAF should be below 0.55 for residential areas

Average ETAF should be below 0.45 for non-residential areas

REFERENCE FACTORS

ET o Rate	(Evaporation transporation rate for area)	**4.65**	in / yr
ETAF	(factor from state for residential - used for MAWA)	**0.45**	
CF (Conversion Factor)	(used to convert acre-inches/year to gal/sf per year)	**0.62**	
IE (Irrigation Efficiency)	(from state - efficency for drip)	**0.81**	
IE (Irrigation Efficiency)	(from state - efficency for spray)	**0.75**	
PF (Plant Factor) High	(factor from state or jurisdiction)	**.7-1.0**	
PF (Plant Factor) Medium	(factor from state or jurisdiction)	**.4-.6**	
PF (Plant Factor) Low	(factor from state or jurisdiction)	**.1-.3**	
PF (Plant Factor) Very Low	(factor from state or jurisdiction)	**0-.1**	

LANDSCAPE DOCUMENTATION PACKAGE

PROJECT INFORMATION:

1. Project Site / Location: Del Rey Oaks, CA
2. Total landscape area: 10,425 sf
3. Project type: Public Trail
4. Irrigation Water supply type: Potable Water + Well
5. Documents in this package include:
   - Irrigation specifications and plans / details
   - Planting specifications and plans / details
   - MAWA water budget calculations
   - ETWU water budget calculations

- See Civil plans for grading information

Soils management report of site soil conditions to be PROVIDED BY CONTRACTOR after site grading completion, but prior to landscape planting

- Contractor to provide soil analysis certification of all imported soil used for back fill in planter areas.
- The project applicant / or his/her designee, shall submit documentation verifying implementation of soil analysis report recommendations with the certificate of completion.

DESIGNER'S STATEMENT

I agree to comply with the requirements of the water efficient landscape ordinance and submit a complete landscape documentation package.

Statement Prepared by

Thomas Hessel, CA LLA 6552 Landscape Architect

GHD, Inc.
916-256-2675
tom.hessel@ghd.com

CERTIFICATE OF COMPLIANCE

Upon completion of the installation of the landscaping, the Contractor shall notify the Landscape Architect so that the designer can certify that the landscape complies with all City water conserving landscape requirements. Certification shall be accomplished by completion of a certificate of compliance on a form approved by the City of Del Rey Oaks.

95% SUBMITTAL

No.	Issue	Checked	Approved	Date
Author	TH	Drafting Check	LP	Project Manager L. VAN PARYS
Designer	TH	Design Check	LP	Project Director K. VEDULA

Bar is one inch on original size sheet
0 1"

GHD Inc.
3831 North Freeway Blvd Suite 220
Sacramento California 95834 USA
T 1 916 372 6606 F 1 916 372 6616
www.ghd.com

Client: TRANSPORTATION AGENCY FOR MONTEREY COUNTY

Project: FORTAG TRAIL PROJECT

Project No. 11220281 | Date JANUARY 2023 | Scale AS SHOWN

Title: Landscape Irrigation MWELO Documents

Size: ANSI D

Status Code

Sheet No. L-003 | Sheet 156 of 187

Plot Date: 7 March 2023 - 12:53 PM Plotted By: Tom Hessel Path and Filename: N:\US\Roseville\Projects\561\11220281\06 - Digital_Design\ACAD 2020\Sheets\11220281-GHD-LA-SPEC-0001 THRU 0007.dwg

PRELIMINARY DESIGN NOT FOR CONSTRUCTION