Final Drainage Report
Terra Ridge North
Colorado Springs, Colorado 80908

Prepared for:
El Paso County, CO

On Behalf of:
Phillip S. and Jennifer Miles
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Colorado Springs, CO 80908
719-352-8886

Prepared by:
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Phillip Shay Miles, PE
719-352-8886

April 20, 2023

PCD File# SF2239

ENGINEER'S STATEMENT:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors, or omissions on my part in preparing this report.

Signature: _____ Date: _____

Phillip Shay Miles, PE
Registered Professional Engineer State of Colorado No.40462

DEVELOPER'S STATEMENT:

I, the owner/developer, have read and will comply with all of the requirements specified in this drainage report and plan.

Name of Owner/Developer

Authorized Signature: ____ _____Date: 4/20/23

Title: Owner

Address: 15630 Fox Creek Lane, Colorado Springs, CO 80908

EL PASO COUNTY:

Filed in accordance with the requirements of the Drainage Criteria Manual, Volumes 1 and 2, El Paso County Engineering Criteria Manual and Land Development Code as amended.

_____ _____

County Engineer / ECM Administrator Date

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1. Purpose

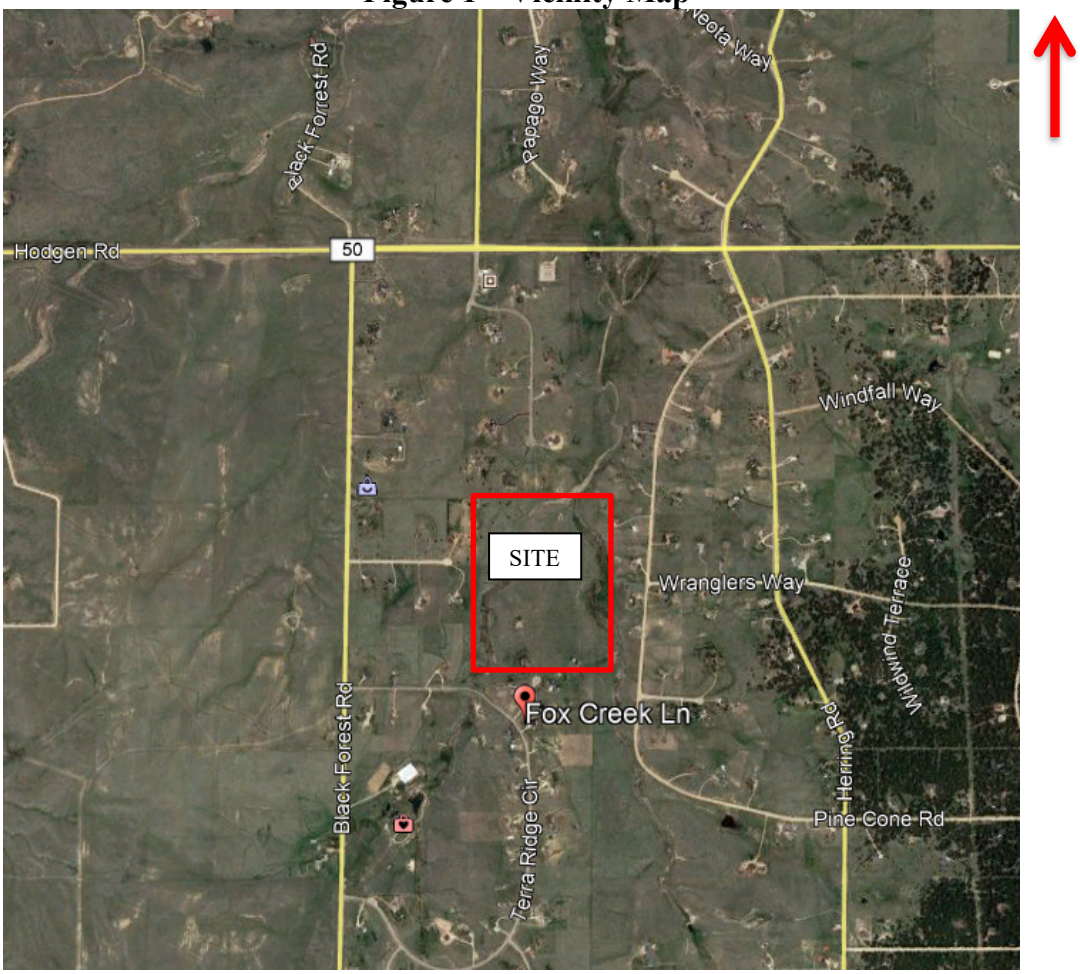
The purpose of this Final Drainage Report for Terra Ridge North is to quantify and evaluate the impacts of stormwater runoff generated by this Project and to provide adequate water quality/detention treatment.

2. General Description

The Terra Ridge North property (Project) is a 52.34-acre single-family development consisting of 13 lots and a public street (Fox Creek Lane) located within Black Forest, Colorado in El Paso County. The project will consist of a public street, detention pond A, and new home construction and associated site elements typical of single-family residential development (e.g. – driveways, patios, landscaping, etc.). The property is bounded by Ridgeview Acres to the north, Whispering Hills Estates to the west Wildwood Village to the east, and Terra Ridge Estates to the south. All lots surrounding the subject property are all zoned RR-5. The entire 52.34-acre parcel lies within unincorporated El Paso County and is currently zoned RR-2.5 (11 northern lots) and RR-5 (2 southern lots).

This project is located in the Town of Black Forest, El Paso County, Colorado. Access to the site is from Fox Creek Lane. It is located in Section 29, Township 11 south, Range 65 west of the 6th principal meridian. A vicinity map is provided below in Figure 1.

Figure 1 – Vicinity Map



The existing site is covered with native grasses with a few randomly located ponderosa pines. The topography of the site is rolling hills with two drainage ways extending from south to north through the property. A 100-foot-wide electric easement extends north to south along the eastern portion of the site.

3. Soils Conditions

The proposed development is 52.34 acres. Ground cover primarily consists of existing vegetation primarily consisting of native grass and shrubs.

The general topography of the land slopes to the south at slopes in the range of 2% to 30%. According to the Natural Resources Conservation Service (NRCS), the soils in this area consist of Peyton-Pring Complex and Tomah-Crowfoot loamy sands, and can be classified as a Hydrologic Soil Group (HSG) Types B. A soil map and map unit (soils type) descriptions describing the HSG and other soils properties are provided in Appendix A. For the purposes of this report an HSG type B soil has been used to define rational method runoff coefficients.

Generally speaking, stormwater runoff from this project flows to the north and will initially enter an unnamed drainageway which ultimately discharges into East Cherry Creek.

4. Drainage Criteria

The hydrologic and hydraulic analysis performed in this report utilizes The City of Colorado Springs and El Paso County Drainage Criteria Manual (Vol 1, 1991) (Vol 2, 2002), The City of Colorado Springs (Chpt. 6, 2014, and the MHFD USDCM (Urban Storm Drainage Criteria Manual) Volumes 1 & 2. Stormwater runoff was determined using the Rational Method and was calculated for existing and proposed conditions for the 5-yr (minor) and 100-yr (major) recurrences. 1-hour rainfall depths were derived from NOAA Atlas 14, Volume 8, Version 2 specific to the Project location.

The following MHFD hydrologic and hydraulic software were used in this report:

- UD-Culvert v3.05 –Culvert and Erosion Protection Calculations
- MHFD-Detention v4.06 – Water Quality and Detention Calculations

Additional software was needed for the triple 54” pipes to accurately model a parabolic overflow weir (driveway sag curve). USDOT Federal Highway Administration (FHWA) Culvert Analysis Program HY-8, version 7.6. The culverts have been designed so there will not be any overtopping during the 100yr storm event.

5. Existing and Proposed Drainage Conditions

5.1 Drainage Patterns and Hydraulic Routing

Existing

Stormwater runoff from this Project generally flows to the north and will initially enter an unnamed tributary ultimately discharging to East Cherry Creek. The imperviousness value of undeveloped land is ~2% in accordance with DCM Table 6-6.

Design Point EX flows are generated from a naturally vegetated field in combination with the developed flows from the existing Terra Ridge subdivision filings to the south. The Q_{100} flow is 433.7cfs.

Proposed

Proposed roadway construction and associated grading will create five (5) on-site basins and two (2) off-site basins. Refer to the drainage plan in Appendix C. A portion of basins A and B extend into Terra Ridge Filing No. 1. These basin boundaries include the new portion of roadway (Fox Creek Lane) being extended to the north along with roadside ditches. Ditches are provided to capture and convey as much area as possible from the roadway to Pond A for water quality and detention treatment. Refer to summary table in Section 10 for additional information. It is noteworthy to mention that portions of basin A and B areas have already been accounted for in the Terra Ridge Filing No. 1 basins, therefore runoff values have been slightly conservative for these areas.

Design Point 1 flows are generated from basin B. Basin B consists of public roadway improvements to include pavement, and roadside ditches. Unconcentrated sheet flow across the pavement is collected in the adjacent ditch and is routed north to the proposed 18" storm culvert. At this location, runoff will be conveyed under the proposed roadway to the ditch on the east side. Runoff is then conveyed under the proposed maintenance access road via a 24" storm culvert with flow ultimately discharging into the proposed water quality/detention pond A facility.

Design Point 2 flows are generated from basins A and B. Basin A consists of public roadway improvements to include pavement, and roadside ditches. Unconcentrated sheet flow across the pavement is collected in the adjacent ditch and combines with basin B runoff and is routed north to design point 2. At this location, runoff will be conveyed in a proposed ditch to the forebay of the proposed water quality/detention pond A facility. Riprap will be provided on three sides of the structure with a d50 of 6" and a thickness of 12" to prevent erosion when overtopping during frequent storm events. The proposed forebay will be ~44cf in volume and will have a notch width of 3.7inches. Flows into a 1.5' wide concrete trickle channel will be conveyed to the outlet structure micropool. Refer to the forebay and detention pond A calculations located in Appendix B. The emergency overflow route is over a 4' wide (i.e. – 4' long crest length) proposed spillway which has been designed to pass the peak flow from the 100yr flow event. For non-excluded soil disturbance areas and areas that are excluded from pond treatment for basins A and B, refer to Section 10 summary table for each associated value.

Design Point 3: The JR report shows flows entering the project site with a Q100yr value of 369cfs (JR DP5). To route this flow to Fox Creek Design Point 3, this flow value (369cfs) and the time of concentration (Tc) for Design Point 5 from the JR report (0.765hrs = 45.9minutes) was held and a corresponding CA equivalent (rational method input) was calculated for routing to Design Point 4. The Tc for the JR flow (45.9cfs) was added to the additional Tc (9.2 minutes) to route thru the site to Design Point 4, yielding a higher Tc (55.1) for Design Point 4 and was used to determine the Q100yr peak flow value of 432cfs. As a rough check, using the JR Design Point 5 report data and the 371 tributary acres with a resultant flow of 369cfs yields ~1.01cfs/acre. Our addition of off-site basin OS1 and onsite basin D (total 45acres) yielded a peak flow at Design Point 4 of 431.8cfs. Therefore, our project site had flows of ~1.04cfs/acre which is close to the 1.01cfs/acre value determined by JR.

Design Point 4 flows are generated from off-site basins OS1 and OS2, Design Point 3 as well as on-site basin D. Basin OS1 and OS2 consist of large lot single family subdivision development improvements with homes, driveways, sheds, and various outbuildings. Runoff flows down the side slope and directly into the adjacent drainageway. Basin D consists of a naturally vegetated field which will have some minor impervious area additions from the proposed home sites. Portions of basins D can be excluded from water quality treatment per ECM appendix I.7.1.B.5. Refer to section 10 summary table for those areas. Runoff from basin D is routed directly into the drainageway and then to the north to design point 4. To enable the flows at this

location to pass under the proposed driveway, three (3) 54" culverts are proposed. Riprap energy dissipation will be provided at the outfall to minimize the potential for erosion/local scour. Refer to appendix B calculations for additional information.

Basin E flows are generated from a naturally vegetated field and a short segment of driveway pavement. This basin runoff is not being treated in the proposed water quality/detention pond A because of the topographical constraints on site. Portions of basins E can be excluded from water quality treatment per ECM appendix I.7.1.B.5. Refer to section 10 summary table for those areas. Basin E flows are routed in the existing drainageway to the northeast combining with the main channel of East Cherry Creek at the northeastern lot corner.

Basin F flows are generated from a naturally vegetated field which will have home site construction. Basin F flows are routed in an existing drainageway (East Cherry Creek) on the east side of the property which combines with the aforementioned onsite drainageway within basin E near the northeastern lot corner. Portions of basins F can be excluded from water quality treatment per ECM appendix I.7.1.B.5. Refer to section 10 summary table for those areas.

Basic C is not used.

These disturbances are not applicable to this exclusion because the grading is for the development of the roadway, not the residential lots. Thus I've been asking you to do Runoff Reduction or some WQ treatment PBMP. Previous Review 2 comment provided at bottom of this page for reference.

As stated above, portions of basins D, E & F are excluded from permanent water quality per ECM Appendix I Section I.7.1.B.5 since these contain large lot single family sites (greater than 2.5 ac) and will have soil and vegetation conditions which are suitable for infiltration/filtration. Refer to section 10 summary table for those areas.

Design Point 5 is the ultimate outflow outfall located at the northeast corner of the subdivision and is a combination of flows from DP4, basin E, F, JR basin 17, and pond A outfall. The Q_{100} flow is 472.7cfs.

The developed 100-year flow at design point 5 is 39cfs higher than the historic 100-year flow at the same location (Design Point EX). This yields an 8.9% increase in flows from the proposed subdivision which is negligible and will not negatively impact downstream properties.

5.2 Site Improvements

Utilities that exist within the project area are overhead electric lines running north to south across the east half of the project. There are no other known public utilities in the area. The existing electric lines are contained within an easement.

No improvements will be made to the existing Fox Creek Lane south of the proposed development.

5.3 Hydraulic Calculations

Culverts

The calculations for the 18" culvert and 24" culvert which routes ditch flows from basin B to basin A under the proposed driveway and under the proposed maintenance access road were performed using 2022 Civil3D design software and are contained in Appendix B. The triple 54" storm culverts routing the drainageway under the proposed driveway were modeled using FHWA HY-8 software. Refer to Appendix B.

Review 2 comment:
This is a follow-up to my Review 1 comment on the drainage map about untreated proposed soil disturbances in Basin D:
Per direction from the State, subdivision developments that include impervious pavement roads do not qualify for Exclusion E (Large Lot Single-Family Site) on the PBMP form for those roadway areas. Therefore, a permanent WQ facility should be designed to treat runoff from the impervious roadway area and the subsequent grading like roadside ditches (but only if the total area of soil disturbance is >1ac). A driveway that feeds and crosses multiple lots counts toward roadway impervious area. But individual driveways for individual lots counts towards the impervious area for the large single-family lot.
For this site, I recommend you look into utilizing Runoff Reduction (RR) for WQ treatment per MHFD Detail T-0. MHFD has a calculation spreadsheet for RR. See further guidance in my comment at the bottom of pdf page 11 below.

Ditch Design
The hydraulic analysis for the Fox Creek Lane roadway ditches was performed using 2022 Civil3D design software and are contained in Appendix B. A grassed lined channel Manning's roughness coefficient value of 0.040 was used for the ditches per table 10-2 of the drainage criteria manual which is the "normal" value as indicated at the top of the table. For all roadside ditches proposed for this project, a Shotgun seed mix will be used which results in long native grasses. Using a mix like this will provide adequate surface roughness and the stability needed to accommodate the 100yr storm event flow velocities. Long native grass is capable of withstanding velocities up to 6ft/sec. Our proposed design velocity values range from 3.2ft/sec to 5.5ft/sec. Furthermore, the existing on-site soils do not have a significant amount of sand content and are somewhat cohesive in nature. Therefore, we believe the onsite soils coupled with long native vegetative cover can be considered erosion resistant.

Channel Analysis
The hydraulic analysis for the drainageway (unnamed tributary to East Cherry Creek) routed through the development was performed using 2022 Civil3D design software and is contained in Appendix B. A natural stream Manning's roughness coefficient value of 0.040 was used for the channel per table 10-2, of the drainage criteria manual which as stated above is the "normal" value used for computations. Five locations were chosen for normal depth flow analysis. Velocities ranged from 3.6ft/sec to 5.0ft/sec which as we have stated above would be considered non erosive being below the 6ft/sec threshold. Furthermore, the channel appears to be stable with no signs of thalweg incision, head cutting or unstable banks.

5.4 On-site Detention Requirements

A full spectrum water quality/detention pond A is proposed for this site to provide water quality for developed flows as a result of this development. In addition to water quality, detention is provided in the pond A design. Refer to section 7 in this report for additional information regarding water quality capture volume (WQCV) and detention (peak flow attenuation) flow requirements for this project.

The Terra Ridge North HOA will own and maintain the water quality/detention pond A.

5.5 Compliance with Other Studies

The only studies related to this project are the Terra Ridge Filing No 1 and 2 reports (see references). The basins that are common to this project (Terra Ridge – basin 12 and 17) have only been modified slightly to account for the proposed roadway construction. Flows as determined in the Terra Ridge reports for the natural drainageway have been used and supplemented with the additional flows from the Terra Ridge North watershed to determine the on-site flow at the proposed driveway crossing.

5.6 Four Step Process

Step 1 – Runoff Reduction Practices
This development address Low Impact Development strategies primarily through the utilization of roadway ditches. Runoff from the pavement sheet flows across the grass lined ditch side slopes which provides some level of water quality treatment.

Step 2 – Stabilize Drainageways
Portions of the existing conditions runoff currently enter the on-site natural drainageway via overland flow across the vacant lots and via the proposed full-spectrum detention pond A. Due to the minor anticipated extent of land disturbance and improvements on these large lots coupled with on-site detention; the amount of runoff entering the drainageways remains basically the same. Predevelopment levels of release of the Excess Urban

Runoff Volume (EURV) help the drainageway maintain its current morphology by mimicking the natural historic runoff rates over a longer period by peak flow attenuation.

Step 3 –Implement BMPs that Provide a Water Quality Capture Volume with Slow Release
On-site flow is directed to the on-site private proposed full-spectrum detention/water quality facility. The extended detention basin provides Water Quality Capture Volume (WQCV) required for this site and attenuates the peak flows releasing them at approximate historic runoff rates over a longer period by releasing Excess Urban Runoff Volume (EURV).

Step 4 – Consider Need for Industrial and Commercial BMPs
No industrial and commercial development exist onsite.

6. Water Quality

Stormwater that is generated from this Project is either discharged offsite in the form of unconcentrated sheet flow or is collected in roadside ditches and routed thru the proposed water quality/detention facility outfalling via an 18" storm sewer pipe.

The proposed on-site imperviousness of the area contributing to pond A is 25.9%. Basin C is not used in this report.

The proposed full spectrum extended detention basin (EDB) has been analyzed in this study based on the proposed site conditions as shown on the Drainage Plan. The facility provides 0.060 acre-ft of water quality capture volume, 0.138acre-ft of excess urban runoff volume and 0.236 acre-ft of detention storage. The proposed EDB will release a peak flow 5.4cfs during the 100-year storm event. Outflows from the proposed EDB are released via a proposed 18" storm sewer pipe with a restrictor plate located within the outlet structure box. The outlet structure will have an orifice plate designed to drain the EURV over a period of 72 hours. The orifice plate will have 3 rows of holes. The lowest will be 15/16" in diameter, and the second and third rows will be 7/16" in diameter. The EDB will have a rip rap emergency overflow spillway that will drain the 100yr peak flows (8.0cfs) in the event the outlet structure becomes entirely clogged or the pond is already full. The spillway will be constructed of rip rap with a d50 = 9", 18" thick, a crest length of 4.0' with 3:1 side slopes. Flow depth over the crest of the spillway during the 100yr event storm will be 0.61' with 1.12' of freeboard. The outfall pipe will outfall onto the riprap of the emergency overflow spillway (see appendix B calculations) to dissipate any energy. A 10ft maintenance road has been provided extending from the private driveway to the bottom of the pond. Pond A will be maintained using a skid loader. Refer to the design calculations in Appendix B for additional information.

7. Floodplain Statement

According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) number 08041C0315G dated December 7, 2018 this project is not located within a FEMA designated 100yr floodplain. Therefore, no map revisions will be necessary as a result of this project. A copy of the FIRM maps is provided in Appendix A.

8. Drainage and Bridge Fees

The drainage basin is located within the East Cherry Creek Drainage Basin.

The project is not located within a fee (drainage) basin and bridge fees are not required. Therefore, no drainage or bridge fees are required for this development.

9. Construction Cost Opinion

Item	Unit	Quantity	Unit Price	Extended Cost
18" Storm Pipe	LF	24	$70	$1,680
24" Storm Pipe	LF	20	$75	$1,992
54" Storm Pipe	LF	150	$195	$29,250
Outlet Structure	EA	1	$12,450	$12,450
Forebay	EA	1	$3,250	$3,250
Trickle Channel	LS	1	$1,548	$1,548
			Sub-total	$50,170
			Contingency 10%	$5,017
			TOTAL	$55,187

All storm system elements for this project are private and therefore there will be no reimbursement from El Paso County.

Where are these RRcalcs? None seen in FDR. Also need a map that delineates RPAs, UIAs, and SPAs. See comment on next page for more info.

No Runoff Reduction necessary for these two basins since you are stating that 100% of their proposed disturbances are trib to Pond A.

10. Summary

The Final Drainage Report for Terra Ridge North was prepared using the El Paso County Engineering Criteria Manual, City of Colorado Springs Drainage Criteria Manuals, and Mile High Flood Control District Manuals. Stormwater quality and detention is provided by a proposed facility located on-site. No adverse downstream impacts are anticipated as a result of the proposed site improvements.

Looks like an excel drag-down error, they all should be B.5.

Basin ID	Total Area (ac)	Total Proposed Disturbed Area (ac)	Area Trib to Pond A (ac)	Disturbed Area Treated Via Runoff Reduction (ac)	Area Excluded from WQ per ECM App I.7.1.c.1 (ac)	Area Excluded from WQ per ECM App I.7.1.B.# (ac)	Applicable WQ Exclusions (App I.7.1.B.#)
A	4.2	3.24	4.2	0.61	0		
B	0.94	0.94	1.02	0.54	0		
D	14.59			0.02	0.55	1.5	ECM App I.1.7.B.5
E	6.36			0.02	0.17	0.6	ECM App I.1.7.B.6
F	14.15				0.28	1.4	ECM App I.1.7.B.7
Total	40.24	4.18			1	3.5	

Please fill these cells in. Looks like F should be 0, but D and E have proposed disturbances

11. References

1. Engineering Criteria Manual, El Paso County, December 2016
2. Drainage Criteria Manual, Volumes I and II, El Paso County and City of Colorado Springs, Vol 1, 1991 and Vol 2, 2002
3. Drainage Criteria Manual, Chapter 6, Volume 1 Update, October 2018
4. Urban Storm Drainage Criteria Manual (USDCM), Volumes I-III, Mile High Flood Control District (MHFD).

5. Preliminary drainage report for Terra Ridge Filing No. 1, JR Engineering, April 1997.
6. Preliminary drainage report for Terra Ridge Filing No. 2, JR Engineering, June 1999.
7. FEMA Flood Insurance Rate Map Numbers 08041C0305G and 08041C0305G, El Paso County, Colorado, December 7, 2018
8. Natural Resources Conservation Service, Web Soil Survey, http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx
9. United States Geological Survey (USGS) Topographic Quadrangle Map

Unresolved Review 2 comment:

In accordance with the MHFD, runoff reduction has the following vegetation requirements:
- All RPA/SPA areas will need to be within a no build/drainage easement (or tract) and discussed in the maintenance agreement and O&M manual.
- RPA vegetation should be turf grass (from seed [provide appropriate seed mix] or sod).
- Turf grass vegetation should have a uniform density of at least 80%.
- RPA/SPA limits must be shown on GEC Plans (not just FDR) so our SW inspectors and the QSM know that these areas are to remain pervious and vegetated (80%). Our SW inspectors do not look at drainage reports.

Other requirements:
- Provide a figure showing all proposed UIA, RPA and SPA areas to be utilized for runoff reduction.
- Provide a detail for the UIA:RPA interface that shows the recommended vertical drop of 4”.

Appendix A
Maps

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for El Paso County Area, Colorado

fox creek subdivision

October 13, 2019

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map

Map Scale: 1:5,510 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 250 500 1000 1500

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

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

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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 17, Sep 13, 2019

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

Date(s) aerial images were photographed: Sep 8, 2018—May 26, 2019

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
14	Brussett loam, 1 to 3 percent slopes	1.2	1.0%
68	Peyton-Pring complex, 3 to 8 percent slopes	123.2	94.7%
92	Tomah-Crowfoot loamy sands, 3 to 8 percent slopes	5.7	4.4%
Totals for Area of Interest		**130.1**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or

landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

El Paso County Area, Colorado

14—Brussett loam, 1 to 3 percent slopes

Map Unit Setting

National map unit symbol: 367j
Elevation: 7,200 to 7,500 feet
Frost-free period: 115 to 125 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Brussett and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Brussett

Setting

Landform: Flats
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Eolian deposits

Typical profile

A - 0 to 8 inches: loam
BA - 8 to 12 inches: loam
Bt - 12 to 26 inches: clay loam
Bk - 26 to 60 inches: silt loam

Properties and qualities

Slope: 1 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 9.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3c
Hydrologic Soil Group: B
Ecological site: Loamy Park (R048AY222CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

68—Peyton-Pring complex, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 369f
Elevation: 6,800 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

Peyton and similar soils: 40 percent
Pring and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Peyton

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock and/or arkosic residuum weathered from sedimentary rock

Typical profile

A - 0 to 12 inches: sandy loam
Bt - 12 to 25 inches: sandy clay loam
BC - 25 to 35 inches: sandy loam
C - 35 to 60 inches: sandy loam

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: B
Ecological site: Sandy Divide (R049BY216CO)
Hydric soil rating: No

Description of Pring

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock

Typical profile

A - 0 to 14 inches: coarse sandy loam
C - 14 to 60 inches: gravelly sandy loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 6.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: Loamy Park (R048AY222CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

92—Tomah-Crowfoot loamy sands, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 36b9
Elevation: 7,300 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

Tomah and similar soils: 50 percent
Crowfoot and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tomah

Setting

Landform: Hills, alluvial fans
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from arkose and/or residuum weathered from arkose

Typical profile

A - 0 to 10 inches: loamy sand
E - 10 to 22 inches: coarse sand
C - 48 to 60 inches: coarse sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 2.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: Sandy Divide (R049BY216CO)
Hydric soil rating: No

Description of Crowfoot

Setting

Landform: Alluvial fans, hills
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

A - 0 to 12 inches: loamy sand
E - 12 to 23 inches: sand
Bt - 23 to 36 inches: sandy clay loam
C - 36 to 60 inches: coarse sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches

Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: Sandy Divide (R049BY216CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

National Flood Hazard Layer FIRMette

FEMA

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 10/28/2019 at 7:40:48 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

Appendix B
Calculations

FINAL DRAINAGE REPORT

Terra Ridge North

(Composite Runoff Coefficient - 5 Year)

ON-SITE							
Basin	***Area (acres)***						***C5***
	Paved/Drive/Walk	***Res 2.5ac***	***Gravel***	***Lawn/Meadow***	***Undev - Hist***	***TOTAL***	
A	0.43	2.69	0.12	0.96	0.00	4.20	0.18
B	0.40	0.00	0.06	0.49	0.00	0.94	0.46
C	Not Used						
D	0.19	14.38	0.02	0.00	0.00	14.59	0.09
E	0.17	6.18	0.02	0.00	0.00	6.36	0.10
F	0.00	14.15	0.00	0.00	0.00	14.15	0.08

OFF-SITE							
Basin	***Area (acres)***						***C5***
	Paved/Drive/Walks	***Res 5ac***	***Gravel***	***Lawn/Meadow***	***Undev - Hist***	***TOTAL***	
OS1	0.00	30.00	0.00	0.00	0.00	30.00	0.05
OS2	0.13	6.23	0.00	0.00	0.00	6.36	0.07

EXISTING							
Basin	***Area (acres)***						***C5***
	Paved/Drive/Walks	***Res 5ac***	***Gravel***	***Lawn/Meadow***	***Undev - Hist***	***TOTAL***	
EX1	0.00	0.00	0.00	0.00	24.84	24.84	0.09
EX2	0.00	0.00	0.00	0.00	14.10	14.10	0.09

Per DCM Table 6-6 Vol 1 Update

Surface	**Runoff Coefficent**
Paved/Drive/Walk	0.90
Res 2.5ac	0.08
Res 5ac	0.05
Gravel	0.59
Lawn/Meadow	0.08
Undev - Hist	0.09

Note: Res 2.5ac and Res 5ac C5 based on 11% Imp and 5% Imp (Table 3-1) and Interpolation of MHFD table 6-5

FINAL DRAINAGE REPORT

Terra Ridge North

(Composite Runoff Coefficient - 100 Year)

ON-SITE							
Basin	***Area (acres)***						***C100***
	Paved/Drive/Walk	***Res 2.5ac***	***Gravel***	***Lawn/Meadow***	***Undev - Hist***	***TOTAL***	
A	0.43	2.69	0.12	0.96	0.00	4.20	0.51
B	0.40	0.00	0.06	0.49	0.00	0.94	0.63
C	Not Used						
D	0.19	14.38	0.02	0.00	0.00	14.59	0.49
E	0.17	6.18	0.02	0.00	0.00	6.36	0.49
F	0.00	14.15	0.00	0.00	0.00	14.15	0.48

OFF-SITE							
Basin	***Area (acres)***						***C100***
	Paved/Drive/Walks	***Res 5ac***	***Gravel***	***Lawn/Meadow***	***Undev - Hist***	***TOTAL***	
OS1	0.00	30.00	0.00	0.00	0.00	30.00	0.46
OS2	0.13	6.23	0.00	0.00	0.00	6.36	0.47

EXISTING							
Basin	***Area (acres)***						***C100***
	Paved/Drive/Walks	***Res 5ac***	***Gravel***	***Lawn/Meadow***	***Undev - Hist***	***TOTAL***	
EX1	0.00	0.00	0.00	0.00	24.84	24.84	0.36
EX2	0.00	0.00	0.00	0.00	14.10	14.10	0.36

Per DCM Table 6-6 Vol 1 Update

Surface	**Runoff Coefficent**
Paved/Drive/Walk	0.96
Res 2.5ac	0.48
Res 5ac	0.46
Gravel	0.70
Lawn/Meadow	0.35
Undev - Hist	0.36

Note: Res 2.5ac and Res 5ac C5 based on 11% Imp and 5% Imp (Table 3-1) and Interpolation of MHFD table 6-5

FINAL DRAINAGE REPORT

Terra Ridge North

(Percentage of Imperviousness)

ON-SITE: PROPOSED							
Basin	***Area (acres)***						***% Imp***
	Paved/Drive/Walk	***Res 2.5ac***	***Gravel***	***Lawn/Meadow***	***Undev - Hist***	***TOTAL***	
A	0.43	2.69	0.12	0.96	0.00	4.20	19.68
B	0.48	0.00	0.06	0.49	0.00	1.02	51.42
C	NOT USED						
D	0.00	14.38	0.02	0.00	0.00	14.40	11.10
E	0.17	6.18	0.02	0.00	0.00	6.36	13.49
F	0.00	14.15	0.00	0.00	0.00	14.15	11.00
Totals	**1.08**	**37.39**	**0.22**	**1.44**	**0.00**	**40.12**	**13.37**

OFF-SITE: PROPOSED							
Basin	***Area (acres)***						***% Imp***
	Paved/Drive/Walks	***Res 5ac***	***Gravel***	***Lawn/Meadow***	***Undev - Hist***	***TOTAL***	
OS1	0.00	30.00	0.00	0.00	0.00	30.00	7.00
OS2	0.13	6.23	0.00	0.00	0.00	6.36	8.93
Totals	**0.13**	**36.23**	**0.00**	**0.00**	**0.00**	**36.36**	**7.34**

TO POND: PROPOSED							
A,B	**0.91**	**2.69**	**0.18**	**1.44**	**0.00**	**5.22**	**25.90**

EXISTING							
Basin	***Area (acres)***						***% Imp***
	Paved/Drive/Walks	***Res 5ac***	***Gravel***	***Lawn/Meadow***	***Undev - Hist***	***TOTAL***	
EX1	0.00	0.00	0.00	0.00	24.84	24.84	2.00
EX2	0.00	0.00	0.00	0.00	14.10	14.10	2.00
Totals	**0.00**	**0.00**	**0.00**	**0.00**	**38.94**	**38.94**	**2.00**

Per DCM Table 6-6

Surface	**% Impervious**
Paved/Drive/Walk	100
Res 2.5ac	11
Res 5ac	7
Gravel	80
Lawn/Meadow	0
Undeveloped - Historic	2

Note: Res 2.5+ac % Imp. Per ECM Appendix L, Table 3-1

Final Drainage Report

Terra Ridge North

(Basin Summary)

From Area Runoff Coefficient Summary				*OVERLAND FLOW TIME*				*TRAVEL TIME*					TOTAL	*INTENSITY **		*TOTAL FLOWS*	
BASIN	**AREA TOTAL** *(Acres)*	C_5 *From DCM Table 6-6*	C_{100} *From DCM Table 6-6*	C_5	**Length** *(ft)*	**Height** *(ft)*	T_C *(min)*	**Conveyance Coeff.**	**Slope** *(%)*	**Length** *(ft)*	**Velocity** *(fps)*	T_t *(min)*	*(min)*	I_5 *(in/hr)*	I_{100} *(in/hr)*	Q_5 *(c.f.s.)*	Q_{100} *(c.f.s.)*
A	4.20	0.18	0.51	0.18	150	10	11.3	15	4.0%	320	3.0	1.8	13.0	3.7	6.3	***2.8***	***13.4***
B	1.02	0.46	0.63	0.46	10	3.3	1.2	15	5.6%	1285	3.5	6.0	7.2	4.6	7.8	***2.2***	***5.0***
C	Basin C no longer used. Combined into Basin E																
D	14.40	0.09	0.49	0.09	300 .	24	16.5	10	5.0%	240	2.2	1.8	18.3	3.2	5.4	***4.2***	***38.2***
E	6.36	0.10	0.49	0.10	300	20	17.3	15	4.9%	70	3.3	0.4	17.7	3.3	5.5	***2.1***	***17.1***
F	14.15	0.08	0.48	0.08	300	28	15.8	15	3.2%	1180	2.7	7.3	23.1	2.9	4.8	***3.2***	***32.7***
OS1	30.00	0.05	0.46	0.05	300	12	21.5	15	3.0%	815	2.6	5.2	26.8	2.7	4.5	***4.0***	***61.4***
OS2	6.36	0.07	0.47	0.07	300	10	22.4	15	3.0%	580	2.6	3.7	26.1	2.7	4.5	***1.2***	***13.5***
EX1	24.84	0.09	0.36	0.09	300	24	16.5	15	5.0%	990	3.4	4.9	21.4	3.0	5.0	***6.7***	***44.9***
EX2	14.10	0.09	0.36	0.09	300	28	15.7	15	3.2%	1180	2.7	7.3	23.0	2.9	4.8	***3.7***	***24.5***

* Intensity equations assume a minimum travel time of 5 minutes.

Calculated by: PSM

Date: 2/5/2023

Checked by: PSM

FINAL DRAINAGE REPORT

Terra Ridge North

(Surface Routing Summary)

					Intensity		Flow		
Design Point(s)	***Contributing Basins/Design Points***	***Equivalent CA_5***	***Equivalent CA_{100}***	***Maximum T_C***	***I_5***	***I_{100}***	***Q_5***	***Q_{100}***	***Comments***
1	B	0.43	0.59	7.5	4.6	7.6	***2.0***	***4.5***	***To proposed 18" culvert***
2	DP1, A	1.19	2.73	11.6	3.9	6.6	***4.6***	***18.0***	***To proposed pond (inflow)***
3	JR ENG DP-005	47.97	118.08	45.9	1.8	3.1	***86.3***	***366.0***	***Creek flow at entrance to property***
4	DP3, OS1, OS2, D	3.26	23.94	55.1	1.6	2.6	***92.1***	***432.0***	***To proposed Triple 54" culverts***
5	DP4, E, F, JR17, POND OUT	DP4, Basin E and F Routed, Pond Out and JR 17 Direct Addition					***100.1***	***472.7***	***Proposed Site Outfall - Compare to DP EX***
EX	JR ENG DP-005, JR17, OS1, OS2, EX1	JR ENG DP-005 and OS1 and OS2 and EX1 routed, JR17 Direct Addition					***96.9***	***433.7***	***Existing Site Outfall - Compare to DP 5***

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Sunday, Feb 5 2023

Basin A ditch 100yr Sta 6+50

Triangular

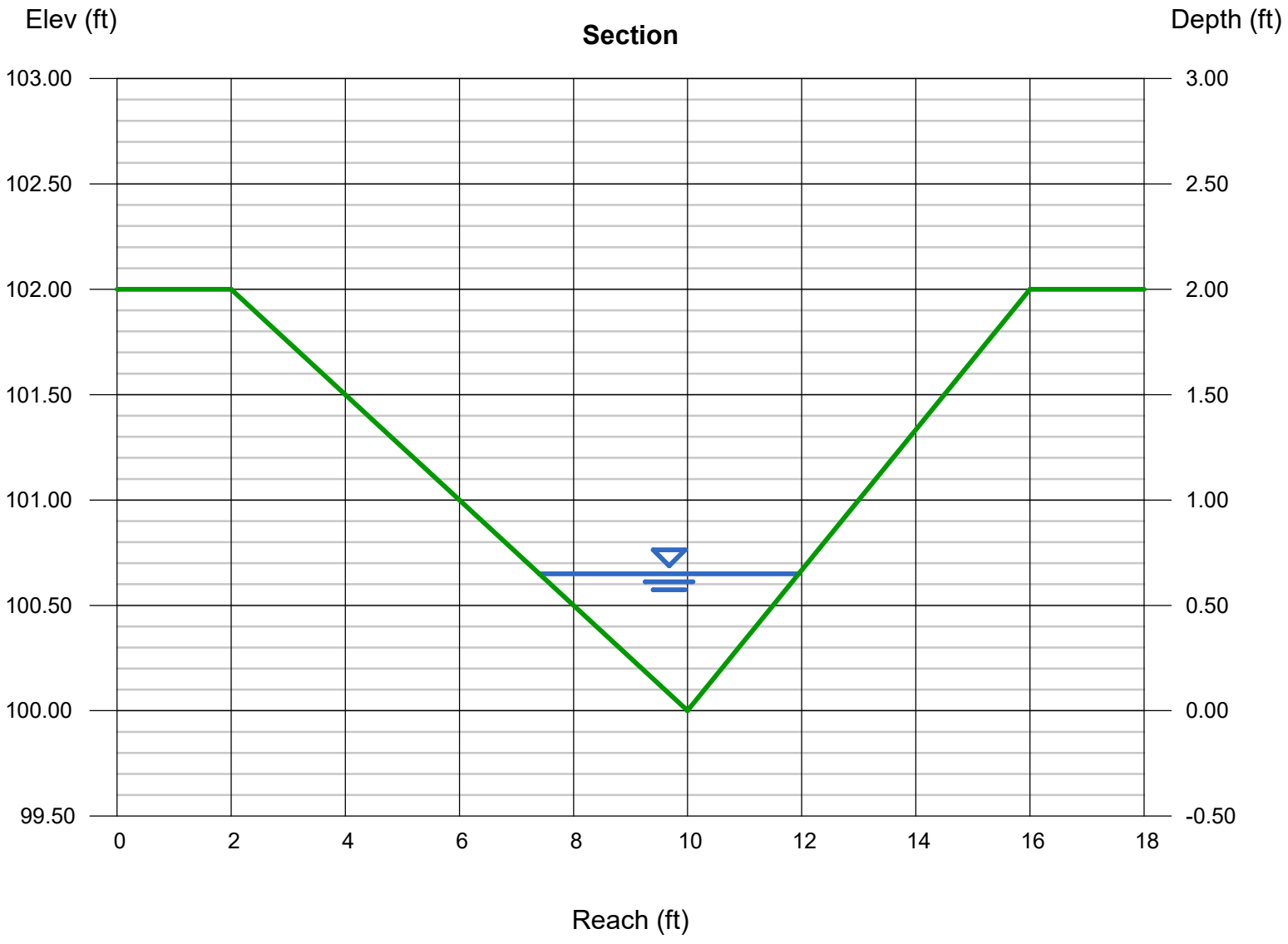
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 100.00
Slope (%)	= 3.50
N-Value	= 0.040

Calculations

Compute by:	Known Q
Known Q (cfs)	= 4.70

Highlighted

Depth (ft)	= 0.65
Q (cfs)	= 4.700
Area (sqft)	= 1.48
Velocity (ft/s)	= 3.18
Wetted Perim (ft)	= 4.74
Crit Depth, Yc (ft)	= 0.65
Top Width (ft)	= 4.55
EGL (ft)	= 0.81



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Sunday, Feb 5 2023

Basin A ditch 100yr Sta 10+00

Triangular

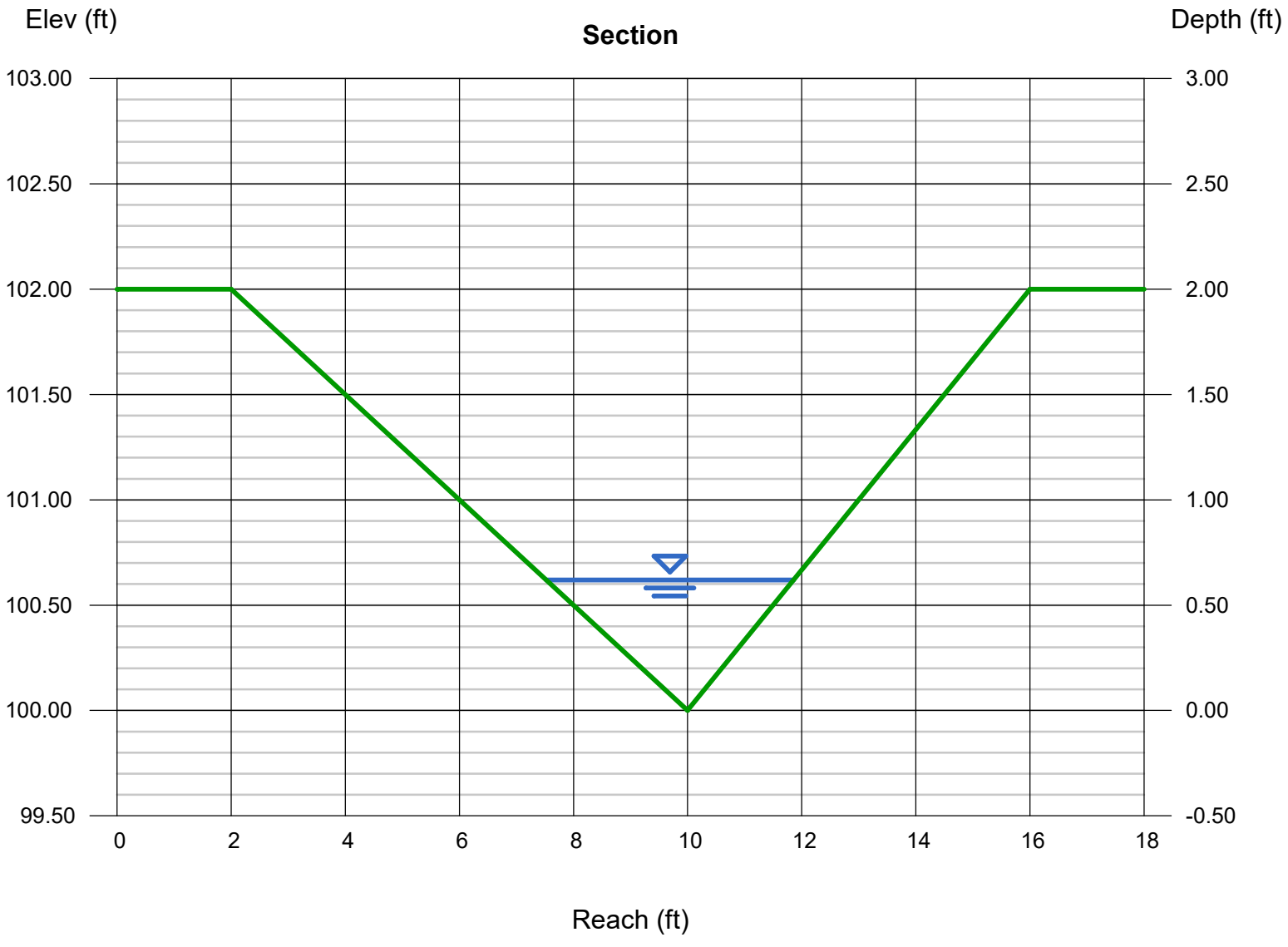
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 100.00
Slope (%)	= 6.50
N-Value	= 0.040

Calculations

Compute by:	Known Q
Known Q (cfs)	= 5.50

Highlighted

Depth (ft)	= 0.62
Q (cfs)	= 5.500
Area (sqft)	= 1.35
Velocity (ft/s)	= 4.09
Wetted Perim (ft)	= 4.52
Crit Depth, Yc (ft)	= 0.69
Top Width (ft)	= 4.34
EGL (ft)	= 0.88



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Sunday, Feb 5 2023

Basin A ditch 100yr Sta 12+00

Triangular

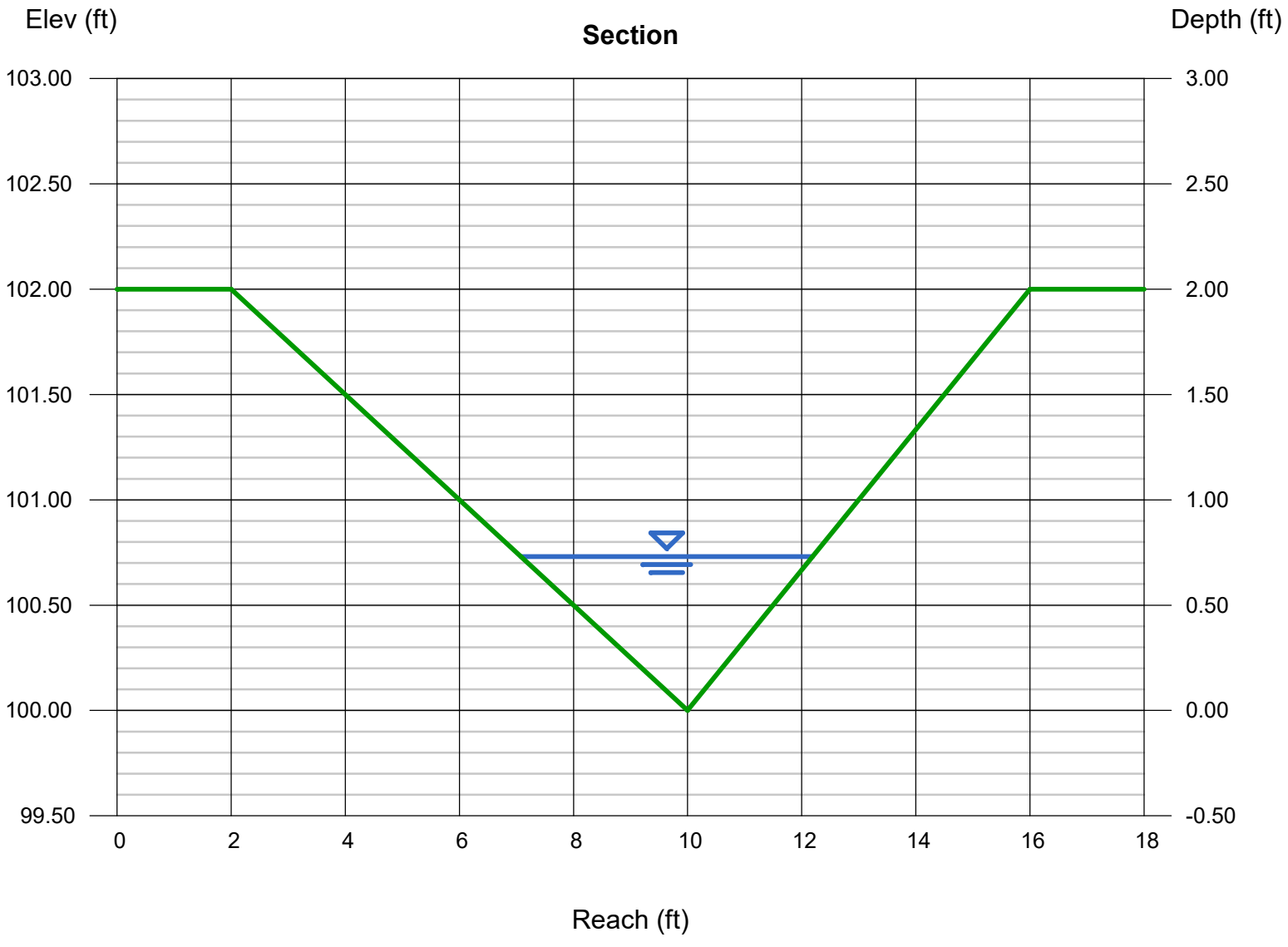
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 100.00
Slope (%)	= 8.30
N-Value	= 0.040

Calculations

Compute by:	Known Q
Known Q (cfs)	= 9.80

Highlighted

Depth (ft)	= 0.73
Q (cfs)	= 9.800
Area (sqft)	= 1.87
Velocity (ft/s)	= 5.25
Wetted Perim (ft)	= 5.32
Crit Depth, Yc (ft)	= 0.87
Top Width (ft)	= 5.11
EGL (ft)	= 1.16



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Sunday, Feb 5 2023

Basin A + B ditch 100ft South of Pond

Triangular

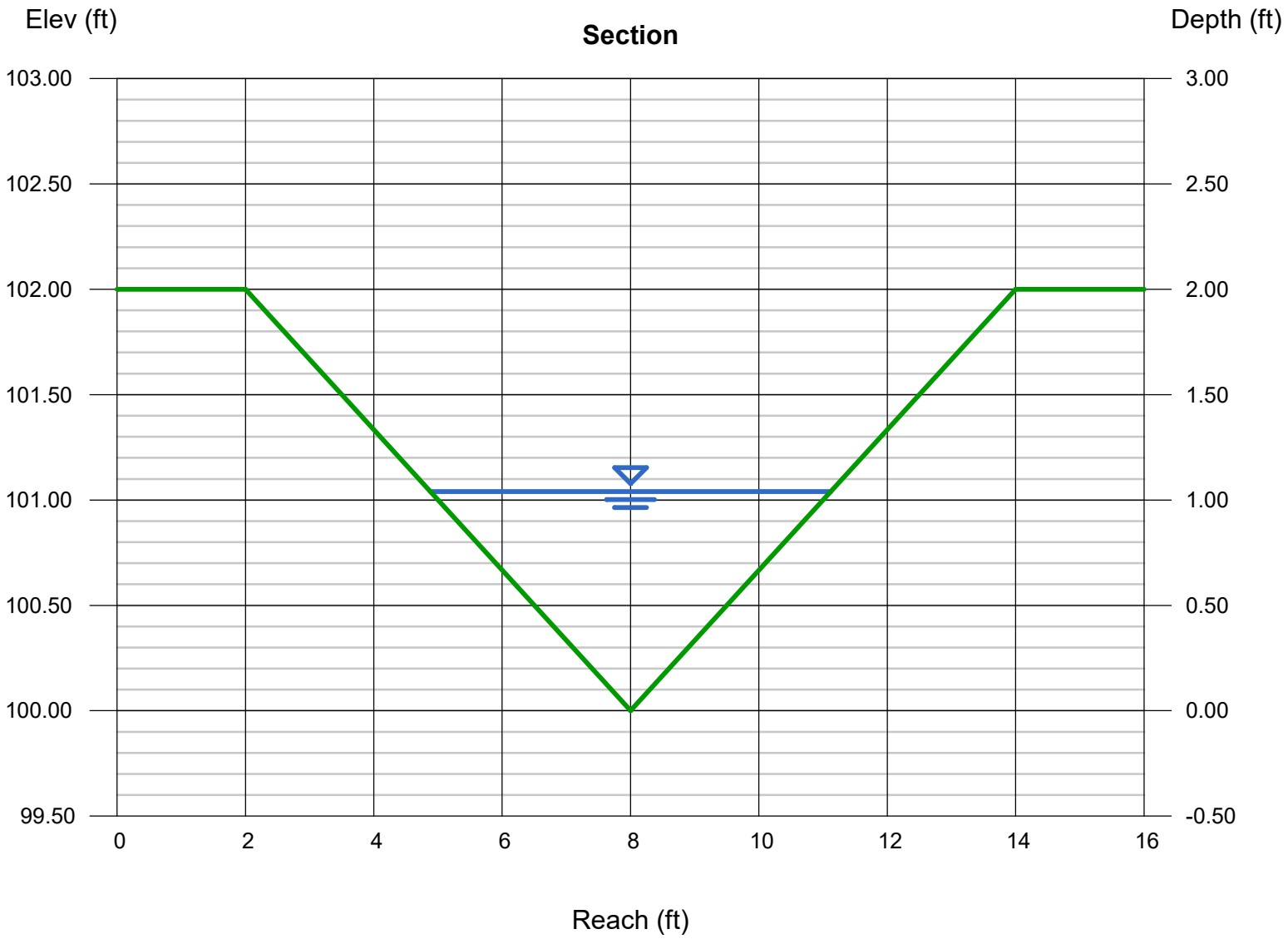
Side Slopes (z:1)	= 3.00, 3.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 100.00
Slope (%)	= 5.60
N-Value	= 0.040

Calculations

Compute by:	Known Q
Known Q (cfs)	= 17.80

Highlighted

Depth (ft)	= 1.04
Q (cfs)	= 17.80
Area (sqft)	= 3.24
Velocity (ft/s)	= 5.49
Wetted Perim (ft)	= 6.58
Crit Depth, Yc (ft)	= 1.17
Top Width (ft)	= 6.24
EGL (ft)	= 1.51



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Sunday, Feb 5 2023

Main 75ft DS of Driveway

User-defined

Invert Elev (ft)	= 44.00
Slope (%)	= 1.12
N-Value	= 0.040

Calculations

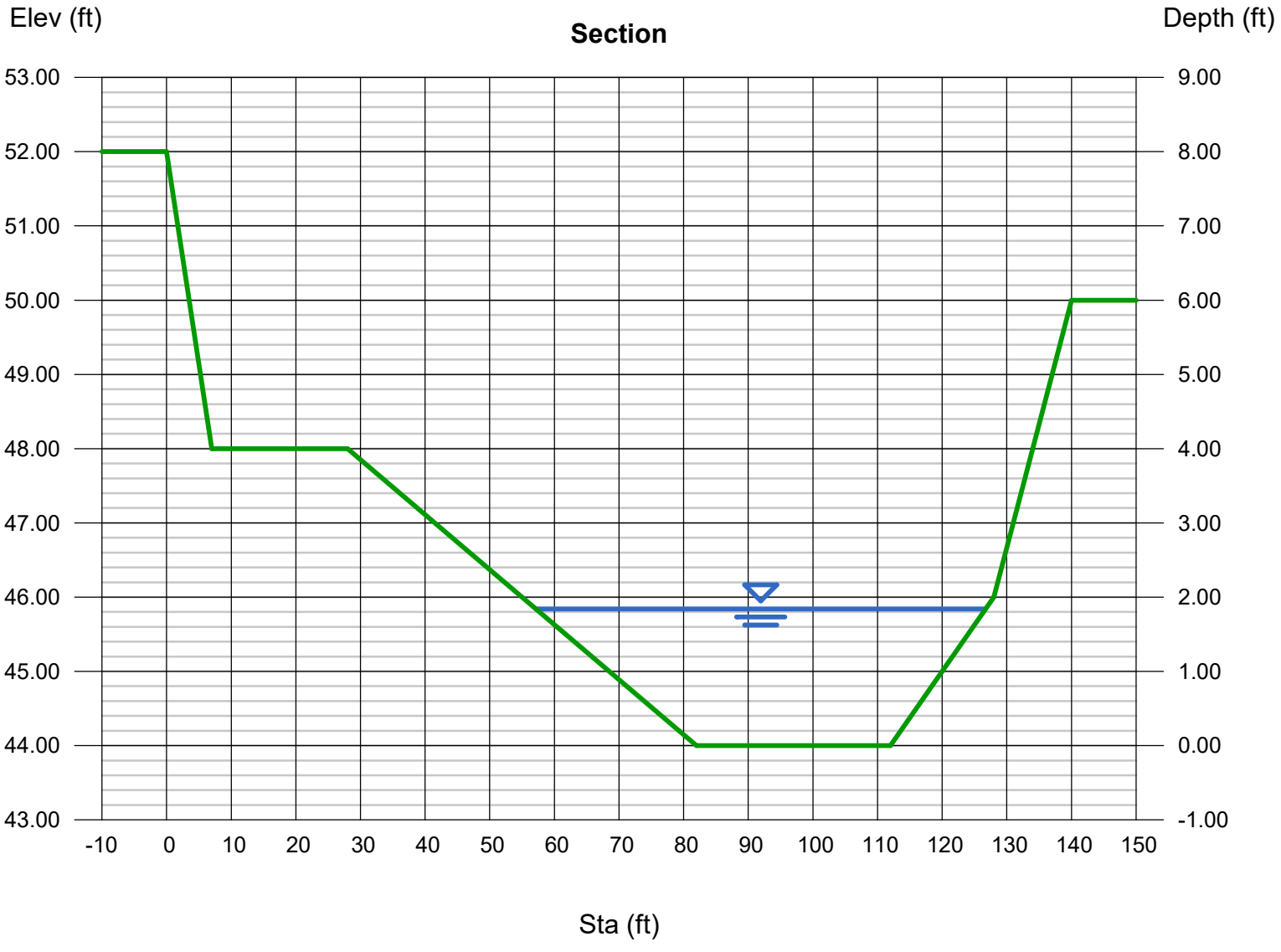
Compute by:	Known Q
Known Q (cfs)	= 432.00

Highlighted

Depth (ft)	= 1.84
Q (cfs)	= 432.00
Area (sqft)	= 91.60
Velocity (ft/s)	= 4.72
Wetted Perim (ft)	= 69.74
Crit Depth, Yc (ft)	= 1.54
Top Width (ft)	= 69.56
EGL (ft)	= 2.19

(Sta, El, n)-(Sta, El, n)...

(0.00, 52.00)-(7.00, 48.00, 0.040)-(28.00, 48.00, 0.040)-(82.00, 44.00, 0.040)-(112.00, 44.00, 0.040)-(120.00, 45.00, 0.040)-(128.00, 46.00, 0.040)-(140.00, 50.00, 0.040)



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Sunday, Feb 5 2023

Main 190ft DS of Driveway

User-defined

Invert Elev (ft)	= 42.00
Slope (%)	= 1.70
N-Value	= 0.040

Calculations

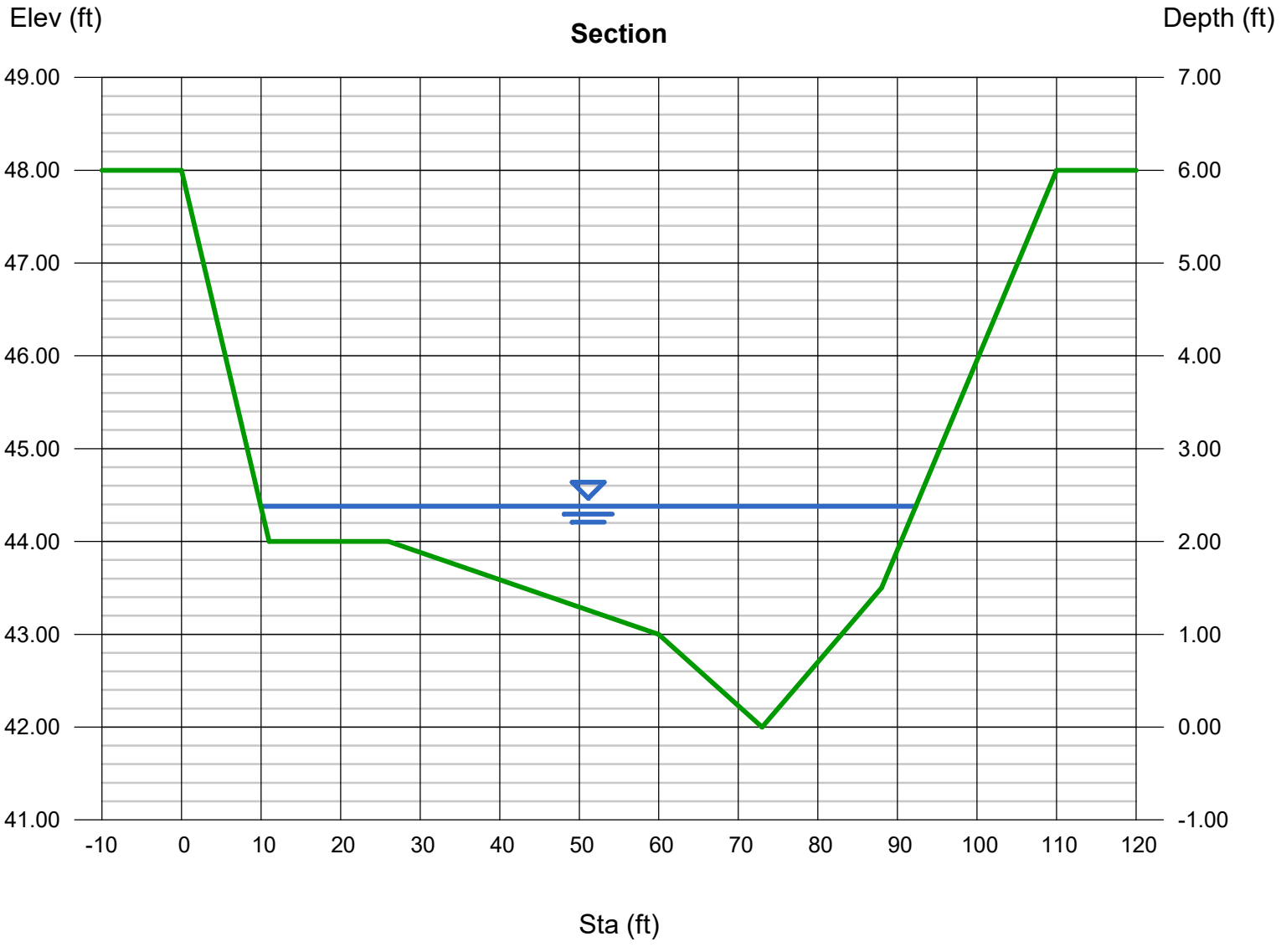
Compute by:	Known Q
Known Q (cfs)	= 432.00

Highlighted

Depth (ft)	= 2.38
Q (cfs)	= 432.00
Area (sqft)	= 86.60
Velocity (ft/s)	= 4.99
Wetted Perim (ft)	= 82.63
Crit Depth, Yc (ft)	= 2.28
Top Width (ft)	= 82.35
EGL (ft)	= 2.77

(Sta, El, n)-(Sta, El, n)...

(0.00, 48.00)-(11.00, 44.00, 0.040)-(26.00, 44.00, 0.040)-(60.00, 43.00, 0.040)-(73.00, 42.00, 0.040)-(88.00, 43.50, 0.040)-(110.00, 48.00, 0.040)



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Sunday, Feb 5 2023

Main 370ft DS of Driveway

User-defined

Invert Elev (ft)	= 36.50
Slope (%)	= 1.25
N-Value	= 0.040

Calculations

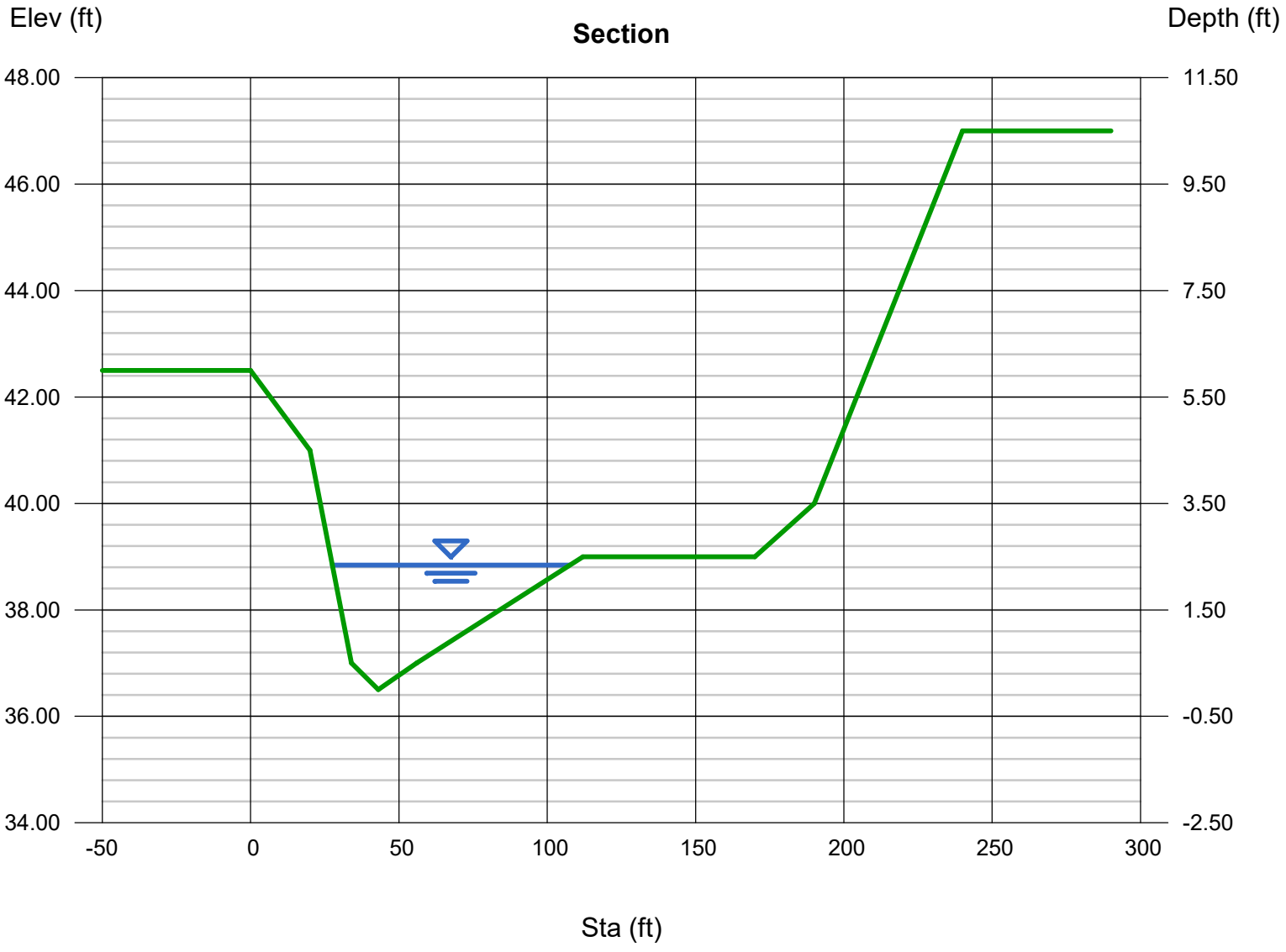
Compute by:	Known Q
Known Q (cfs)	= 473.00

Highlighted

Depth (ft)	= 2.34
Q (cfs)	= 473.00
Area (sqft)	= 99.30
Velocity (ft/s)	= 4.76
Wetted Perim (ft)	= 80.27
Crit Depth, Yc (ft)	= 2.08
Top Width (ft)	= 79.96
EGL (ft)	= 2.69

(Sta, El, n)-(Sta, El, n)...

(0.00, 42.50)-(20.00, 41.00, 0.040)-(34.00, 37.00, 0.040)-(43.00, 36.50, 0.040)-(56.00, 37.00, 0.040)-(112.00, 39.00, 0.040)-(170.00, 39.00, 0.040)
-(190.00, 40.00, 0.040)-(240.00, 47.00, 0.040)



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Sunday, Feb 5 2023

Main 560ft DS of Driveway

User-defined

Invert Elev (ft)	= 42.00
Slope (%)	= 1.12
N-Value	= 0.040

Calculations

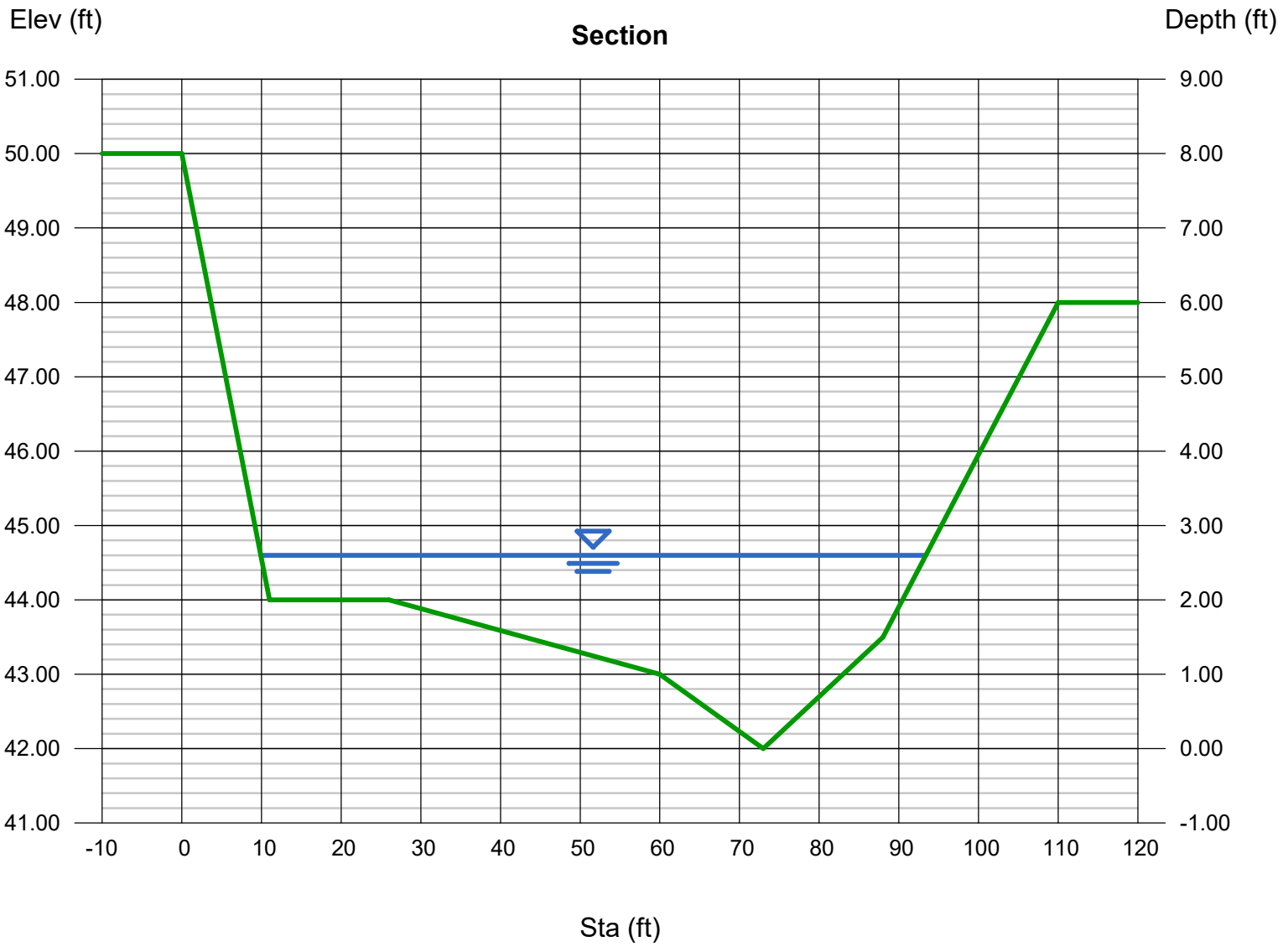
Compute by:	Known Q
Known Q (cfs)	= 473.00

Highlighted

Depth (ft)	= 2.60
Q (cfs)	= 473.00
Area (sqft)	= 104.74
Velocity (ft/s)	= 4.52
Wetted Perim (ft)	= 83.87
Crit Depth, Yc (ft)	= 2.34
Top Width (ft)	= 83.48
EGL (ft)	= 2.92

(Sta, El, n)-(Sta, El, n)...

(0.00, 50.00)-(11.00, 44.00, 0.040)-(26.00, 44.00, 0.040)-(60.00, 43.00, 0.040)-(73.00, 42.00, 0.040)-(88.00, 43.50, 0.040)-(110.00, 48.00, 0.040)



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Sunday, Feb 5 2023

Main 700ft DS of Driveway

User-defined

Invert Elev (ft)	= 35.00
Slope (%)	= 0.62
N-Value	= 0.040

Calculations

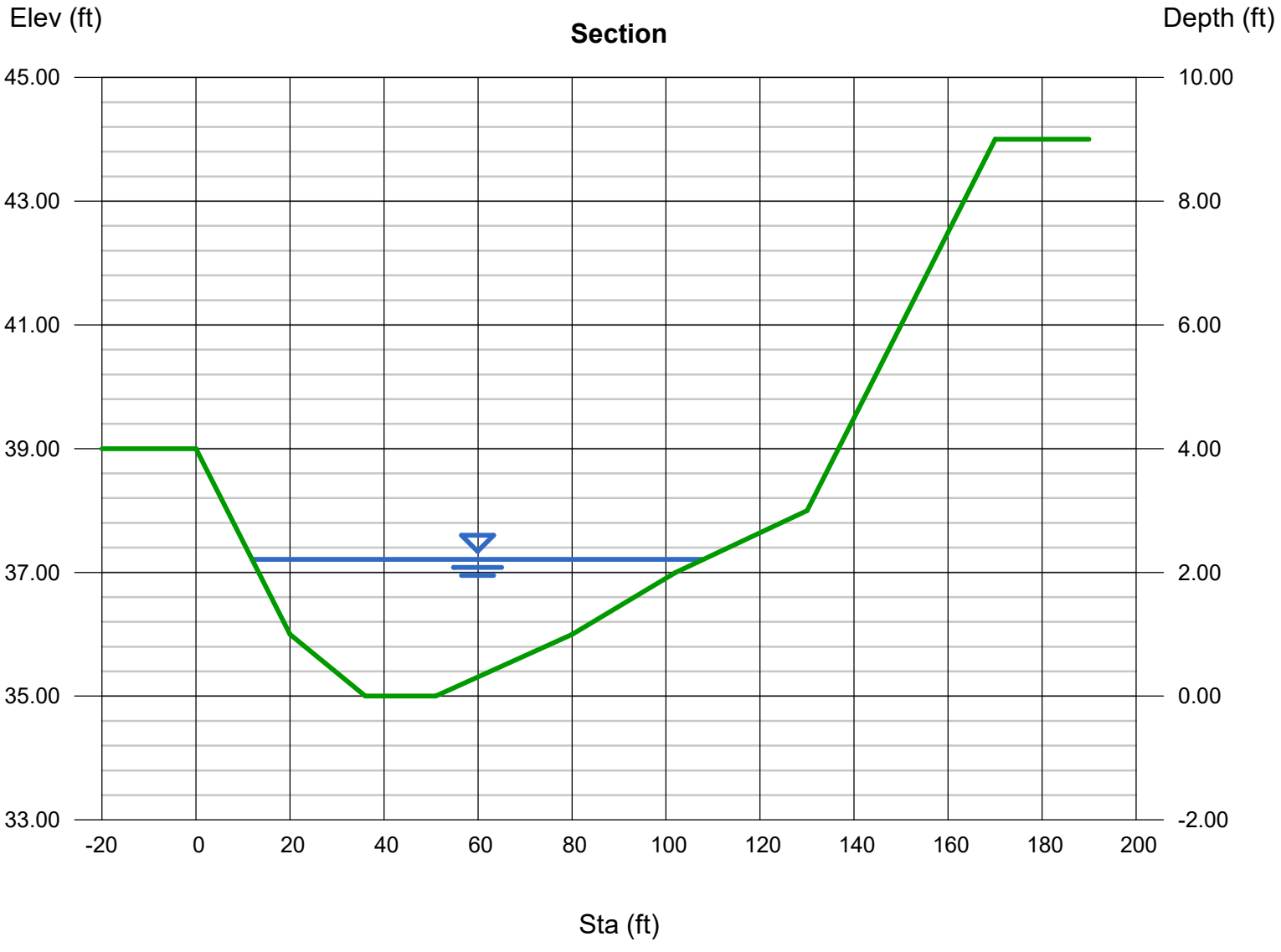
Compute by:	Known Q
Known Q (cfs)	= 473.00

Highlighted

Depth (ft)	= 2.21
Q (cfs)	= 473.00
Area (sqft)	= 131.22
Velocity (ft/s)	= 3.60
Wetted Perim (ft)	= 96.11
Crit Depth, Yc (ft)	= 1.64
Top Width (ft)	= 95.95
EGL (ft)	= 2.41

(Sta, El, n)-(Sta, El, n)...

(0.00, 39.00)-(20.00, 36.00, 0.040)-(36.00, 35.00, 0.040)-(51.00, 35.00, 0.040)-(80.00, 36.00, 0.040)-(102.00, 37.00, 0.040)-(130.00, 38.00, 0.040) -(170.00, 44.00, 0.040)



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Sunday, Aug 21 2022

18inch Culvert

Invert Elev Dn (ft)	=	100.00
Pipe Length (ft)	=	50.00
Slope (%)	=	1.00
Invert Elev Up (ft)	=	100.50
Rise (in)	=	18.0
Shape	=	Circular
Span (in)	=	18.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

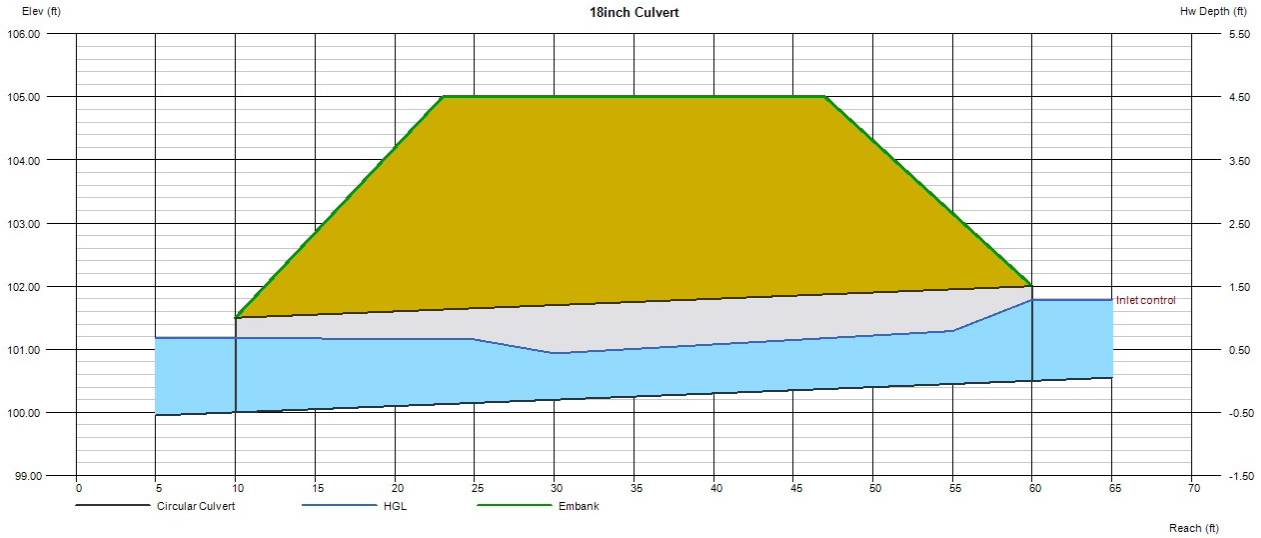
Top Elevation (ft)	=	105.00
Top Width (ft)	=	24.00
Crest Width (ft)	=	150.00

Calculations

Qmin (cfs)	=	5.00
Qmax (cfs)	=	5.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	5.00
Qpipe (cfs)	=	5.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	3.35
Veloc Up (ft/s)	=	4.77
HGL Dn (ft)	=	101.18
HGL Up (ft)	=	101.36
Hw Elev (ft)	=	101.78
Hw/D (ft)	=	0.86
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Sunday, Aug 21 2022

24inch Culvert

Invert Elev Dn (ft)	=	100.00
Pipe Length (ft)	=	25.00
Slope (%)	=	1.00
Invert Elev Up (ft)	=	100.25
Rise (in)	=	24.0
Shape	=	Circular
Span (in)	=	24.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

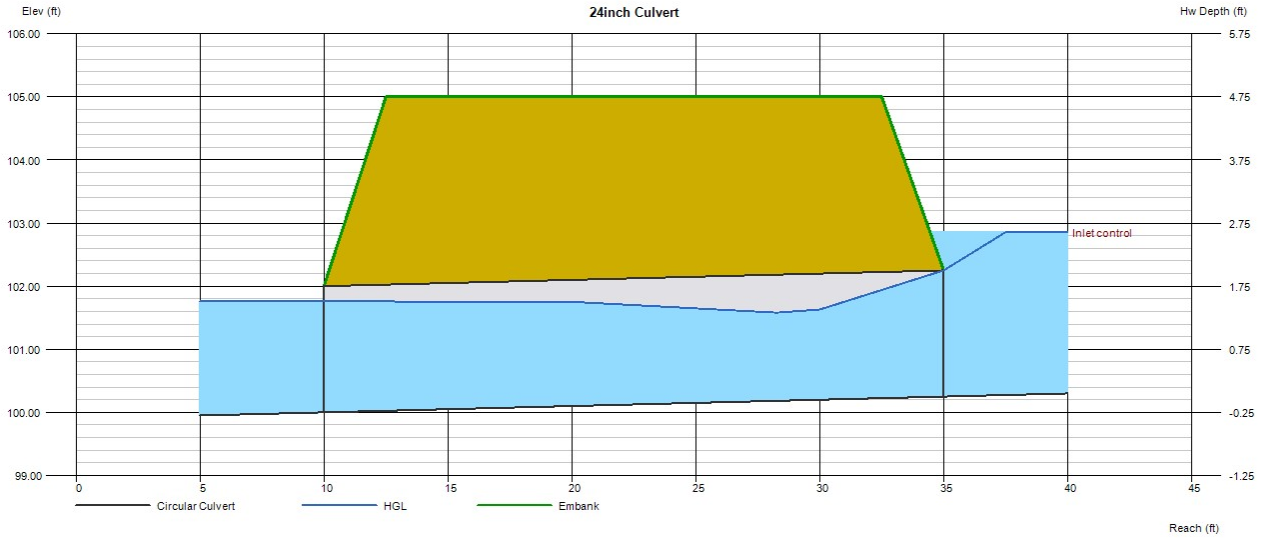
Top Elevation (ft)	=	105.00
Top Width (ft)	=	20.00
Crest Width (ft)	=	150.00

Calculations

Qmin (cfs)	=	17.80
Qmax (cfs)	=	17.80
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	17.80
Qpipe (cfs)	=	17.80
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	6.08
Veloc Up (ft/s)	=	6.93
HGL Dn (ft)	=	101.76
HGL Up (ft)	=	101.77
Hw Elev (ft)	=	102.86
Hw/D (ft)	=	1.30
Flow Regime	=	Inlet Control



HY-8 Culvert Analysis Report

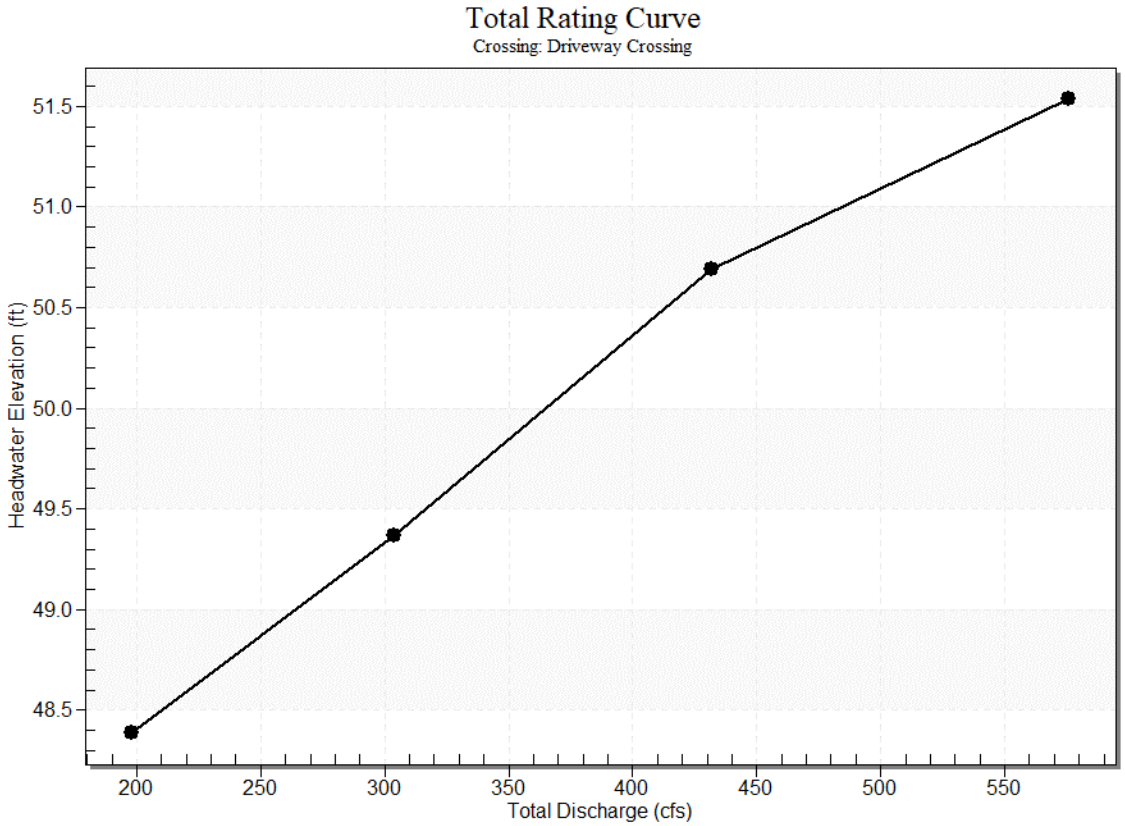
Crossing Discharge Data

Discharge Selection Method: User Defined

Table 1 - Summary of Culvert Flows at Crossing: Driveway Crossing

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	3 54s Discharge (cfs)	Roadway Discharge (cfs)	Iterations
48.39	25yr	198.00	198.00	0.00	1
49.37	50yr	304.00	304.00	0.00	1
50.69	100yr	431.80	431.80	0.00	1
50.75	Overtopping	436.84	436.84	0.00	Overtopping

Rating Curve Plot for Crossing: Driveway Crossing



Culvert Data: 3 54s

Table 1 - Culvert Summary Table: 3 54s

Discharge Names	Total Discharg	Culvert Discharg	Headwater	Inlet Contro	Outlet Contro	Flow	Normal	Critical	Outlet	Tailwater Depth	Outlet Velocit	Tailwater

	e (cfs)	e (cfs)	Elevation (ft)	l Depth (ft)	l Depth (ft)	Type	Depth (ft)	Depth (ft)	Depth (ft)	(ft)	y (ft/s)	Velocity (ft/s)
25yr	198.00 cfs	198.00 cfs	48.39	3.39	2.492	1-S2n	2.18	2.37	2.21	1.12	8.50	3.80
50yr	304.00 cfs	304.00 cfs	49.37	4.37	3.596	1-S2n	2.85	2.96	2.86	1.43	9.51	4.39
100yr	431.80 cfs	431.80 cfs	50.69	5.69	5.674	7-M2c	3.84	3.52	3.52	1.74	10.77	4.92

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

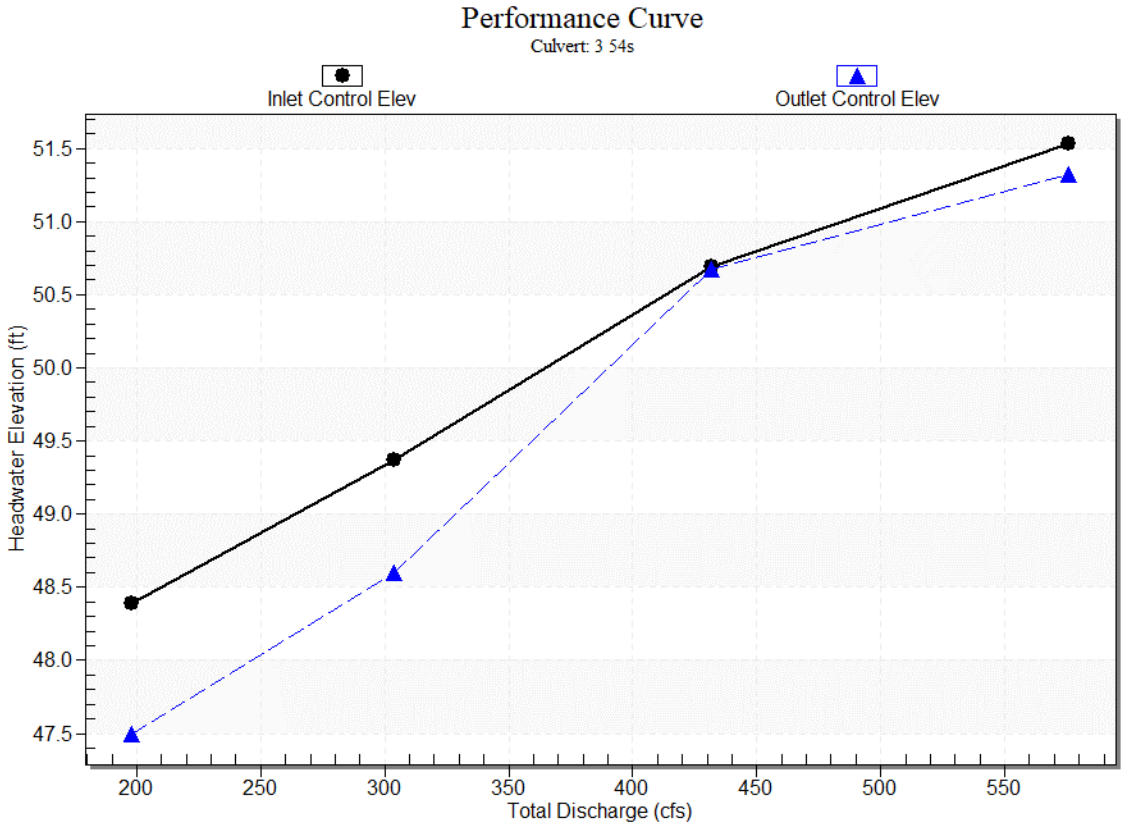
Inlet Elevation (invert): 45.00 ft,

Outlet Elevation (invert): 44.75 ft

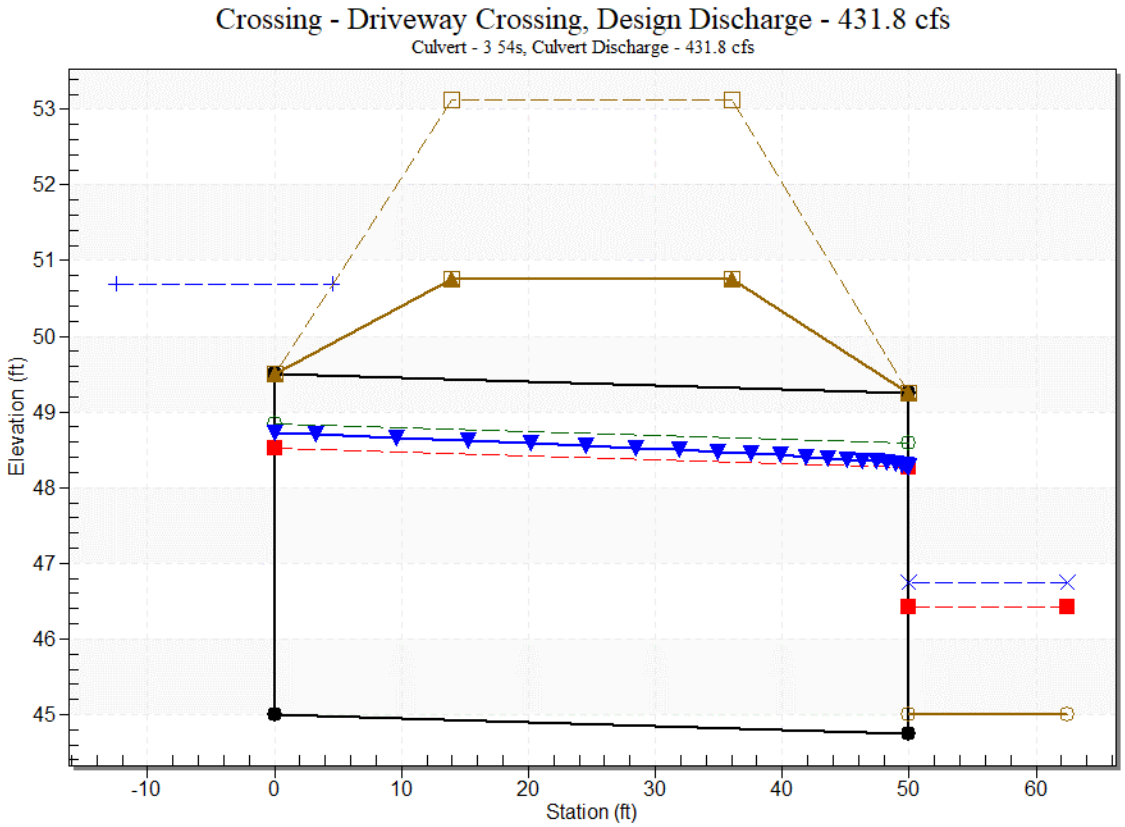
Culvert Length: 50.00 ft,

Culvert Slope: 0.0050

Culvert Performance Curve Plot: 3 54s



Water Surface Profile Plot for Culvert: 3 54s



Site Data - 3 54s

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 45.00 ft

Outlet Station: 50.00 ft

Outlet Elevation: 44.75 ft

Number of Barrels: 3

Culvert Data Summary - 3 54s

Barrel Shape: Circular

Barrel Diameter: 4.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting (Ke=0.2)

Inlet Depression: None

Tailwater Data for Crossing: Driveway Crossing

Table 2 - Downstream Channel Rating Curve (Crossing: Driveway Crossing)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
198.00	46.12	1.12	3.80	0.58	0.68
304.00	46.43	1.43	4.39	0.74	0.70
431.80	46.74	1.74	4.92	0.90	0.72

Tailwater Channel Data - Driveway Crossing

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 40.00 ft

Side Slope (H:V): 6.00 (_:1)

Channel Slope: 0.0083

Channel Manning's n: 0.0350

Channel Invert Elevation: 45.00 ft

Roadway Data for Crossing: Driveway Crossing

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Irregular Roadway Cross-Section

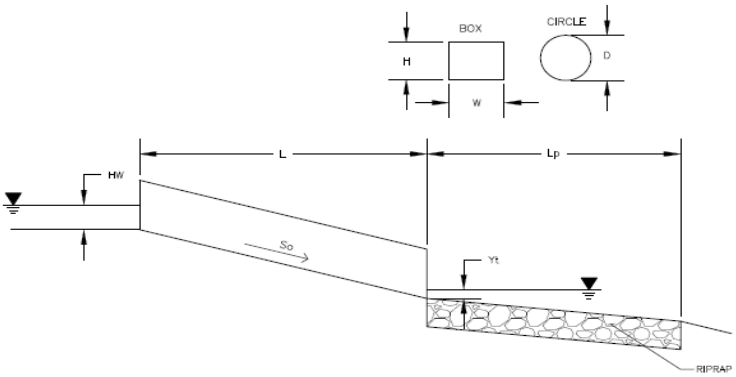
Coord No.	Station (ft)	Elevation (ft)
0	-110.00	53.12
1	-95.00	52.91
2	-20.00	51.02
3	0.00	50.75
4	20.00	51.01
5	40.00	51.81
6	60.00	53.03

Roadway Surface: Paved

Roadway Top Width: 22.00 ft

Determination of Culvert Headwater and Outlet Protection

Project: Terra Ridge North
Basin ID: 18" Culvert Outfall Pad



Soil Type:
Choose One:
○ Sandy
◉ Non-Sandy

Supercritical Flow! Using Da to calculate protection type.

Design Information (Input):

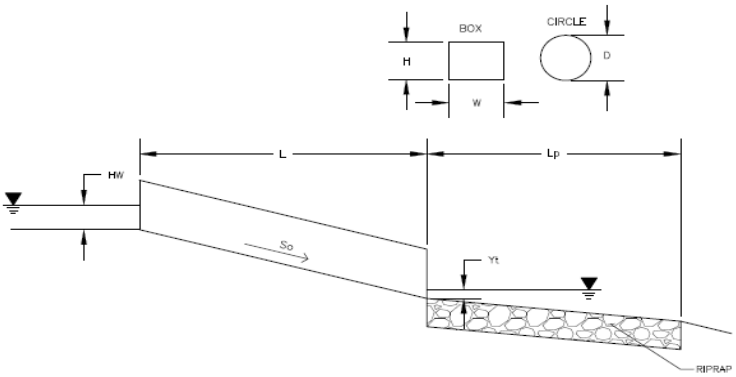
	Design Discharge	Q =	4.5	cfs
Circular Culvert:				
	Barrel Diameter in Inches	D =	18	inches
	Inlet Edge Type (Choose from pull-down list)		Grooved End Projection	
Box Culvert:			**OR**	
	Barrel Height (Rise) in Feet	Height (Rise) =		ft
	Barrel Width (Span) in Feet	Width (Span) =		ft
	Inlet Edge Type (Choose from pull-down list)			
	Number of Barrels	No =	1	
	Inlet Elevation	Elev IN =	100.45	ft
	Outlet Elevation **OR** Slope	Elev OUT =	100	ft
	Culvert Length	L =	45	ft
	Manning's Roughness	n =	0.012	
	Bend Loss Coefficient	k_b =	0	
	Exit Loss Coefficient	k_x =	1	
	Tailwater Surface Elevation	Elev Y_t =		ft
	Max Allowable Channel Velocity	V =	7	ft/s

Required Protection (Output):

Tailwater Surface Height	Y_t =	0.60	ft
Flow Area at Max Channel Velocity	A_t =	0.64	ft^2
Culvert Cross Sectional Area Available	A =	1.77	ft^2
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	0.69	
Sum of All Losses Coefficients	k_s =	1.89	ft
Culvert Normal Depth	Y_n =	0.65	ft
Culvert Critical Depth	Y_c =	0.81	ft
Tailwater Depth for Design	d =	1.16	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	1.08	ft
Expansion Factor	1/(2*tan(Θ)) =	6.70	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	1.63	$ft^{0.5}/s$
Froude Number	Fr =	1.52	**Supercritical!**
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	0.56	
Inlet Control Headwater	HW_I =	1.17	ft
Outlet Control Headwater	HW_O =	0.90	
Design Headwater Elevation	**HW =**	**101.62**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**0.78**	
Minimum Theoretical Riprap Size	d_{50} =	2	in
Nominal Riprap Size	d_{50} =	6	in
UDFCD Riprap Type	**Type =**	**VL**	
Length of Protection	**L_p =**	**5**	**ft**
Width of Protection	**T =**	**3**	**ft**

Determination of Culvert Headwater and Outlet Protection

Project: Terra Ridge North
Basin ID: 24" Culvert Outfall Pad



Soil Type:
Choose One:
○ Sandy
◉ Non-Sandy

Supercritical Flow! Using Da to calculate protection type.

Design Information (Input):

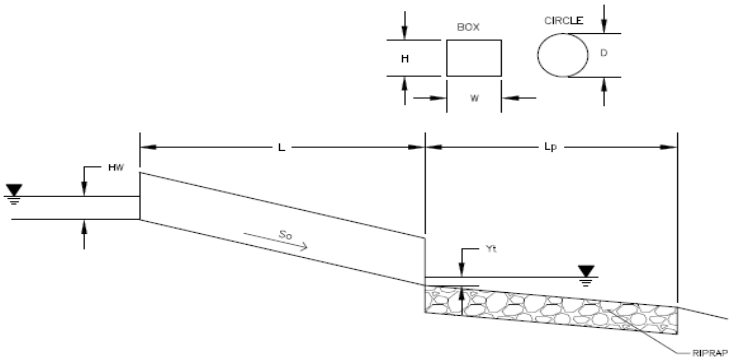
	Design Discharge	Q =	17.8	cfs
Circular Culvert:				
	Barrel Diameter in Inches	D =	24	inches
	Inlet Edge Type (Choose from pull-down list)		Grooved End Projection	
Box Culvert:			**OR**	
	Barrel Height (Rise) in Feet	Height (Rise) =		ft
	Barrel Width (Span) in Feet	Width (Span) =		ft
	Inlet Edge Type (Choose from pull-down list)			
	Number of Barrels	No =	1	
	Inlet Elevation	Elev IN =	100.25	ft
	Outlet Elevation **OR** Slope	Elev OUT =	100	ft
	Culvert Length	L =	25	ft
	Manning's Roughness	n =	0.012	
	Bend Loss Coefficient	k_b =	0	
	Exit Loss Coefficient	k_x =	1	
	Tailwater Surface Elevation	Elev Y_t =		ft
	Max Allowable Channel Velocity	V =	7	ft/s

Required Protection (Output):

Tailwater Surface Height	Y_t =	0.80	ft
Flow Area at Max Channel Velocity	A_t =	2.54	ft^2
Culvert Cross Sectional Area Available	A =	3.14	ft^2
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	0.26	
Sum of All Losses Coefficients	k_s =	1.46	ft
Culvert Normal Depth	Y_n =	1.26	ft
Culvert Critical Depth	Y_c =	1.52	ft
Tailwater Depth for Design	d =	1.76	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	1.63	ft
Expansion Factor	1/(2*tan(Θ)) =	5.59	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	3.15	$ft^{0.5}/s$
Froude Number	Fr =	1.44	**Supercritical!**
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	0.49	
Inlet Control Headwater	HW_I =	2.39	ft
Outlet Control Headwater	HW_O =	2.24	
Design Headwater Elevation	**HW =**	**102.64**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**1.20**	
Minimum Theoretical Riprap Size	d_{50} =	6	in
Nominal Riprap Size	d_{50} =	6	in
UDFCD Riprap Type	**Type =**	**VL**	
Length of Protection	**L_p =**	**7**	**ft**
Width of Protection	**T =**	**4**	**ft**

Determination of Culvert Headwater and Outlet Protection

Project: Terra Ridge North
Basin ID: Triple 54" Culvert Outfall Riprap



Soil Type:
Choose One:
○ Sandy
◉ Non-Sandy

Design Information (Input):

Design Discharge	Q =	432	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	54	inches
Inlet Edge Type (Choose from pull-down list)		Grooved End Projection	
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	Height (Rise) =		ft
Barrel Width (Span) in Feet	Width (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	No =	3	
Inlet Elevation	Elev IN =	100	ft
Outlet Elevation **OR** Slope	Elev OUT =	99.75	ft
Culvert Length	L =	60	ft
Manning's Roughness	n =	0.012	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	Elev Y_t =	103.75	ft
Max Allowable Channel Velocity	V =	7	ft/s

Required Protection (Output):

Tailwater Surface Height	Y_t =	4.00	ft
Flow Area at Max Channel Velocity	A_t =	20.57	ft^2
Culvert Cross Sectional Area Available	A =	15.90	ft^2
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	0.21	
Sum of All Losses Coefficients	k_s =	1.41	ft
Culvert Normal Depth	Y_n =	3.90	ft
Culvert Critical Depth	Y_c =	3.53	ft
Tailwater Depth for Design	d =	4.01	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	-	ft
Expansion Factor	1/(2*tan(Θ)) =	6.70	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	3.35	$ft^{0.5}/s$
Froude Number	Fr =	0.79	
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	0.89	
Inlet Control Headwater	HW_I =	5.69	ft
Outlet Control Headwater	HW_O =	5.56	
Design Headwater Elevation	**HW =**	**105.69**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**1.27**	
Minimum Theoretical Riprap Size	d_{50} =	5	in
Nominal Riprap Size	d_{50} =	6	in
UDFCD Riprap Type	**Type =**	**VL**	
Length of Protection	**L_p =**	**14**	**ft**
Width of Protection	**T =**	**7**	**ft**

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Designer: PSM
Company: Lodestar
Date: February 5, 2023
Project: Terra Ridge North
Location: Forebay Calculations

1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a — I_a = 25.9 %

B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$) — i = 0.259

C) Contributing Watershed Area — Area = 5.220 ac

D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm — d_6 = 0.43 in

E) Design Concept (Select EURV when also designing for flood control)

Choose One
- (•) Water Quality Capture Volume (WQCV)
- ( ) Excess Urban Runoff Volume (EURV)

F) Design Volume (WQCV) Based on 40-hour Drain Time
($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area$) — V_{DESIGN} = ac-ft

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume
($V_{WQCV\ OTHER} = (d_6 * (V_{DESIGN} / 0.43))$) — $V_{DESIGN\ OTHER}$ = 0.060 ac-ft

H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired) — $V_{DESIGN\ USER}$ = ac-ft

I) NRCS Hydrologic Soil Groups of Tributary Watershed
- i) Percentage of Watershed consisting of Type A Soils — HSG_A = %
- ii) Percentage of Watershed consisting of Type B Soils — HSG_B = %
- iii) Percentage of Watershed consisting of Type C/D Soils — $HSG_{C/D}$ = %

J) Excess Urban Runoff Volume (EURV) Design Volume
For HSG A: $EURV_A = 1.68 * i^{1.28}$
For HSG B: $EURV_B = 1.36 * i^{1.08}$
For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$
— $EURV_{DESIGN}$ = ac-f t

K) User Input of Excess Urban Runoff Volume (EURV) Design Volume (Only if a different EURV Design Volume is desired) — $EURV_{DESIGN\ USER}$ = ac-f t

2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.) — L : W = 2.0 : 1

3. Basin Side Slopes

A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred) — Z = 4.00 ft / ft

4. Inlet

A) Describe means of providing energy dissipation at concentrated inflow locations:

5. Forebay

A) Minimum Forebay Volume (V_{FMIN} = 1% of the WQCV) — V_{FMIN} = 0.00100 ac-ft

B) Actual Forebay Volume — V_F = 0.00100 ac-ft

C) Forebay Depth (D_F = 12 inch maximum) — D_F = 12.0 in

D) Forebay Discharge

i) Undetained 100-year Peak Discharge — Q_{100} = 18.00 cfs

ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$) — Q_F = 0.36 cfs

E) Forebay Discharge Design

Choose One
- ( ) Berm With Pipe
- (•) Wall with Rect. Notch
- ( ) Wall with V-Notch Weir

Flow too small for berm w/ pipe

F) Discharge Pipe Size (minimum 8-inches) — Calculated D_P = in

G) Rectangular Notch Width — Calculated W_N = 3.7 in

Design Procedure Form: Extended Detention Basin (EDB)

Designer: PSM
Company: Lodestar
Date: February 5, 2023
Project: Terra Ridge North
Location: Forebay Calculations

6. Trickle Channel	
A) Type of Trickle Channel	Choose One: ○ Concrete ○ Soft Bottom
F) Slope of Trickle Channel	S = ____ ft / ft
7. Micropool and Outlet Structure	
A) Depth of Micropool (2.5-feet minimum)	D_M = ____ ft
B) Surface Area of Micropool (10 ft^2 minimum)	A_M = ____ sq ft
C) Outlet Type	Choose One: ○ Orifice Plate ○ Other (Describe):
D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention)	$D_{orifice}$ = ____ inches
E) Total Outlet Area	A_{ot} = ____ square inches
8. Initial Surcharge Volume	
A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches)	D_{IS} = ____ in
B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV)	V_{IS} = ____ cu ft
C) Initial Surcharge Provided Above Micropool	V_s= ____ cu ft
9. Trash Rack	
A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$	A_t = ____ square inches
B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.)	
Other (Y/N): N	
C) Ratio of Total Open Area to Total Area (only for type 'Other')	User Ratio = ____
D) Total Water Quality Screen Area (based on screen type)	A_{total} = ____ sq. in.
E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E)	H= ____ feet
F) Height of Water Quality Screen (H_{TR})	H_{TR}= ____ inches
G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended)	$W_{opening}$ = ____ inches

Why "N?" One is provided on the CDs. Per my comment on the CDs with Review 2, I asked that you complete this Step 9 to determine which type of microscreen is acceptable. The type that you have spec'd out is likely not acceptable for the orifice sizes. Revise this to "Y" and see what Type of Screen is specified and revise CDs accordingly.

Design Procedure Form: Extended Detention Basin (EDB)

Designer: PSM
Company: Lodestar
Date: February 5, 2023
Project: Terra Ridge North
Location: Forebay Calculations

10. Overflow Embankment

A) Describe embankment protection for 100-year and greater overtopping:

B) Slope of Overflow Embankment
(Horizontal distance per unit vertical, 4:1 or flatter preferred)

Ze = ft / ft

11. Vegetation

Choose One
- Irrigated
- Not Irrigated

12. Access

A) Describe Sediment Removal Procedures

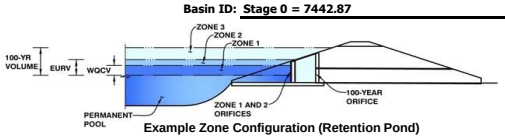
Notes:

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: Terra Ridge North

Basin ID: Stage 0 = 7442.87



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	5.22	acres
Watershed Length =	950	ft
Watershed Length to Centroid =	450	ft
Watershed Slope =	0.047	ft/ft
Watershed Imperviousness =	25.90%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Denver - Capitol Building	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.060	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.137	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.140	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.238	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.328	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.469	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.573	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.714	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	0.984	acre-feet		inches
Approximate 2-yr Detention Volume =	0.097	acre-feet		
Approximate 5-yr Detention Volume =	0.140	acre-feet		
Approximate 10-yr Detention Volume =	0.211	acre-feet		
Approximate 25-yr Detention Volume =	0.251	acre-feet		
Approximate 50-yr Detention Volume =	0.264	acre-feet		
Approximate 100-yr Detention Volume =	0.317	acre-feet		

Define Zones and Basin Geometry

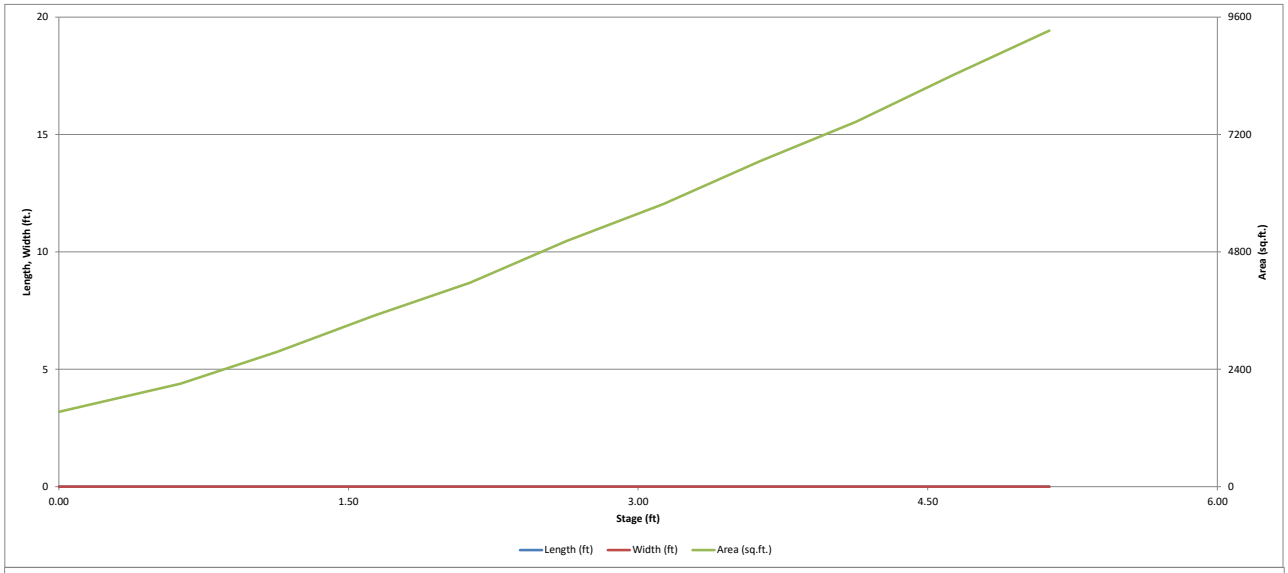
Zone 1 Volume (WQCV) =	0.060	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.077	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.180	acre-feet
Total Detention Basin Volume =	0.317	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

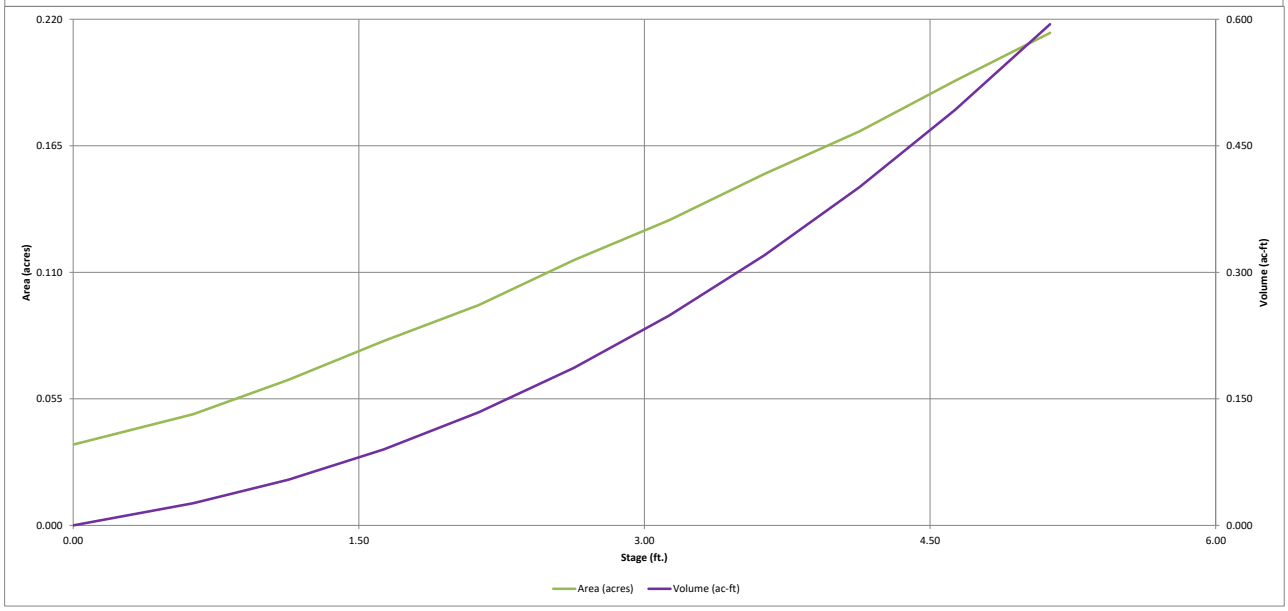
Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	1,530	0.035		
	--	0.63	--	--	--	2,106	0.048	1,145	0.026
7444	--	1.13	--	--	--	2,757	0.063	2,361	0.054
	--	1.63	--	--	--	3,492	0.080	3,923	0.090
7445	--	2.13	--	--	--	4,170	0.096	5,839	0.134
	--	2.63	--	--	--	5,024	0.115	8,137	0.187
7446	--	3.13	--	--	--	5,778	0.133	10,838	0.249
	--	3.63	--	--	--	6,653	0.153	13,946	0.320
7447	--	4.13	--	--	--	7,462	0.171	17,474	0.401
	--	4.63	--	--	--	8,414	0.193	21,443	0.492
7448	--	5.13	--	--	--	9,325	0.214	25,878	0.594

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



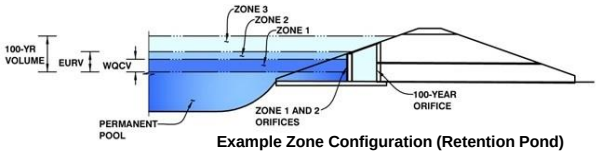


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **Terra Ridge North**

Basin ID: **Stage 0 = 7442.87**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.22	0.060	Orifice Plate
Zone 2 (EURV)	2.17	0.077	Orifice Plate
Zone 3 (100-year)	3.62	0.180	Weir&Pipe (Restrict)
Total (all zones)		0.317	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

			Calculated Parameters for Underdrain		
Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft²
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

			Calculated Parameters for Plate		
Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft²
Depth at top of Zone using Orifice Plate =	2.17	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	N/A	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	sq. inches	Elliptical Slot Area =	N/A	ft²

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.75	1.50					
Orifice Area (sq. inches)	0.70	0.14	0.14					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected		Calculated Parameters for Vertical Orifice	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A	N/A	ft²
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A	feet
Vertical Orifice Diameter =	N/A	N/A	inches				

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

	Zone 3 Weir	Not Selected		Calculated Parameters for Overflow Weir	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.17	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	2.17	N/A	feet
Overflow Weir Front Edge Length =	4.00	N/A	feet	Overflow Weir Slope Length =	2.50	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	11.98	N/A	
Horiz. Length of Weir Sides =	2.50	N/A	feet	Overflow Grate Open Area w/o Debris =	7.91	N/A	ft²
Overflow Grate Type =	Close Mesh Grate	N/A		Overflow Grate Open Area w/ Debris =	3.96	N/A	ft²
Debris Clogging % =	50%	N/A	%				

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected		Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.25	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	0.66	N/A	ft²
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.35	N/A	feet
Restrictor Plate Height Above Pipe Invert =	7.20		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.37	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

			Calculated Parameters for Spillway		
Spillway Invert Stage=	3.10	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.61	feet
Spillway Crest Length =	4.00	feet	Stage at Top of Freeboard =	4.71	feet
Spillway End Slopes =	3.00	H:V	Basin Area at Top of Freeboard =	0.20	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	0.51	acre-ft

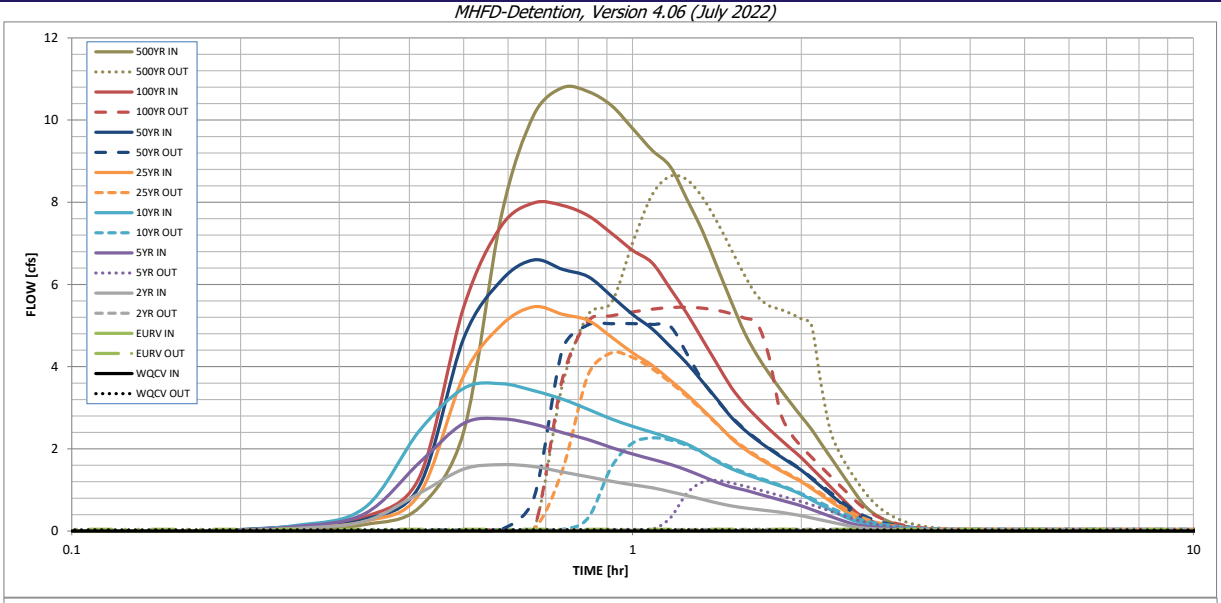
Routed Hydrograph Results

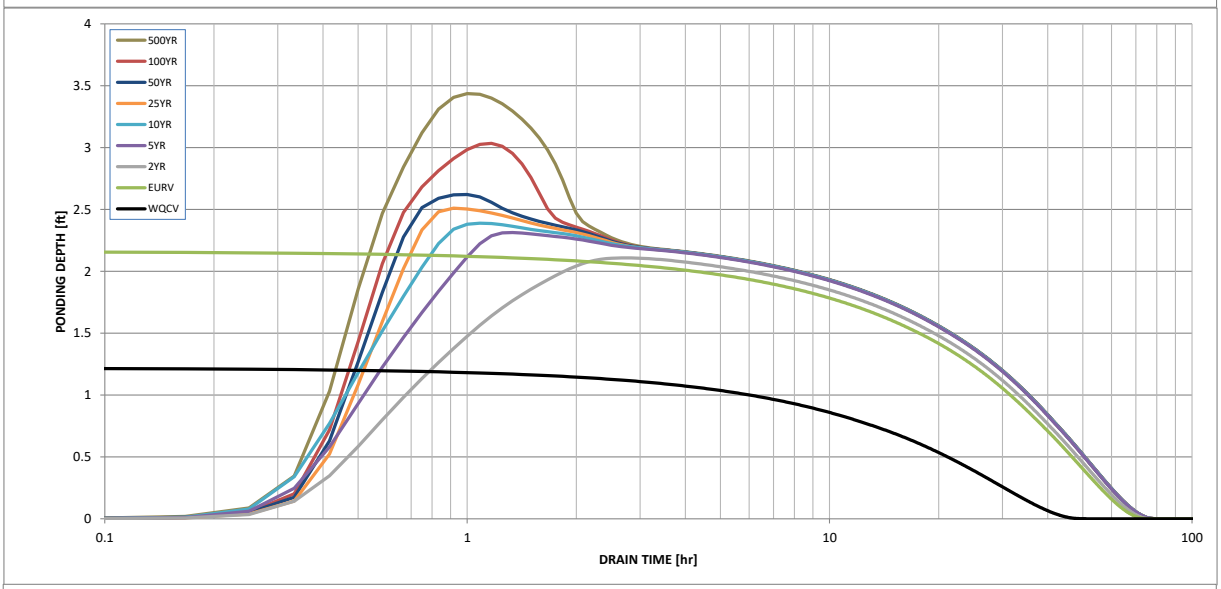
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

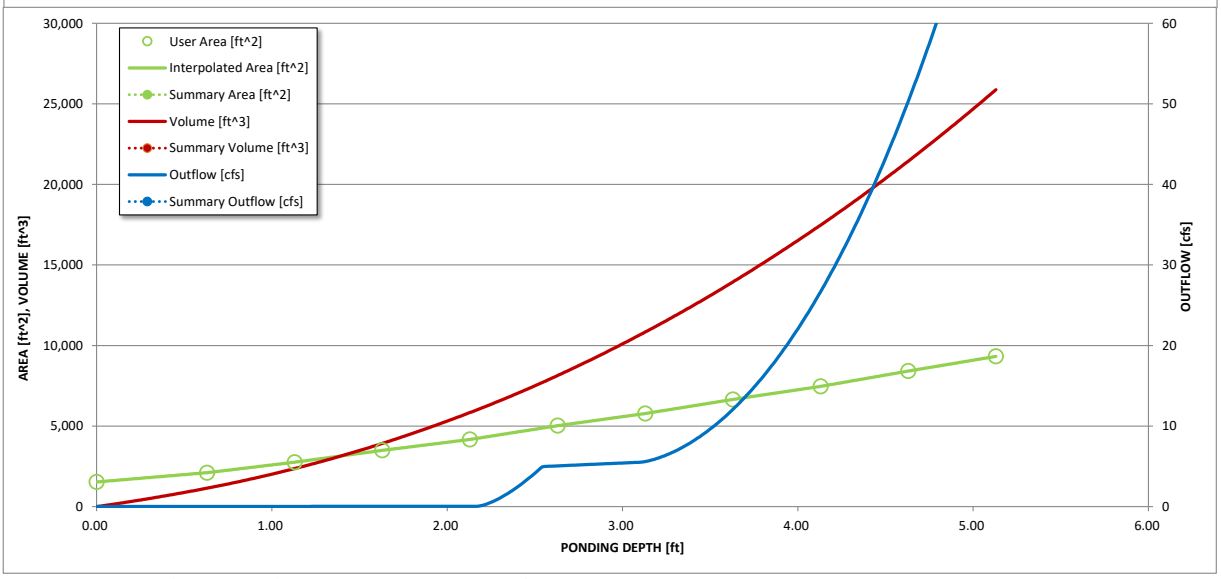
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.060	0.137	0.140	0.238	0.328	0.469	0.573	0.714	0.984
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.140	0.238	0.328	0.469	0.573	0.714	0.984
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.5	1.5	2.3	4.0	5.0	6.4	9.0
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.10	0.29	0.43	0.77	0.96	1.24	1.72
Peak Inflow Q (cfs) =	N/A	N/A	1.6	2.7	3.6	5.5	6.6	8.0	10.8
Peak Outflow Q (cfs) =	0.0	0.0	0.0	1.2	2.3	4.3	5.0	5.4	8.6
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.8	1.0	1.1	1.0	0.8	1.0
Structure Controlling Flow =	Plate	Overflow Weir 1	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.1	0.3	0.5	0.6	0.7	0.7
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	41	63	64	62	59	55	53	50	45
Time to Drain 99% of Inflow Volume (hours) =	**45**	68	69	69	68	65	64	62	60
Maximum Ponding Depth (ft) =	1.22	2.17	2.11	2.31	2.39	2.51	2.62	3.03	3.44
Area at Maximum Ponding Depth (acres) =	0.07	0.10	0.09	0.10	0.11	0.11	0.11	0.13	0.14
Maximum Volume Stored (acre-ft) =	0.060	0.138	0.131	0.152	0.159	0.173	0.186	0.236	0.290

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.02
	0:15:00	0.00	0.00	0.07	0.11	0.13	0.09	0.11	0.11	0.16
	0:20:00	0.00	0.00	0.24	0.43	0.57	0.24	0.28	0.35	0.57
	0:25:00	0.00	0.00	0.92	1.66	2.44	0.90	1.10	1.31	2.42
	0:30:00	0.00	0.00	1.51	2.62	3.47	3.78	4.69	5.45	7.66
	0:35:00	0.00	0.00	1.62	2.73	3.59	5.01	6.10	7.42	10.13
	0:40:00	0.00	0.00	1.57	2.60	3.41	5.46	6.60	7.98	10.79
	0:45:00	0.00	0.00	1.44	2.39	3.21	5.27	6.37	7.92	10.69
	0:50:00	0.00	0.00	1.32	2.22	2.96	5.13	6.19	7.67	10.36
	0:55:00	0.00	0.00	1.21	2.03	2.73	4.72	5.72	7.25	9.80
	1:00:00	0.00	0.00	1.12	1.88	2.55	4.34	5.27	6.83	9.27
	1:05:00	0.00	0.00	1.05	1.75	2.40	4.03	4.92	6.53	8.87
	1:10:00	0.00	0.00	0.96	1.62	2.26	3.67	4.49	5.90	8.07
	1:15:00	0.00	0.00	0.86	1.48	2.12	3.32	4.08	5.29	7.29
	1:20:00	0.00	0.00	0.77	1.33	1.91	2.95	3.63	4.65	6.41
	1:25:00	0.00	0.00	0.68	1.18	1.69	2.60	3.20	4.05	5.58
	1:30:00	0.00	0.00	0.61	1.07	1.52	2.26	2.77	3.50	4.83
	1:35:00	0.00	0.00	0.56	1.00	1.39	2.00	2.46	3.09	4.28
	1:40:00	0.00	0.00	0.53	0.91	1.29	1.80	2.22	2.77	3.84
	1:45:00	0.00	0.00	0.49	0.83	1.19	1.63	2.01	2.49	3.45
	1:50:00	0.00	0.00	0.46	0.76	1.10	1.47	1.82	2.23	3.11
	1:55:00	0.00	0.00	0.42	0.69	1.00	1.33	1.65	2.00	2.78
	2:00:00	0.00	0.00	0.37	0.61	0.89	1.20	1.48	1.78	2.48
	2:05:00	0.00	0.00	0.32	0.53	0.76	1.04	1.28	1.54	2.14
	2:10:00	0.00	0.00	0.27	0.44	0.64	0.88	1.09	1.31	1.81
	2:15:00	0.00	0.00	0.22	0.36	0.52	0.73	0.90	1.09	1.50
	2:20:00	0.00	0.00	0.18	0.28	0.41	0.58	0.72	0.87	1.20
	2:25:00	0.00	0.00	0.14	0.21	0.32	0.44	0.55	0.66	0.90
	2:30:00	0.00	0.00	0.10	0.16	0.24	0.32	0.39	0.46	0.64
	2:35:00	0.00	0.00	0.08	0.12	0.19	0.22	0.28	0.33	0.47
	2:40:00	0.00	0.00	0.06	0.10	0.16	0.17	0.21	0.24	0.35
	2:45:00	0.00	0.00	0.05	0.08	0.13	0.12	0.16	0.18	0.26
	2:50:00	0.00	0.00	0.04	0.07	0.11	0.09	0.12	0.13	0.19
	2:55:00	0.00	0.00	0.03	0.05	0.09	0.07	0.09	0.09	0.14
	3:00:00	0.00	0.00	0.03	0.04	0.07	0.06	0.07	0.07	0.10
	3:05:00	0.00	0.00	0.02	0.03	0.05	0.04	0.06	0.05	0.07
	3:10:00	0.00	0.00	0.02	0.03	0.04	0.03	0.04	0.04	0.06
	3:15:00	0.00	0.00	0.02	0.02	0.03	0.03	0.03	0.03	0.04
	3:20:00	0.00	0.00	0.01	0.02	0.03	0.02	0.03	0.02	0.04
	3:25:00	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.02	0.03
	3:30:00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.01	0.02
	3:35:00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02
	3:40:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

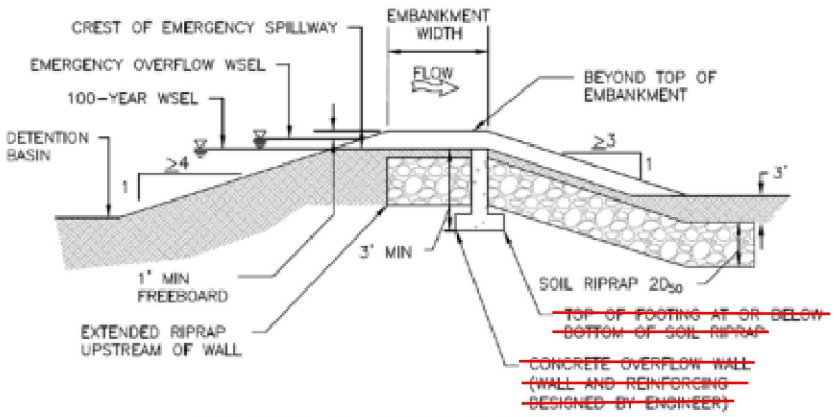
The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

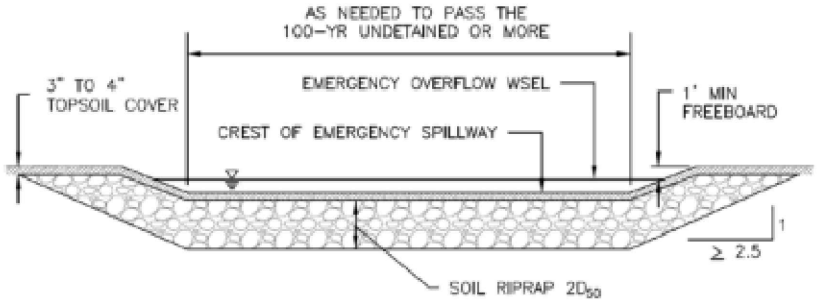
Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).



EMERGENCY SPILLWAY PROFILE



EMERGENCY SPILLWAY SECTION AND SPILLWAY CHANNEL

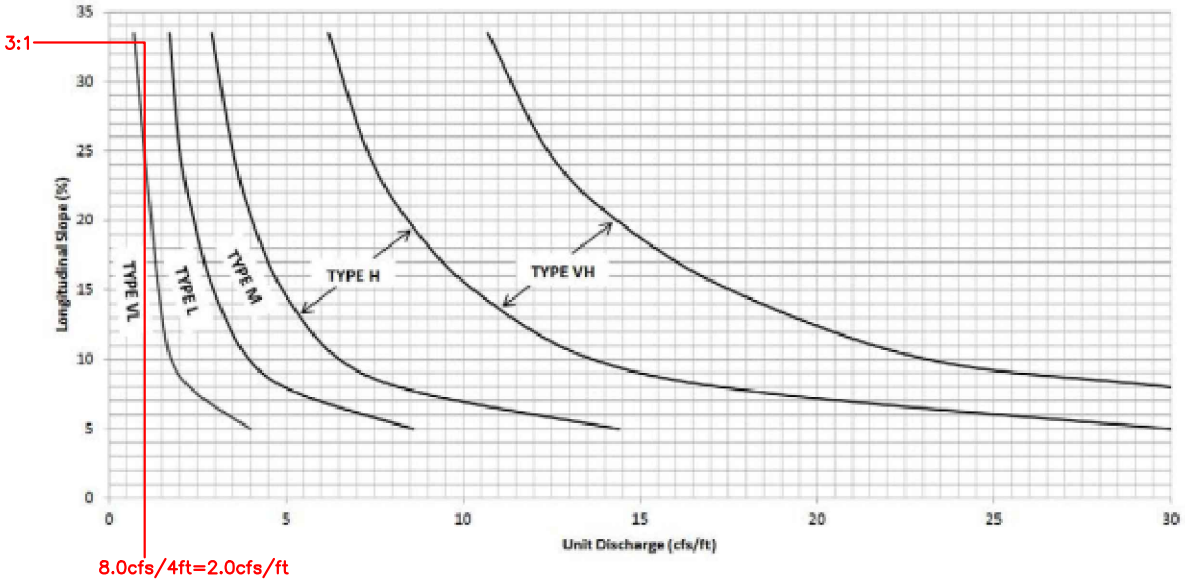
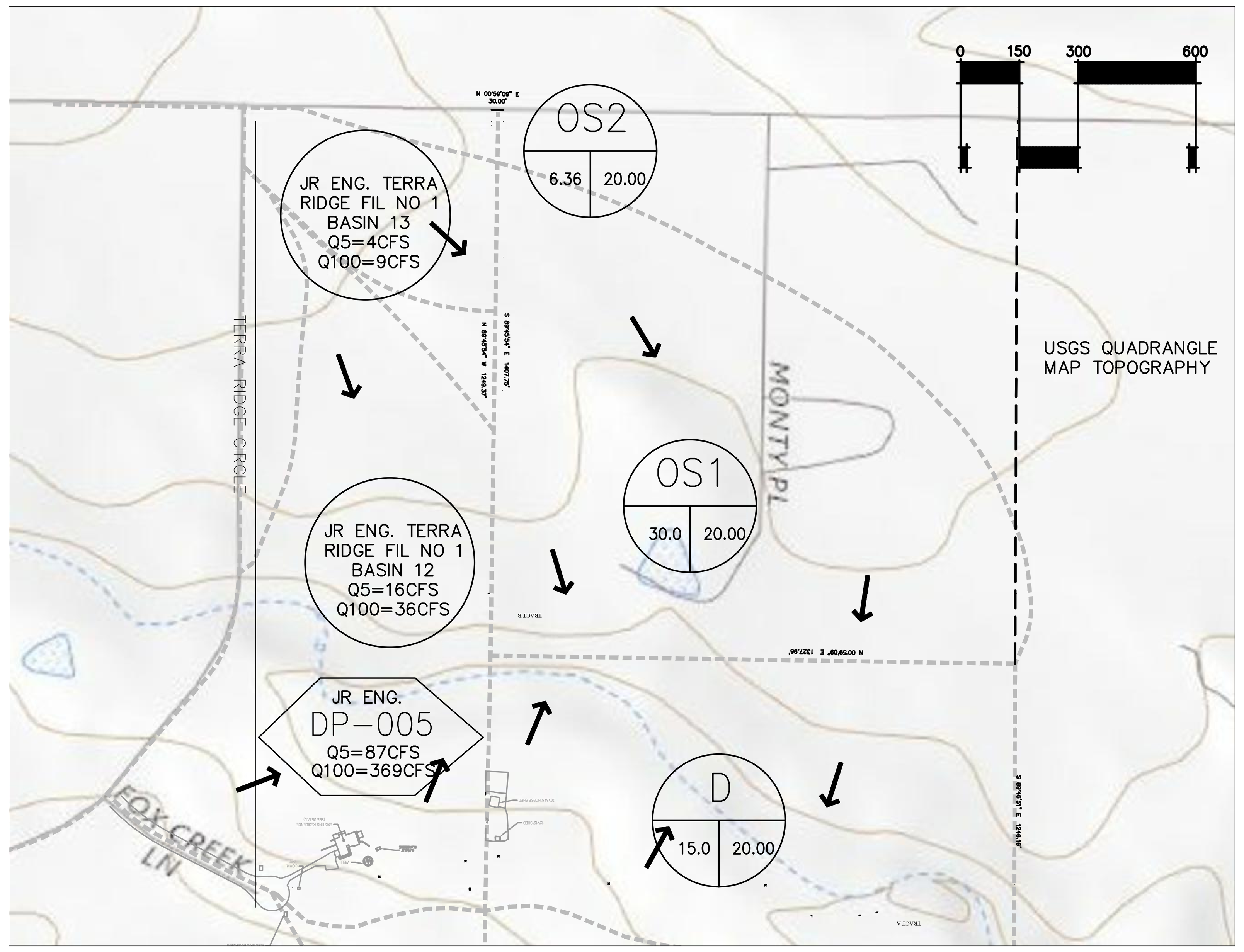
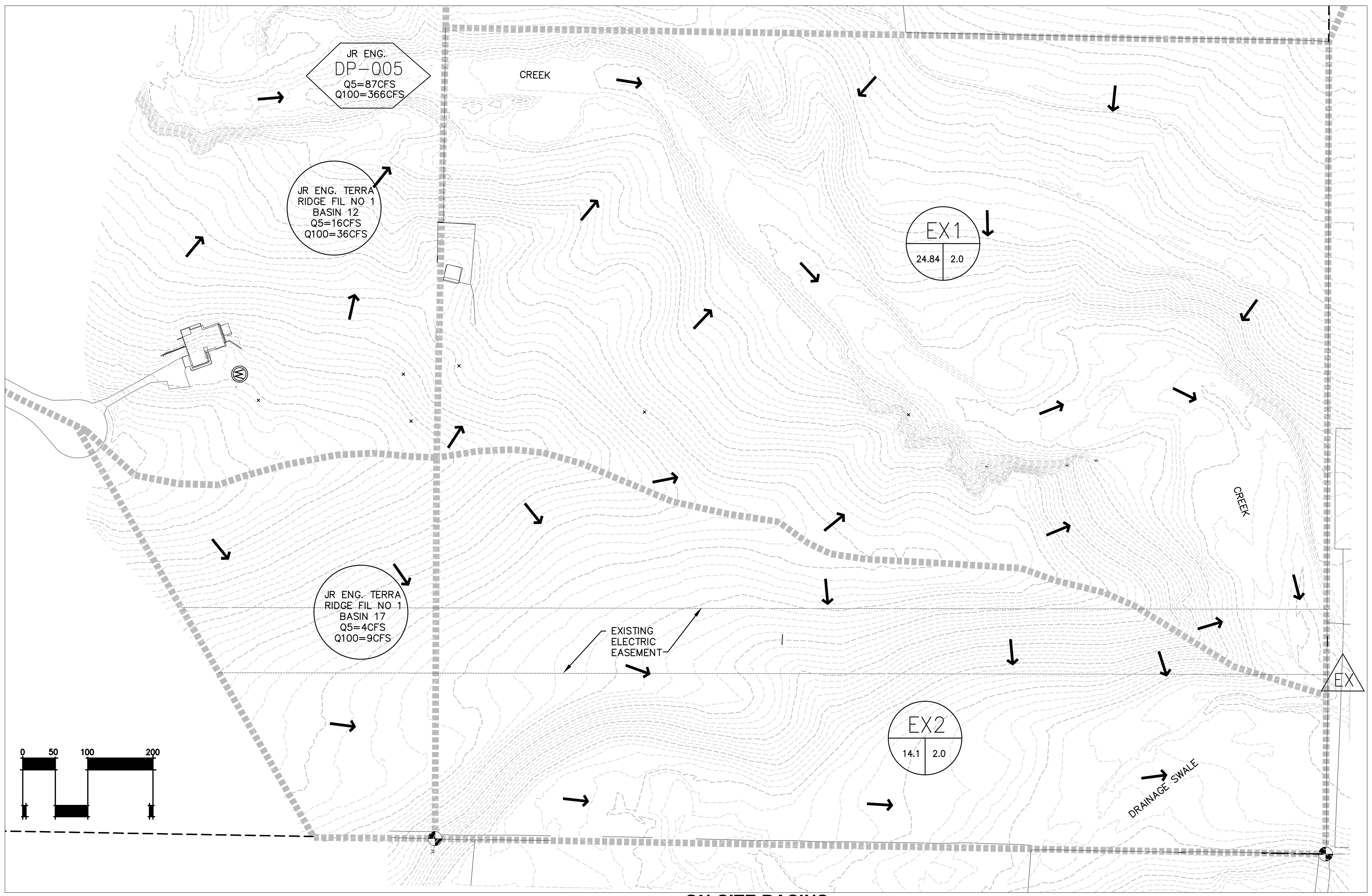


Figure 12-21. Embankment protection details and rock sizing chart (adapted from Arapahoe County)

USE TYPE L



OFF-SITE BASINS



ON-SITE BASINS

NORTH

LODESTAR ENGINEERING, LLC

ISSUED 2/23/23

REVISIONS

TERRA RIDGE NORTH
TOWN OF BLACK FOREST
EL PASO COUNTY, COLORADO

EXISTING DRAINAGE PLAN

LEGEND

- A / 1.25 3.0 — BASIN ID; % IMPERVIOUS; AREA (ACRES)
- 1 — DESIGN POINT
- DRAINAGE BASIN BOUNDARY
- EXISTING CONTOUR (2')
- PROPOSED CONTOUR (2')
- SURFACE FLOW DIRECTION

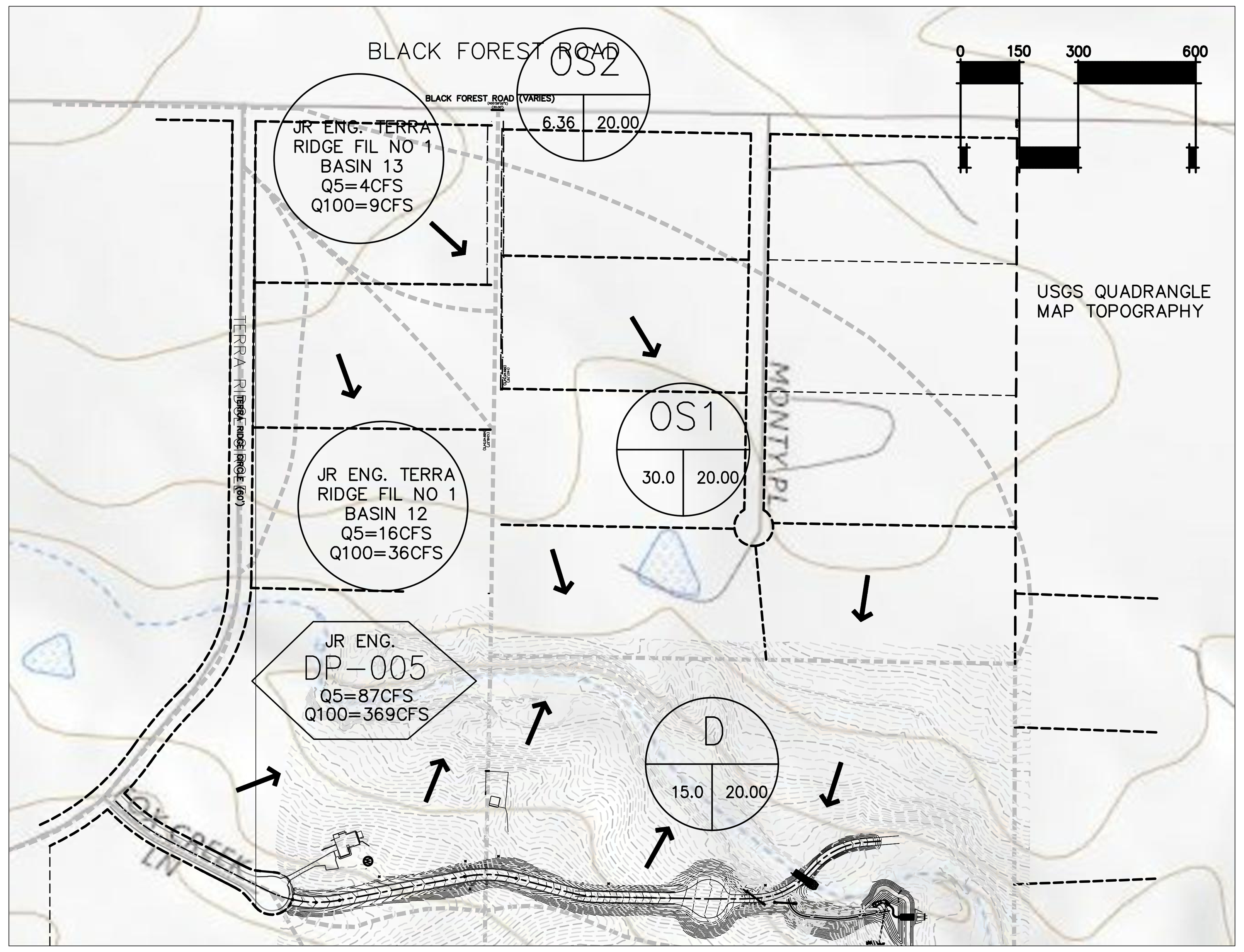
RUNOFF COEFFICIENT SUMMARY

BASIN	AREA (ACRES)	C5	C100
EX1	24.84	0.09	0.36
EX2	6.36	0.09	0.36

RUNOFF SUMMARY

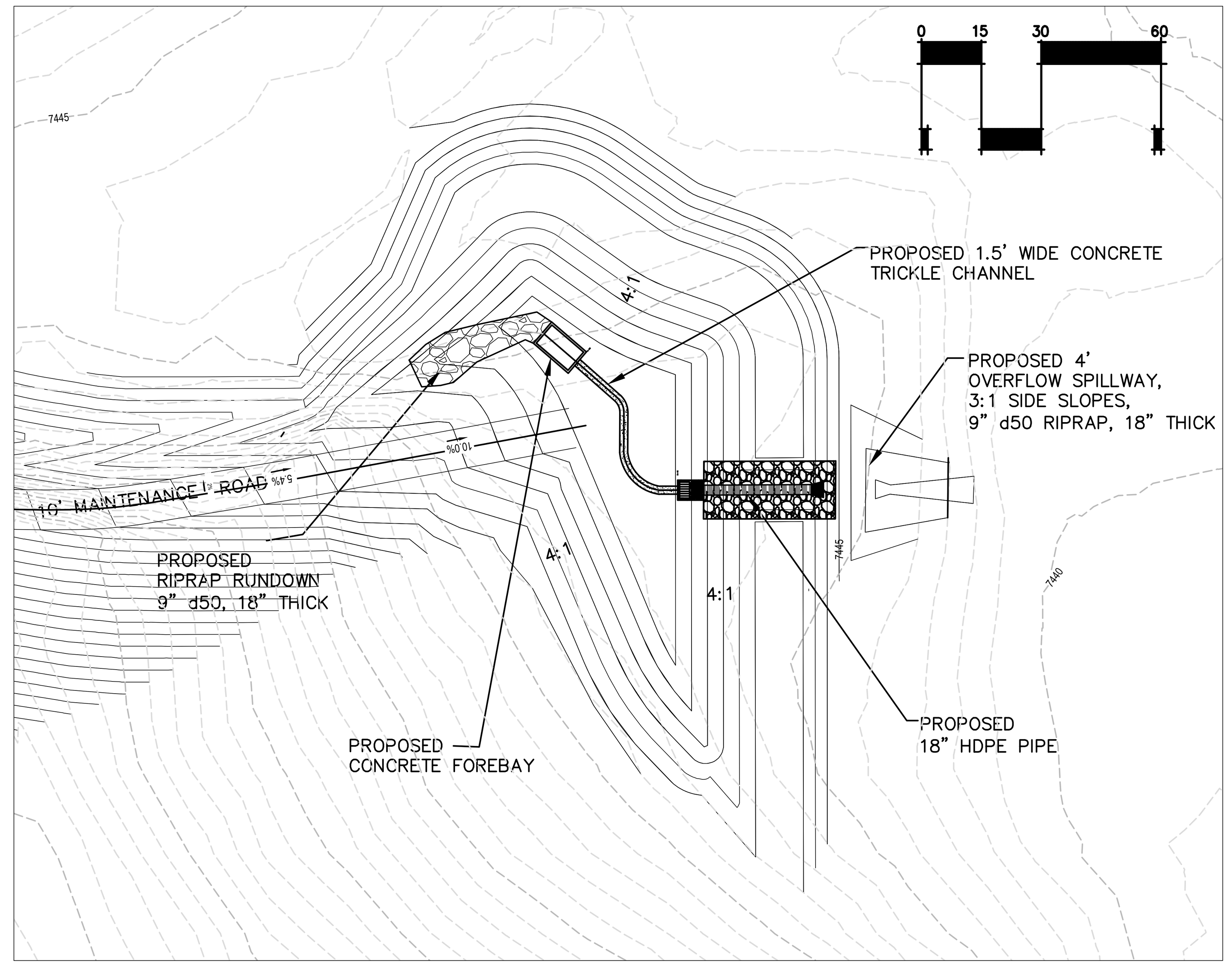
DESIGN POINT	Q5	Q100
EX	93.1	433.2

D1
SHEET NO.



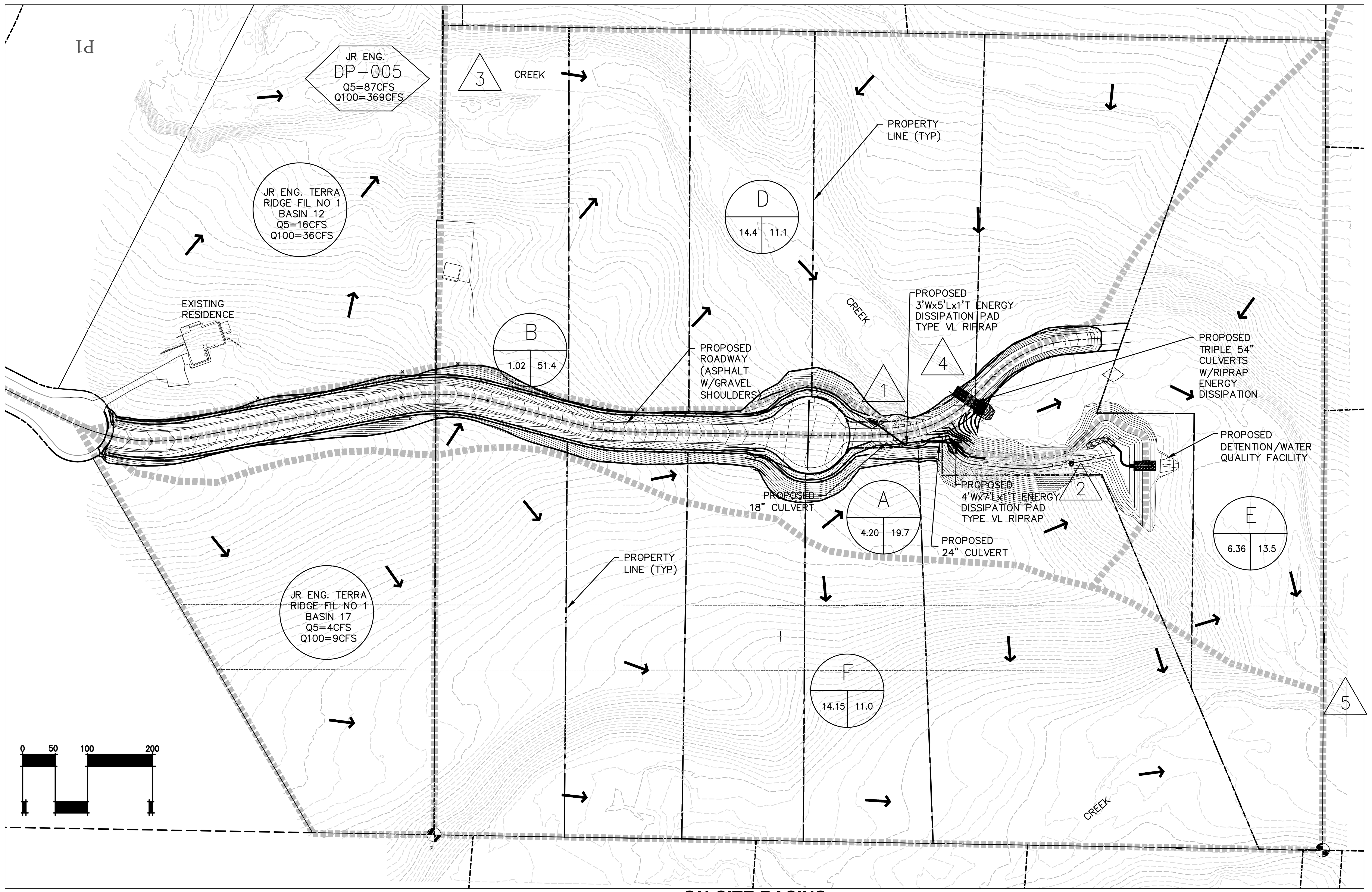
OFF-SITE BASINS

1"=300'



DETENTION/WATER QUALITY FACILITY

1"=30'



ON-SITE BASINS

1"=100'

LEGEND

A — BASIN ID
1.25 | 2.0 — % IMPERVIOUS; AREA (ACRES)
DESIGN POINT
DRAINAGE BASIN BOUNDARY
EXISTING CONTOUR (2')
PROPOSED CONTOUR (2')
SURFACE FLOW DIRECTION

RUNOFF COEFFICIENT SUMMARY

BASIN	AREA (ACRES)	C5	C100
A	4.20	0.18	0.51
B	0.94	0.46	0.63
C	N/A	N/A	N/A
D	14.59	0.09	0.49
E	6.36	0.10	0.49
F	14.15	0.08	0.48
OS1	30.00	0.05	0.46
OS2	6.36	0.07	0.47
EX1	24.84	0.09	0.36
EX2	14.10	0.09	0.36

RUNOFF SUMMARY

DESIGN POINT	Q5	Q100
1	2.0	4.5
2	5.4	18.0
3	86.3	366.0
4	92.1	432.0
5	100.1	472.7
EX	96.9	433.7

WATER QUALITY/DETENTION SUMMARY

FACILITY TYPE	EXTENDED DET. BASIN
WQCV	0.060 ACRE-FT
EURV	0.137 ACRE-FT
100-YR STORAGE PROVIDED	0.236 ACRE-FT
100-YR PEAK OUTFLOW Q	5.4 CFS

NORTH

LODESTAR ENGINEERING, LLC

ISSUED 8/29/21

REVISIONS

TERRA RIDGE NORTH

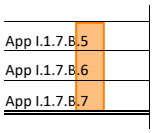
TOWN OF BLACK FOREST
EL PASO COUNTY, COLORADO

DEVELOPED DRAINAGE PLAN

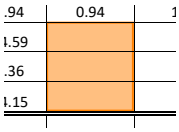
D2
SHEET NO.

V3_Drainage Report - Final_Comments.pdf Markup Summary

SW - Rectangle (2)

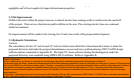


Subject: SW - Rectangle
Page Label: 10
Author: Glenn Reese - EPC Stormwater
Date: 5/10/2023 2:41:09 PM
Status:
Color:
Layer:
Space:



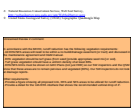
Subject: SW - Rectangle
Page Label: 10
Author: Glenn Reese - EPC Stormwater
Date: 5/10/2023 2:41:37 PM
Status:
Color:
Layer:
Space:

SW - Textbox (2)



Subject: SW - Textbox
Page Label: 7
Author: Glenn Reese - EPC Stormwater
Date: 5/10/2023 3:05:37 PM
Status:
Color:
Layer:
Space:

Review 2 comment:
This is a follow-up to my Review 1 comment on the drainage map about untreated proposed soil disturbances in Basin D:
Per direction from the State, subdivision developments that include impervious pavement roads do not qualify for Exclusion E (Large Lot Single-Family Site) on the PBMP form for those roadway areas. Therefore, a permanent WQ facility should be designed to treat runoff from the impervious roadway area and the subsequent grading like roadside ditches (but only if the total area of soil disturbance is >1ac). A driveway that feeds and crosses multiple lots counts toward roadway impervious area. But individual driveways for individual lots counts towards the impervious area for the large single-family lot.
For this site, I recommend you look into utilizing Runoff Reduction (RR) for WQ treatment per MHFD Detail T-0. MHFD has a calculation spreadsheet for RR. See further guidance in my comment at the bottom of pdf page 11 below.



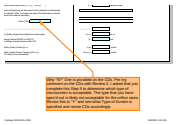
Subject: SW - Textbox
Page Label: 11
Author: Glenn Reese - EPC Stormwater
Date: 5/10/2023 3:15:29 PM
Status:
Color:
Layer:
Space:

Unresolved Review 2 comment:

In accordance with the MHFD, runoff reduction has the following vegetation requirements:
- All RPA/SPA areas will need to be within a no build/drainage easement (or tract) and discussed in the maintenance agreement and O&M manual.
- RPA vegetation should be turf grass (from seed [provide appropriate seed mix] or sod).
- Turf grass vegetation should have a uniform density of at least 80%.
- RPA/SPA limits must be shown on GEC Plans (not just FDR) so our SW inspectors and the QSM know that these areas are to remain pervious and vegetated (80%). Our SW inspectors do not look at drainage reports.

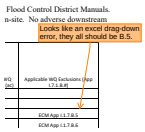
Other requirements:
- Provide a figure showing all proposed UIA, RPA and SPA areas to be utilized for runoff reduction.
- Provide a detail for the UIA:RPA interface that shows the recommended vertical drop of 4".

SW - Textbox with Arrow (6)



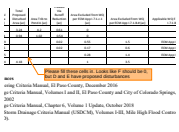
Subject: SW - Textbox with Arrow
Page Label: 57
Author: Glenn Reese - EPC Stormwater
Date: 5/16/2023 12:01:37 PM
Status:
Color:
Layer:
Space:

Why "N?" One is provided on the CDs. Per my comment on the CDs with Review 2, I asked that you complete this Step 9 to determine which type of microscreen is acceptable. The type that you have spec'd out is likely not acceptable for the orifice sizes. Revise this to "Y" and see what Type of Screen is specified and revise CDs accordingly.



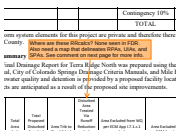
Subject: SW - Textbox with Arrow
Page Label: 10
Author: Glenn Reese - EPC Stormwater
Date: 5/10/2023 2:52:13 PM
Status:
Color:
Layer:
Space:

Looks like an excel drag-down error, they all should be B.5.



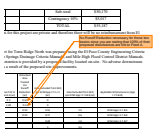
Subject: SW - Textbox with Arrow
Page Label: 10
Author: Glenn Reese - EPC Stormwater
Date: 5/10/2023 2:53:14 PM
Status:
Color:
Layer:
Space:

Please fill these cells in. Looks like F should be 0, but D and E have proposed disturbances



Subject: SW - Textbox with Arrow
Page Label: 10
Author: Glenn Reese - EPC Stormwater
Date: 5/17/2023 3:55:11 PM
Status:
Color:
Layer:
Space:

Where are these RRcalcs? None seen in FDR. Also need a map that delineates RPAs, UIAs, and SPAs. See comment on next page for more info.



Subject: SW - Textbox with Arrow
Page Label: 10
Author: Glenn Reese - EPC Stormwater
Date: 5/10/2023 2:55:55 PM
Status:
Color:
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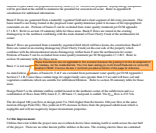
Space:

No Runoff Reduction necessary for these two basins since you are stating that 100% of their proposed disturbances are trib to Pond A.



Subject: SW - Textbox with Arrow
Page Label: 7
Author: Glenn Reese - EPC Stormwater
Date: 5/10/2023 3:04:48 PM
Status:
Color:
Layer:
Space:

These disturbances are not applicable to this exclusion because the grading is for the development of the roadway, not the residential lots. Thus I've been asking you to do Runoff Reduction or some WQ treatment PBMP. Previous Review 2 comment provided at bottom of this page for reference.