FINAL DRAINAGE REPORT

For

PROPOSED ROADWAY AND CULVERTS

And

PRELIMINARY DRAINAGE REPORT

For

OVERALL DEVELOPMENT

PHANTOM CREEK RANCH
ELBERT COUNTY, COLORADO

2N Civil Project No. 22010
Date: December 13, 2022
Revised: April 7, 2023
September 1, 2023
November 17, 2023
December 7, 2023
June 7, 2024

PREPARED FOR:

PHANTOM CREEK DEVELOPMENT, LLC
39622 County Road 21
Elizabeth, CO 80543
Mike P. Brownson

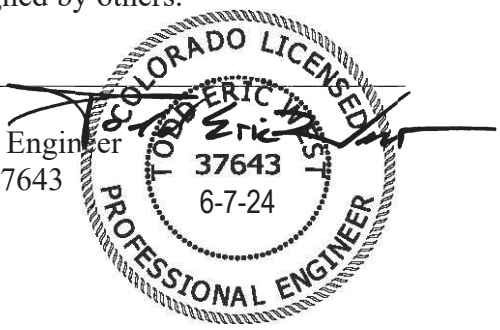
PREPARED BY:

2N CIVIL, LLC
Todd West, P.E.
Reviewed By: Eric P. Tuin, P.E.
6 Inverness Ct. E #125
Englewood, CO 80112
303.925.0544

Engineer's Certification

This report and plan for the preliminary drainage design of Phantom Creek Ranch was prepared by me (or under my direct supervision) in accordance with the provisions of Elbert County Construction Standards & Specifications for the owners thereof. I understand that Elbert County does not and will not assume liability for drainage facilities designed by others.

SIGNATURE: _____
Todd West, P.E.
Registered Professional Engineer
State of Colorado No. 37643
(Affix Seal)



Owner's Certification

Phantom Creek Development, LLC hereby certifies that the drainage facilities for Phantom Creek Ranch shall be constructed according to the design presented in this report. I understand that Elbert County does not and will not assume liability for the drainage facilities designed and/or certified by my engineer and that Elbert County reviews drainage plans, but cannot, on behalf of Phantom Creek Ranch, that final drainage design review will absolve Phantom Creek Development, LLC guarantee and/or their successors and/or assigns of future liability for improper design. I further understand that approval of the final plat does not imply approval of my engineer's drainage design."

SIGNATURE: Mike Brownson
Phantom Creek Development, LLC
Owner

Table of Contents

A. INTRODUCTION

This Drainage Report presents a preliminary drainage design for the development of the new single-family homesites known as Phantom Creek Ranch located in Elbert County, Colorado. This report was prepared in accordance with Elbert County Construction Standards and Specifications 2019 and Mile High Flood District (MHFD) Urban Storm Drainage Criteria Manual (latest revision). Also included is a final design for culverts associated with the main gravel roadway that provides access to all lots within the Phantom Creek Ranch development.

Location
Phantom Creek Ranch is a proposed subdivision located in a part of Section 16, Township 7 South, Range 64 West of the 6th Principal Meridian, County of Elbert, State of Colorado. The project is bounded by County Road 21 to the west, Pronghorn Avenue to the north, and private property to the south and east. A Vicinity Map is included in Appendix A.

Description of Property
The project will consist of the development of 7 single family lots numbered 1 through 7.

The existing ground cover on this site is composed of native grasses. The existing terrain generally slopes from southeast to the northwest, ranging from 0 to 16 percent grade with up to a 4:1 slope for the channel banks. The soil type present onsite consist of Hydrologic Soil Group A soils: Haplustolls, moderately coarse, nearly level, Truckton sandy loam, 3 to 9 percent slopes; Hydrologic Soil Group B soils: Bresser sandy loam, cool 5 to 9 percent slopes, Bresser-Stapleton sandy loams, 8 to 25 percent slopes, Bresser-Truckton sandy loams, 8 to 25 percent slopes, Elbeth sandy loam, 4 to 8 percent slopes, and Peyton sandy loam, 4 to 8 percent slopes; and Hydrologic Soil Group C soils: Weld loam, 0 to 4 percent slopes; as designated by the Natural Resources Conservation Services (NRCS) (see Appendix A). Hydrologic Group A soils have a high infiltration rate when thoroughly wet and a high rate of water transmission. Hydrologic Group B soils have a moderate infiltration rate when thoroughly wet and a moderate rate of water transmission. Hydrologic Group C soils have a slow infiltration rate when thoroughly wet and a slow rate of water transmission.

A topographic depression exists along the north end of the property with no defined outfall. Located on proposed Lot 7, the area was excavated as a source for gravel by Elbert County. This depression is located within Basin EX-1/PR-1 as shown on the overall Basin Map, and is within sub-basin PR-C on the Sub-Basin Map. This area acts as a natural detention area. In the event that this area is regraded in the future and an outfall is provided, the roadway culverts at Design Point C (shown on the Sub-Basin Map) have been sized to convey the developed flow from this basin downstream following the historic drainage path.

An existing drainageway named Phantom Creek traverses the site. It flows from the southeast to northwest direction, and ultimately converges with Running Creek, located about a mile west of the site.

Proposed Development
The proposed development for this site includes subdividing the property into 7, minimum 10-acre single family residential parcels. Access to Lots 1 through 7 will be from a proposed looped roadway intersecting with Pronghorn Avenue. These lots are located to the north of Phantom Creek. Proposed improvements include single-family homes, driveways, and associated infrastructure.

B. HISTORIC DRAINAGE

Overall Basin Description
The proposed development is located within Zone X and is not considered as residing in a flood hazard area as seen on the FEMA Map titled, "Flood Insurance Rate Map for Elbert County and Incorporated Areas", Panel 0255 of 1200, Map Number 08039C0255C, Effective March 17, 2011, see Appendix A. In general, runoff flows in the northwest direction to Phantom Creek which continues downstream to Running Creek. The property is delineated into three drainage basins. The descriptions are as follows:

EXISTING BASINS

Basin EX-1
Basin EX-1 encompasses the area that will be developed with this project. Phantom Creek collects flow from this basin, conveying it west to County Road 21 at Design Point 1. This basin encompasses 136.45 acres and has an existing imperviousness value of 3.38%. The basin contains asphalt paving from County Road 21, gravel from Pronghorn Avenue, and undeveloped land supporting native grasses and weeds. According to the results from the EPA SWMM v.5.1 model, the runoff generated for this basin is 1.55 cfs in the 2-year minor storm, and 144.77 cfs in the 100-year major storm.

Basin EX-2
Basin EX-2 is located to the southwest of the site and contributes flow to the outfall at Design Point 1. This basin encompasses 30.44 acres and has an existing imperviousness value of 5.21%. Runoff from this basin typically flows from the southeast to the northwest direction to Design Point 2. The basin contains asphalt paving from County Road 21, an existing gravel driveway, and undeveloped land supporting native grasses and weeds. According to the results from the EPA SWMM v.5.1 model, the runoff generated for this basin is 0.67 cfs in the 2-year minor storm, and 39.05 cfs in the 100-year major storm.

Basin EX-3
Basin EX-3 is located to the southeast of the site and also contributes flow to the outfall at Design Point 1. This basin encompasses 63.36 acres and has an existing imperviousness value of 2.68%. Runoff from this basin typically flows from the southeast to the northwest to Design Point 3. The basin contains two existing single-family homesites, and undeveloped land supporting native grasses and weeds. According to the results from the

EPA SWMM v.5.1 model, the runoff generated for this basin is 0.59 cfs in the 2-year minor storm, and 67.83 cfs in the 100-year major storm.

The flows from Design Point 2 and Design Point 3 continue to the northwest within Phantom Creek to Design Point 1. The routed flow at Design Point 1 is 1.79 cfs in the 2-year minor storm event, and 245.13 cfs in the 100-year major storm. The flow continues in the northwest direction to Running Creek, ultimately converging with the South Platte River. The overall Drainage Basin Map can be found in Appendix C.

PROPOSED BASINS

Basin PR-1

Basin PR-1 encompasses the same area as Basin EX-1. The impervious value increases to 9.43% with the development of the single-family lots and gravel access road. In general, the existing drainage patterns in the basin remain unchanged, except where the proposed road crosses these historic drainage paths. In that case, flow will be intercepted by the proposed roadside swales and be carried downstream (further analyzed in the Sub-Basin Map 1 found in Appendix D). According to the results from the EPA SWMM v.5.1 model, the runoff generated for this basin is 4.50 cfs in the 2-year minor storm, and 151.72 cfs in the 100-year major storm.

Proposed single-family lots are located within Basin PR-1. Each new lot will be required to mitigate the increase in runoff as described in Section D of this report.

Basin PR-1 has been further divided into sub-basins to analyze the required culvert crossings, and to account for the depression identified in this report. Basins PR-A, PR-B, and PR-C have been defined to calculate the flows at the proposed road culvert crossings at Design Points A, B, and C. Impervious values and a drainage basin map for these sub-basins can be found in Appendix D.

Flow generated from Basin PR-A will pass through the proposed 36” RCP culvert at Design Point A, combining with flow from Basins PR-B and OS-1. This culvert has been sized to convey the major storm plus an additional 20% of Q100 to account for clogging. These combined flows will be directed to Design Point B by the existing berm located on the upper limit of the existing depression.

At Design Point B, a shallow depression will be graded on the upstream side of the culverts to collect stormwater and convey it west via twin 36” RCP pipes across Lot 4 to Phantom Creek. The culvert crossing at Design Point B has been sized to convey the major storm from Basins PR-A and PR-B, plus an additional 20% of Q100 to account for clogging.

A shallow three to four feet deep depression will be graded on the upstream side of the culverts at Design Point B to direct water to these pipes. Outside of this localized depression, the roadside ditch continues to fall to the north, following the grade of the proposed gravel road. Flow that exceeds the upper limit of the depression at approximately elevation 6350’ (and the headwater depth of the twin 36” RCP pipes), will bypass these

pipes and continue downstream following the existing terrain to Design Point C, where it will be conveyed west to Phantom Creek via twin 36" RCP pipes.

The culvert crossing at Design Point C has been sized to convey the major storm from Basins PR-C and OS-1, plus an additional 20% of Q100 to account for clogging. Flow that exceeds the major storm at Design Point C will spill east to the existing depression described earlier in this report.

Off-site Basins OS-1 and OS-2 are located north of Pronghorn Avenue. These basins outfall to the site via existing 18" CMP culverts at Design Point D (Basin OS-1) and E (Basin OS-2). Based on the size of these culverts and shallow nature of the existing roadside swale, this report assumes that during the major storm, flow these off-site basins will overtop Pronghorn Avenue and drain onto the site.

Basin PR-2
Basin PR-2 encompasses the same area as Basin EX-2. Assuming future single-family developed conditions with the basin, the impervious value increases to 8.25%. According to the results from the EPA SWMM v.5.1 model, the runoff generated for this basin is 1.08 cfs in the 2-year minor storm, and 39.91 cfs in the 100-year major storm. Future development will be required to mitigate the increase in runoff per applicable County standards.

Basin PR-3
Basin PR-3 encompasses the same area as Basin EX-3 and includes areas previously developed with single-family homesites, thus the flows remain the same as the existing condition.

The ultimate discharge from the site is at Design Point 1, where twin 36" CMP culverts convey stormwater past County Road 21. Implementing the detention features described in this report will act to mitigate the increase in flow generated from the development of the lots, and reduce flows to their historic release rates.

C. DESIGN CRITERIA

Hydrologic Criteria
The preliminary drainage analysis was performed using the CUHP-SWMM Method to calculate the additional runoff generated from the development of driveways and buildings. As recommended by Elbert County and Mile High Flood District, due to one of the existing basin delineations being greater than 90 acres, the CUHP-SWMM method was utilized over the Rational Method. As directed by guidance within the CUHP program, rainfall data was obtained using NOAA Atlas 14 and developed a hyetograph for the area in the CUHP v2.0.1 spreadsheet provided by Mile High Flood District. See Appendix B. The CUHP spreadsheet developed a hydrograph for each of the existing drainage basins, which was utilized in the SWMM model to determine the amount of flow historically passes through the project site. A composite impervious value was used as part of the analysis for the

applicable basins. As recommended by Elbert County, gravel roadways have an impervious value of 40%, asphalt roadways have an impervious value of 100%, open space has an impervious value of 2%. Mile High Flood District and Elbert County recommend that single-family lots of 2.5 acres or greater have an impervious value of 12%. The proposed basin delineation for this study will be consistent with the existing basin delineation since major earthwork operations (such as overlot grading) are not associated with this project. Below is a summary table comparing the existing and proposed runoff flows in the 100-year major storm event. All hydrologic calculations for the existing and proposed major basins can be found in Appendix B.

Basin	Existing $Q_{100\text{-yr}}$ Runoff	Existing $Q_{100\text{-yr}}$ Routed Flow	Proposed $Q_{100\text{-yr}}$ Runoff	Proposed $Q_{100\text{-yr}}$ Routed Flow
EX-1/PR-1	144.77	245.13	151.72	252.38
EX-2/PR-2	39.05	39.05	39.91	39.91
EX-3/PR-3	67.83	67.83	67.83	67.83

D. DRAINAGE DESIGN PLAN

General Concept

Existing and proposed flow calculations were performed using the CUHP-SWMM method as recommended by Elbert County and Mile High Flood District for basins greater than 90 acres. This is also consistent with the existing drainage analysis. Basin delineation is consistent from existing conditions to proposed conditions, as there is no major earthwork/overlot grading associated with this project.

Conceptual Detention Pond Sizing

Each of the seven (7) new single-family lots will be required to provide sufficient water quality control measures and detention to mitigate the increase in runoff resulting from the new impervious surfaces associated with the development of the lot. These measures shall be in accordance with applicable Elbert County drainage criteria. This report includes a conceptual Extended Detention Basin (EDB) pond design for each new lot. An EDB is a sedimentation basin designed to detain stormwater for many hours after storm runoff ends. This BMP is similar to a detention basin used for flood control, however; the EDB uses a much smaller outlet that extends the emptying time of the more frequently occurring runoff events to facilitate pollutant removal. The EDB shall be equipped with an emergency spillway to convey flows that exceed the primary outlet capacity or when the outlet structure becomes blocked with debris. The emergency spillway also controls the location and direction of the overflow. The Drainage Basin Map provides conceptual spillway paths. These paths shall be directed away from structures, and towards existing drainages to mitigate erosion.

Design of the EDB is based on an assumed developed area of approximately 20,000 square feet, and a composite impervious value of approximately 50%. These values account for a 5,000 square foot roof (combined house, garage, out-building or other), 200 foot long by 12 foot wide gravel driveway, 2,000 square feet of native or landscaped area tributary to

the pond, and the portion of the internal private loop road within each lot. Since the square footage of the private loop road varies within each lot, a conceptual pond design has been included for each individual lot. Pond calculations have been provided in Appendix E.

Lot 1
Based on the assumed values above and Type A Soils as defined by NRCS, the required total detention storage volume for an Extended Detention Basin per MHFD is 0.042 acre-feet or 1,830 cubic feet.

Lot 2
Based on the assumed values above and Type A Soils as defined by NRCS, the required total detention storage volume for an Extended Detention Basin per MHFD is 0.036 acre-feet or 1,570 cubic feet.

Lot 3
Based on the assumed values above and Type B Soils as defined by NRCS, the required total detention storage volume for an Extended Detention Basin per MHFD is 0.047 acre-feet or 2,050 cubic feet.

Lot 4
Based on the assumed values above and Type B Soils as defined by NRCS, the required total detention storage volume for an Extended Detention Basin per MHFD is 0.033 acre-feet or 1,440 cubic feet.

Lot 5
Based on the assumed values above and Type B Soils as defined by NRCS, the required total detention storage volume for an Extended Detention Basin per MHFD is 0.041 acre-feet or 1,790 cubic feet.

Lot 6
Based on the assumed values above and Type B Soils as defined by NRCS, the required total detention storage volume for an Extended Detention Basin per MHFD is 0.064 acre-feet or 2,790 cubic feet.

Lot 7
Based on the assumed values above and Type B Soils as defined by NRCS, the required total detention storage volume for an Extended Detention Basin per MHFD is 0.061 acre-feet or 2,660 cubic feet.

The Drainage Basin Map includes conceptual locations for seven (7) proposed detention ponds. The ponds should be placed to intercept flow from the developed portion of the lot and outside of any historic drainage paths. Once a lot is developed, the lot owner will refine these assumptions based on actual site and house plans.

Private Roadway Drainage Design

As part of the construction of the roadway, roadside swales and culverts will be provided to direct drainage to historic paths. Sizing of culverts and roadside swales has been provided in Appendix D. The capacity of the roadside swale was analyzed in three locations: Design Point A1, Design Point B1, and Design Point C1 (refer to Sub Basin Map 2). In all other locations, the roadside swale only conveys flow from a limited section of the gravel road before the road transitions to a fill condition, and the flow from the swale dissipates across the existing terrain.

The proposed Extended Detention Basin (EDB) detention ponds discussed in this report have been sized to account for the additional imperviousness of the private road adjacent to each new lot. While it is not feasible for each new pond to intercept flow from the adjacent road, by accounting for this new gravel surface in the pond volume, the ponds will be sized to over-detain for those areas that are not hydraulically connected to each pond.

The proposed grass lined swales will intercept flow from the proposed gravel roadway, providing an informal measure of water quality treatment. The grass swales for this project have relatively shallow slopes and broad cross-sections that will convey flow in a slow and shallow manner, which will act to promote sedimentation and filtering (straining) while limiting erosion. The check dams shown on the Erosion Control Plans will further act to reduce velocities and encourage settling and infiltration.

E. EROSION CONTROL

Erosion control measures required during construction of the main roadway and culverts are shown in the Construction Drawings for this project. These Best Management Practice (BMP) measures, including vehicle tracking control, silt fence, stabilized staging area, check dams, riprap, rock berms, seeding and mulching, and erosion control blanket, will act to stabilize disturbed areas and mitigate sediment transport during construction.

These BMPs apply to one or more of the following construction phases: initial stage, the interim stage, and the final stage. The initial BMPs shall be installed at the outset of construction, prior to any land disturbance activities. Initial controls are placed on existing grades, but they shall be based in part on proposed grading operations. The interim BMPs shall be installed during active construction, including road grading, utility installation, and road paving. Final stage BMPs shall be installed as one of the last steps in the construction process to promote final stabilization of disturbed areas.

Details of these BMPs have been provided with the Construction Drawings to guide the proper installation of these features. Check dams provided within the roadside swales shall be spaced according to the steepness of the swale, such that the bottom of the upstream check should be at the same elevation as the top of the downstream check.

The individual homeowner is encouraged to implement steps to help prevent erosion and water pollution. Limiting the use of impervious surfaces such as asphalt or concrete driveways and walks/patios allows stormwater to soak into the ground instead of running

downstream and causing erosion. Permeable pavers can be used to allow water to pass through them, rather than run off the surface. Redirecting downspouts away from hard surfaces and onto grass or shallow depressed planting beds can help reduce the amount of runoff. Planting native vegetation and minimizing the use of fertilizers and pesticides will help reduce the impact of stormwater on the environment.

F. PERMITTING REQUIREMENTS

Construction sites that disturb one acre or greater, or are part of a larger common plan of development, are required to obtain a Construction Stormwater Discharge Permit issued by the Colorado Department of Public Health and Environment (CDPHE). Additional permit requirements such as a Grading Permit will be required by Elbert County Road and Bridge Department.

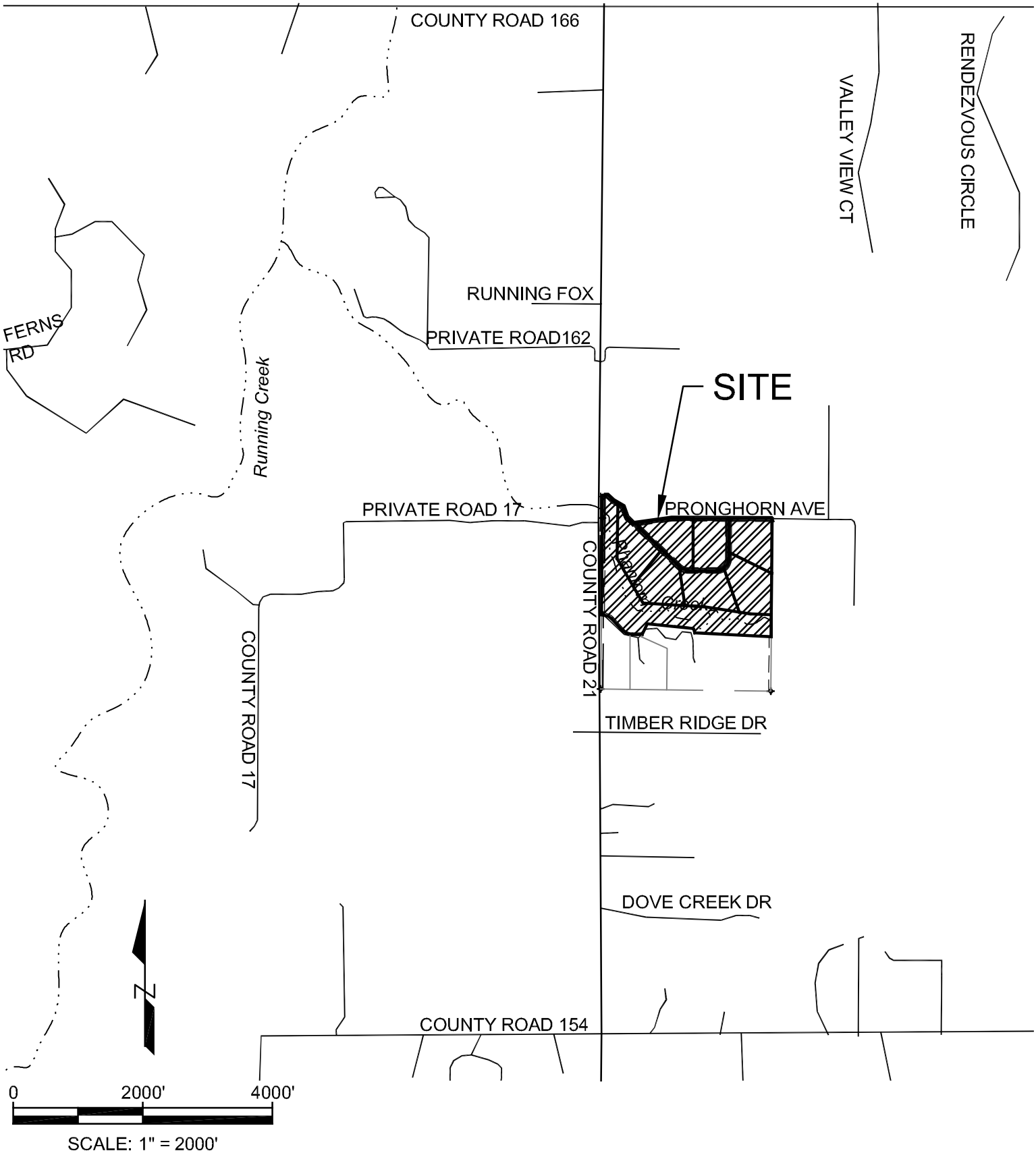
G. CONCLUSION

The additional impervious surfaces resulting from the development of the lots will cause an increase of runoff from the site. This increase will be mitigated by implementing the stormwater quality and detention features outlined in this report.

This Drainage Report was prepared in conformance with Elbert County's Construction Standards and Specifications 2019, with supplemental data from the Mile High Flood District's Urban Storm Drainage Criteria Manual Volumes 1, 2, and 3. This report provides preliminary stormwater calculations including runoff quantities for the proposed development of the lots, and roadway culvert calculations.

Appendix A
Vicinity Map, Soils Map, FIRM

VICINITY MAP



Project Number: 22010

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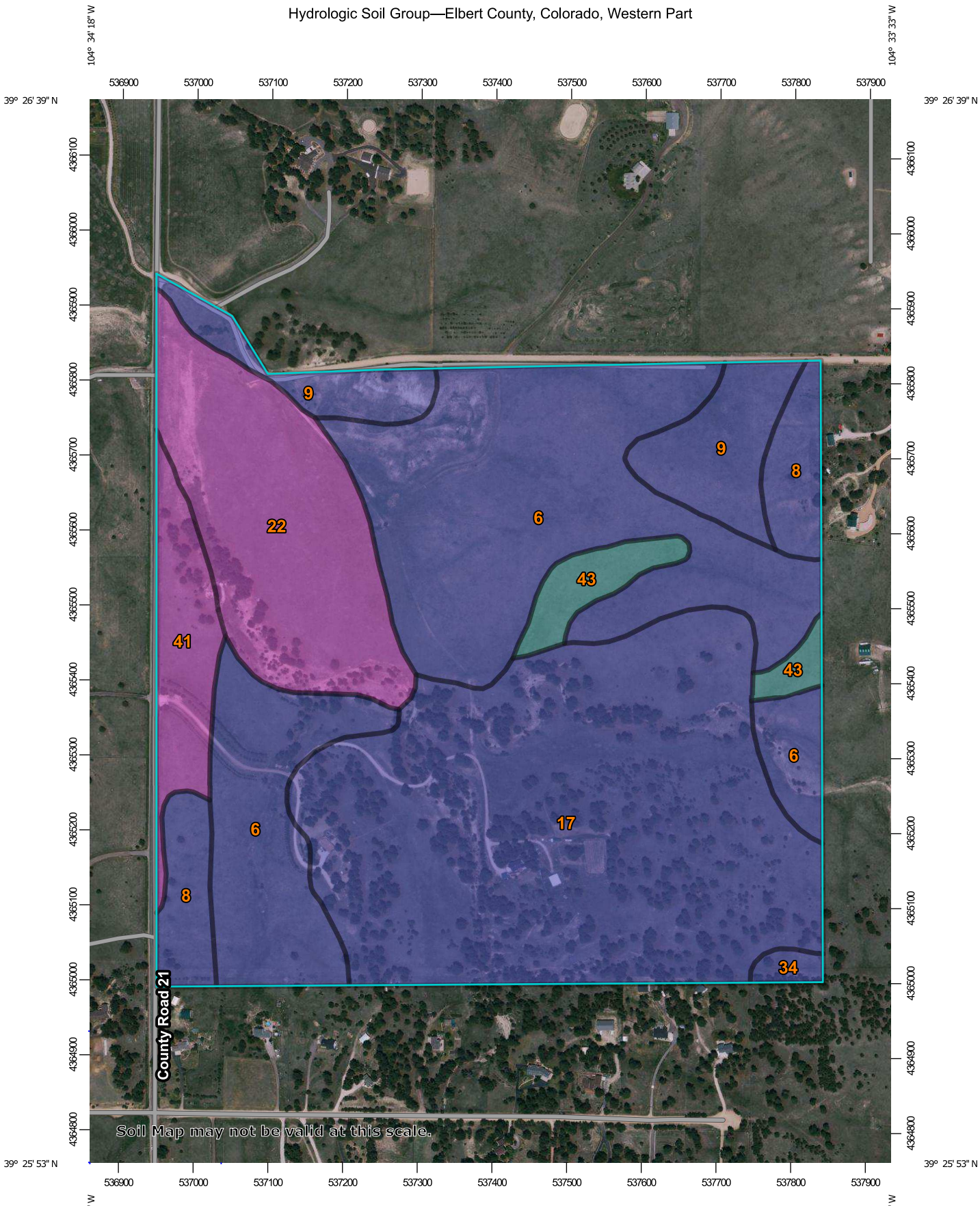
2N Civil, LLC
6 Inverness Ct. E., Suite 125
Englewood, CO 80112
Phone 303-925-0544 Fax 303-925-0547
www.2NCivil.com

VICINITY MAP
PHANTOM CREEK RANCH

Drawn By: ARV
Checked By: EPT
Revisions:12-6-2022

Hydrologic Soil Group—Elbert County, Colorado, Western Part



Map Scale: 1:6,910 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 100 200 400 600

Feet: 0 300 600 1200 1800

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 Rating Polygons

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Lines

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Points

A

A/D

B

B/D

C

C/D

D

Not rated or not available

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: Elbert County, Colorado, Western Part
Survey Area Data: Version 18, Sep 1, 2022

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

Date(s) aerial images were photographed: Jun 9, 2021—Jun 12, 2021

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.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
6	Bresser sandy loam, cool, 5 to 9 percent slopes	B	59.1	32.0%
8	Bresser-Stapleton sandy loams, 8 to 25 percent slopes	B	8.4	4.5%
9	Bresser-Truckton sandy loams, 8 to 25 percent slopes	B	12.0	6.5%
17	Elbeth sandy loam, 4 to 8 percent slopes	B	66.5	36.0%
22	Haplustolls, moderately coarse, nearly level*	A	25.1	13.6%
34	Peyton sandy loam, 4 to 8 percent slopes	B	0.9	0.5%
41	Truckton sandy loam, 3 to 9 percent slopes	A	8.0	4.3%
43	Weld loam, 0 to 4 percent slopes	C	4.9	2.6%
Totals for Area of Interest			**184.9**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the **North American Vertical Datum of 1988 (NAVD88)**. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-2, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242 or visit its website at http://www.ngs.noaa.gov/.

Base Map information shown on this FIRM was provided in digital format by Elbert County GIS Department and Anderson Consulting Engineers, Inc. These data are current as of 2009.

This map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables *in the Flood Insurance Study Report (which contains authoritative hydraulic data)* may reflect stream channel distances that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

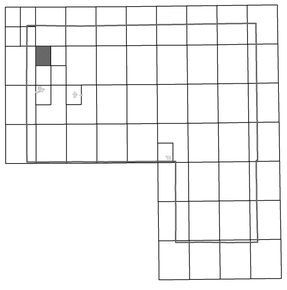
Contact **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, *a Flood Insurance Study Report*, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call 1-877-FEMA Map (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/.

Elbert County Vertical Datum Offset Table

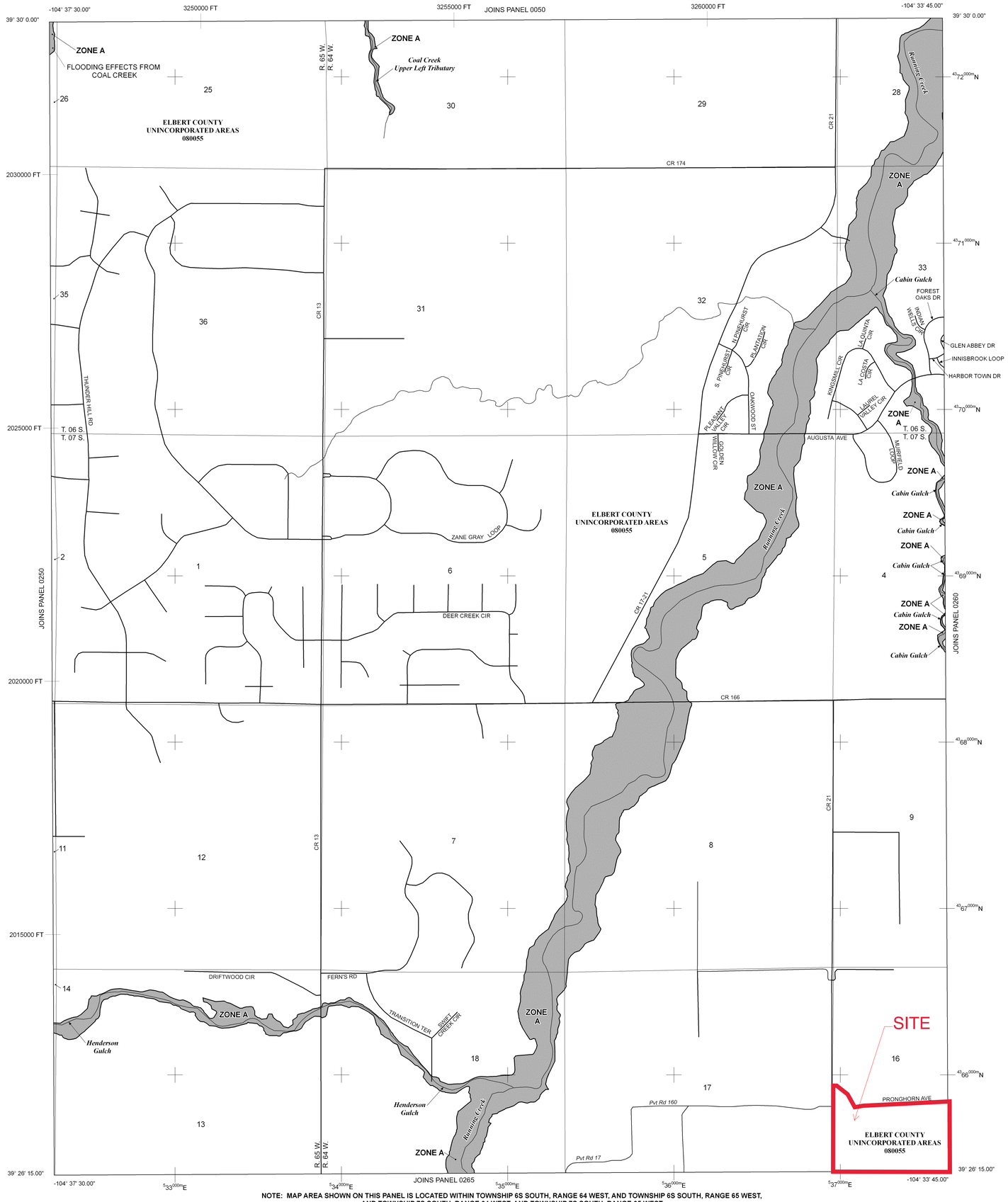
Flooding Source	Vertical Datum Offset (ft)
N/A	N/A

Panel Location Map



This Digital Flood Insurance Rate Map (DFIRM) was produced through a Cooperating Technical Partner (CTP) agreement between the State of Colorado Water Conservation Board (CWCB) and the Federal Emergency Management Agency (FEMA).

Additional Flood Hazard information and resources are available from local communities and the Colorado Water Conservation Board.



NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 6S SOUTH, RANGE 64 WEST, AND TOWNSHIP 6S SOUTH, RANGE 65 WEST, AND TOWNSHIP 7S SOUTH, RANGE 64 WEST, AND TOWNSHIP 7S SOUTH, RANGE 65 WEST.

LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAS) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A No Base Flood Elevations determined.
ZONE AE Base Flood Elevations determined.
ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR Special Flood Hazard Area Formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99 Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

Floodplain boundary
Floodway boundary
Zone D Boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
513 — Base Flood Elevation line and value; elevation in feet*
(EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A — Cross section line
23 — 23 — Transect line
97° 07' 30.00" / 32° 22' 30.00" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
4275000mN — 1000-meter Universal Transverse Mercator grid ticks, zone 13
6000000 FT — 5000-foot grid ticks: Colorado State Plane coordinate system, central zone (FIPSZONE 0502), Lambert Conformal Conic Projection
DX5510 — Bench mark (see explanation in Notes to Users section of this FIRM panel)
M1.5 — River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
MARCH 17, 2011

For community map revision history prior to countywide mapping, refer to the Community Map History Table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 1000'
500 0 1000 2000 FEET
300 0 300 600 METERS

NFIP

PANEL 0255C

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

ELBERT COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 0255 OF 1200

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS

COMMUNITY	NUMBER	PANEL	SUFFIX
ELBERT COUNTY	080055	0255	C

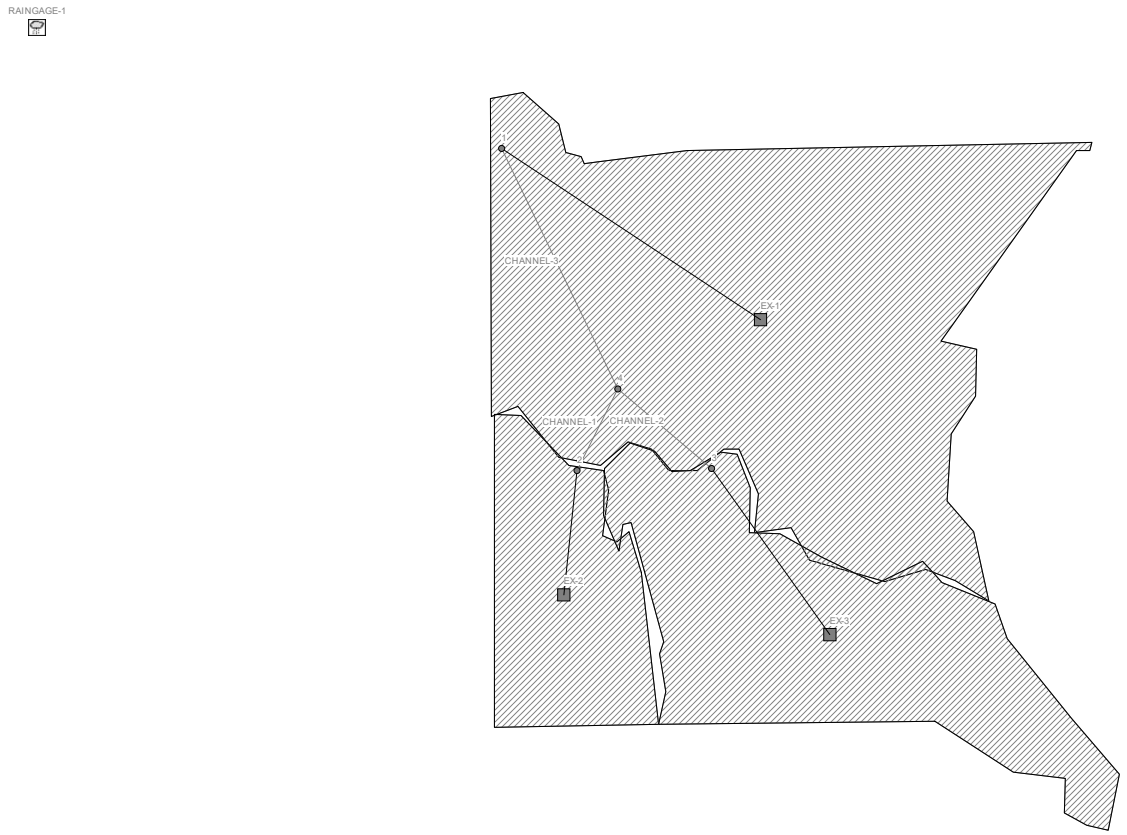
Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
08039C0255C

EFFECTIVE DATE:
MARCH 17, 2011

Federal Emergency Management Agency

Appendix B
Hydrologic Criteria


RAINGAGE-1
1
CHANNEL-3
EX-1
4
CHANNEL-1
CHANNEL-2
3
EX-2
EX-3

Printouts for Storm Hydrographs

Existing 2-yr Storm

flow in cfs

time in minutes	EX-1	EX-2	EX-3
5	0.00	0.00	0.00
10	0.00	0.00	0.00
15	0.00	0.00	0.00
20	0.02	0.03	0.01
25	0.22	0.21	0.11
30	0.75	0.56	0.36
35	1.27	0.67	0.54
40	1.52	0.67	0.59
45	1.55	0.60	0.57
50	1.45	0.53	0.52
55	1.29	0.46	0.46
60	1.16	0.41	0.41
65	1.05	0.36	0.37
70	0.94	0.32	0.33
75	0.85	0.28	0.30
80	0.78	0.24	0.28
85	0.71	0.21	0.25
90	0.65	0.18	0.22
95	0.58	0.17	0.20
100	0.52	0.15	0.17
105	0.45	0.14	0.15
110	0.40	0.12	0.14
115	0.37	0.11	0.13
120	0.34	0.09	0.12
125	0.31	0.08	0.11
130	0.29	0.06	0.10
135	0.26	0.04	0.09
140	0.23	0.03	0.08
145	0.21	0.02	0.07
150	0.18	0.01	0.06
155	0.16	0.01	0.05
160	0.13	0.01	0.04
165	0.11	0.01	0.03
170	0.08	0.01	0.02
175	0.06	0.00	0.01
180	0.04	0.00	0.01
185	0.02	0.00	0.00
190	0.01	0.00	0.00
195	0.01	0.00	0.00
200	0.01	0.00	0.00
205	0.01	0.00	0.00
210	0.01	0.00	0.00
215	0.00	0.00	0.00
220	0.00	0.00	0.00
225	0.00	0.00	0.00
230	0.00	0.00	0.00
235	0.00	0.00	0.00
240	0.00	0.00	0.00
245	0.00	0.00	0.00
250	0.00	0.00	0.00
255	0.00	0.00	0.00
260	0.00	0.00	0.00
265	0.00	0.00	0.00
270	0.00	0.00	0.00
275	0.00	0.00	0.00
280	0.00	0.00	0.00
285	0.00	0.00	0.00
290	0.00	0.00	0.00

Printouts for Storm Hydrographs

Existing 100-yr Storm

flow in cfs

time in minutes	EX-1	EX-2	EX-3
5	0.00	0.00	0.00
10	0.00	0.00	0.00
15	0.01	0.02	0.01
20	0.06	0.06	0.02
25	1.14	1.10	0.61
30	32.10	20.61	21.67
35	82.91	33.85	47.56
40	120.00	38.80	61.31
45	138.52	39.05	67.15
50	144.77	37.75	67.83
55	140.71	35.40	65.28
60	134.95	32.97	62.41
65	129.35	31.20	59.65
70	120.89	27.91	54.88
75	110.01	24.46	49.73
80	99.73	21.05	44.96
85	90.09	17.86	40.42
90	81.04	15.15	36.20
95	72.77	13.14	32.24
100	64.82	11.54	28.38
105	57.09	10.13	24.65
110	49.63	8.86	21.73
115	44.10	7.68	19.48
120	39.76	6.57	17.58
125	36.00	5.53	15.89
130	32.63	4.52	14.34
135	29.55	3.52	12.90
140	26.65	2.53	11.55
145	23.95	1.60	10.30
150	21.44	1.03	9.07
155	18.95	0.68	7.84
160	16.47	0.43	6.62
165	13.99	0.26	5.39
170	11.51	0.14	4.17
175	9.03	0.06	2.95
180	6.56	0.02	1.85
185	4.12	0.02	1.18
190	2.63	0.01	0.76
195	1.71	0.01	0.47
200	1.08	0.01	0.27
205	0.64	0.01	0.14
210	0.35	0.00	0.05
215	0.15	0.00	0.01
220	0.04	0.00	0.01
225	0.03	0.00	0.01
230	0.02	0.00	0.01
235	0.02	0.00	0.00
240	0.01	0.00	0.00
245	0.01	0.00	0.00
250	0.01	0.00	0.00
255	0.00	0.00	0.00
260	0.00	0.00	0.00
265	0.00	0.00	0.00
270	0.00	0.00	0.00
275	0.00	0.00	0.00
280	0.00	0.00	0.00
285	0.00	0.00	0.00
290	0.00	0.00	0.00

Phantom Creek Ranch
2N Project No: 22010
Date: 11-30-2022
Phase I Drainage Report

SWMM 5.1
Existing Hydrology

Existing Basin Characteristics

EX-1				
Area	136.45	ac	5943718.44	sq.ft.
Width	1646.586	ft	width=	area
% Slope	3.02%			avg max flowpath
% Imperv	3.38%			
Flowpaths				
# 1	1786.06	ft		
# 2	3813.38	ft		
# 3	**4740.83**	**ft**		
# 4	3892.92	ft		
# 5	3815.42	ft		
Average	3609.72	*ft*		
*Bold is Longest Flow Length				

EX-2				
Area	30.44	ac	1326074.583	sq.ft.
Width	923.48	ft	width=	area
% Slope	4.16%			avg max flowpath
% Imperv	5.21%			
Flowpaths				
# 1	1121.84	ft		
# 2	1289.28	ft		
# 3	1657.13	ft		
# 4	**1853.45**	**ft**		
# 5	1258.05	ft		
Average	1435.95	*ft*		
*Bold is Longest Flow Length				

EX-3				
Area	63.35	ac	2759598.82	sq.ft.
Width	1249.51	ft	width=	area
% Slope	3.99%			avg max flowpath
% Imperv	2.68%			
Flowpaths				
# 1	1134.30	ft		
# 2	1595.84	ft		
# 3	1967.69	ft		
# 4	**3763.48**	ft		
# 5	2581.37	ft		
Average	2208.54	*ft*		
*Bold is Longest Flow Length				

Phantom Creek Ranch
2N Project No: 22010
Date: 11-30-2022
Phase I Drainage Report

SWMM 5.1
Existing Hydrology

Existing Flowpaths

Average Slope for EX-1

Path # 1		**Path # 2**		**Path # 3**		**Path # 4**		**Path # 5**	
Length	*% Slope*	*Length*	*% Slope*	*Length*	*% Slope*	*Length*	*% Slope*	*Length*	*% Slope*
482	9.5	528	6.5	205	4.1	180	7.9	122	8.1
248	2	400	3.8	221	5.5	194	4.5	145	8.7
322	1.2	297	5.7	402	4.7	205	4.4	466	7.2
288	1.3	277	1.6	293	2.8	433	2.2	226	9.8
331	0.3	150	1.5	206	1.9	196	2.5	387	6
		279	1	223	1.5	207	4.2	280	3.3
		166	0.1	335	1.6	206	4.8	680	3
		427	2	156	1.5	156	1.5	314	2.5
		275	1.2	365	1	365	1	168	3.1
		363	1.3	150	0.1	150	0.1	230	1.3
		305	0.3	440	2	440	2	285	1.7
				275	1.2	275	1.2	343	1.1
				363	1.3	363	1.3		
				305	0.3	305	0.3		
Weighted Slope	3.55	Weighted Slope	2.70	Weighted Slope	2.14	Weighted Slope	2.42	Weighted Slope	4.27
Average Weighted Slope:		**3.02**							

Average Slope for EX-2

Path # 1		**Path # 2**		**Path # 3**		**Path # 4**		**Path # 5**	
Length	*% Slope*	*Length*	*% Slope*	*Length*	*% Slope*	*Length*	*% Slope*	*Length*	*% Slope*
135	4.9	290	12.1	384	2.5	410	6.1	118	2.2
227	10.2	114	2.3	373	2	373	2	243	7.6
140	6.3	255	2.2	255	2.2	255	2.2	260	4.5
210	4.5	210	4.5	210	4.5	210	4.5	210	4.5
276	2	276	2	276	2	276	2	276	2
Weighted Slope	5.42	Weighted Slope	5.09	Weighted Slope	2.51	Weighted Slope	3.48	Weighted Slope	4.31
Average Weighted Slope:		**4.16**							

Average Slope for EX-3

Path # 1		**Path # 2**		**Path # 3**		**Path # 4**		**Path # 5**	
Length	*% Slope*	*Length*	*% Slope*	*Length*	*% Slope*	*Length*	*% Slope*	*Length*	*% Slope*
150	10	193	5.8	230	15.1	400	5.8	103	3.6
127	4.4	213	13.5	590	1.4	652	8.2	88	3.4
100	10.2	325	5.2	296	1.1	345	3.6	306	6.4
425	2.9	708	1.1	708	1.1	233	3.2	260	7.8
232	1.4	166	1.1	166	1.1	236	6	433	4.2
						345	7.5	437	6.5
						296	1.1	708	1.1
						708	1.1	166	1.1
						166	1.1		
Weighted Slope	4.48	Weighted Slope	4.14	Weighted Slope	2.81	Weighted Slope	4.42	Weighted Slope	4.11
Average Weighted Slope		**3.99**							

Phantom Creek Ranch
2N Project No: 22010
Date: 11-30-2022
Phase I Drainage Report

SWMM 5.1
Existing Hydrology

Junction

Junction Name	*Inflow*	*Invert Elevation*	
1	None	6324	ft
2	None	6356	ft
3	None	6365	ft

Conduit

Conduit Name	*Inlet Node*	*Outlet Node*	*Shape*	*Max. Depth*	*Length*	*Roughness*	*Initial Flow*	*Transect Name*
Channel-1	2	1	Irregular	11.96	2071	0.035	0	PHANTOM-CREEK
Channel-2	3	1	Irregular	11.96	2554	0.035	0	PHANTOM-CREEK

Transect

Transect Name
PHANTOM-CREEK

Station	*Elevation*
0	6340
15	6337.82
30	6335.41
45	6333.88
60	6333.01
75	6331.79
90	6330.44
105	6329.16
120	6328.04
135	6328.34
150	6328.8
165	6331.16
180	6333.3
195	6334.01
210	6334.55
225	6334.49
240	6334.49
245.86	6334.55
255	6334.61
270	6334.64
285	6334.71
300	6334.69
315	6334.73
330	6334.86
345.63	6335

Roughness

Left Station	0.035
Right Station	0.035
Channel	0.035

Bank Stations

Left	60
Right	175

Phantom Creek Ranch
2N Project No: 22010
Date: 09-01-2023
Phase I Drainage Report

SWMM 5.1
Existing Hydrology

COMPOSITE IMPERVIOUS VALUES

Basin EX-1		
Surface	*% Impervious*	*Acreage*
Road - Asphalt	100%	1.12
Road - Gravel	40%	2.07
Open Space/Historic	2%	133.26
Sum Area =		136.45
Weighted I% =	**3.38%**	

Basin EX-2		
Surface	*% Impervious*	*Acreage*
Road - Asphalt	100%	0.83
Road - Gravel	40%	0.42
Open Space/Historic	2%	29.18
Sum Area =		30.44
Weighted I% =	**5.21%**	

Basin EX-3		
Surface	% Impervious	*Acreage*
Road - Asphalt	100%	0
Road - Gravel	40%	0
Single Family - 10 ac	12%	4.32
Open Space/Historic	2%	59.04
Sum Area =		63.36
Weighted I% =	**2.68%**	

Comment	HYDROLOGY - PHASE I				
1Hr Depth	0.834	inches	2hr Depth	1.00	inches
6Hr Depth	1.31	inches	3hr Depth	1.12	inches
Correction Area	0.25	Sq. Mi.			
Return Period	2	Years			

NOAA Atlas 14 Point Precipitation Frequency Estimates: CO (Note: Use 60-minute recurrence interval depth)

Time	Adjusted Depth	Unadjusted Depth
0:05	0.0167	0.0167
0:10	0.0334	0.0334
0:15	0.0701	0.0701
0:20	0.1334	0.1334
0:25	0.2085	0.2085
0:30	0.1168	0.1168
0:35	0.0525	0.0525
0:40	0.0417	0.0417
0:45	0.0250	0.0250
0:50	0.0250	0.0250
0:55	0.0250	0.0250
1:00	0.0250	0.0250
1:05	0.0250	0.0250
1:10	0.0167	0.0167
1:15	0.0167	0.0167
1:20	0.0167	0.0167
1:25	0.0167	0.0167
1:30	0.0167	0.0167
1:35	0.0167	0.0167
1:40	0.0167	0.0167
1:45	0.0167	0.0167
1:50	0.0167	0.0167
1:55	0.0083	0.0083
2:00	0.0083	0.0083
2:05	0.0000	0.0000
2:10	0.0000	0.0000
2:15	0.0000	0.0000
2:20	0.0000	0.0000
2:25	0.0000	0.0000
2:30	0.0000	0.0000
2:35	0.0000	0.0000
2:40	0.0000	0.0000
2:45	0.0000	0.0000
2:50	0.0000	0.0000
2:55	0.0000	0.0000
3:00	0.0000	0.0000
3:05	0.0000	0.0000
3:10	0.0000	0.0000
3:15	0.0000	0.0000
3:20	0.0000	0.0000
3:25	0.0000	0.0000
3:30	0.0000	0.0000
3:35	0.0000	0.0000
3:40	0.0000	0.0000
3:45	0.0000	0.0000
3:50	0.0000	0.0000
3:55	0.0000	0.0000
4:00	0.0000	0.0000
4:05	0.0000	0.0000
4:10	0.0000	0.0000
4:15	0.0000	0.0000
4:20	0.0000	0.0000
4:25	0.0000	0.0000
4:30	0.0000	0.0000
4:35	0.0000	0.0000
4:40	0.0000	0.0000
4:45	0.0000	0.0000
4:50	0.0000	0.0000
4:55	0.0000	0.0000
5:00	0.0000	0.0000
5:05	0.0000	0.0000
5:10	0.0000	0.0000
5:15	0.0000	0.0000
5:20	0.0000	0.0000
5:25	0.0000	0.0000
5:30	0.0000	0.0000
5:35	0.0000	0.0000
5:40	0.0000	0.0000
5:45	0.0000	0.0000
5:50	0.0000	0.0000
5:55	0.0000	0.0000
6:00	0.0000	0.0000
6:05	0.0000	0.0000

Comment	HYDROLOGY - PHASE I				
1Hr Depth	2.39	inches	2hr Depth	2.82	inches
6Hr Depth	3.66	inches	3hr Depth	3.15	inches
Correction Area	0.25	Sq. Mi.			
Return Period	100	Years			

NOAA Atlas 14 Point Precipitation Frequency Estimates: CO (Note: Use 60-minute recurrence interval depth)

Time	Adjusted Depth	Unadjusted Depth
0:05	0.0239	0.0239
0:10	0.0717	0.0717
0:15	0.1099	0.1099
0:20	0.1912	0.1912
0:25	0.3346	0.3346
0:30	0.5975	0.5975
0:35	0.3346	0.3346
0:40	0.1912	0.1912
0:45	0.1482	0.1482
0:50	0.1195	0.1195
0:55	0.0956	0.0956
1:00	0.0956	0.0956
1:05	0.0956	0.0956
1:10	0.0478	0.0478
1:15	0.0478	0.0478
1:20	0.0287	0.0287
1:25	0.0287	0.0287
1:30	0.0287	0.0287
1:35	0.0287	0.0287
1:40	0.0287	0.0287
1:45	0.0287	0.0287
1:50	0.0287	0.0287
1:55	0.0287	0.0287
2:00	0.0287	0.0287
2:05	0.0000	0.0000
2:10	0.0000	0.0000
2:15	0.0000	0.0000
2:20	0.0000	0.0000
2:25	0.0000	0.0000
2:30	0.0000	0.0000
2:35	0.0000	0.0000
2:40	0.0000	0.0000
2:45	0.0000	0.0000
2:50	0.0000	0.0000
2:55	0.0000	0.0000
3:00	0.0000	0.0000
3:05	0.0000	0.0000
3:10	0.0000	0.0000
3:15	0.0000	0.0000
3:20	0.0000	0.0000
3:25	0.0000	0.0000
3:30	0.0000	0.0000
3:35	0.0000	0.0000
3:40	0.0000	0.0000
3:45	0.0000	0.0000
3:50	0.0000	0.0000
3:55	0.0000	0.0000
4:00	0.0000	0.0000
4:05	0.0000	0.0000
4:10	0.0000	0.0000
4:15	0.0000	0.0000
4:20	0.0000	0.0000
4:25	0.0000	0.0000
4:30	0.0000	0.0000
4:35	0.0000	0.0000
4:40	0.0000	0.0000
4:45	0.0000	0.0000
4:50	0.0000	0.0000
4:55	0.0000	0.0000
5:00	0.0000	0.0000
5:05	0.0000	0.0000
5:10	0.0000	0.0000
5:15	0.0000	0.0000
5:20	0.0000	0.0000
5:25	0.0000	0.0000
5:30	0.0000	0.0000
5:35	0.0000	0.0000
5:40	0.0000	0.0000
5:45	0.0000	0.0000
5:50	0.0000	0.0000
5:55	0.0000	0.0000
6:00	0.0000	0.0000
6:05	0.0000	0.0000

Existing 2-YR Storm

Node Inflow Summary

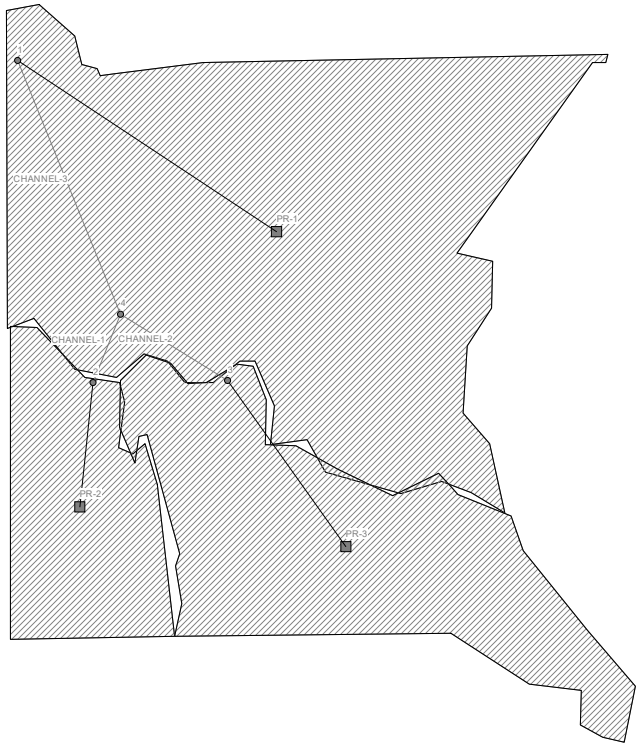
Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Day of Maximum Inflow	Hour of Maximum Inflow	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal	Flow Balance Error %
1	JUNCTION	1.55	1.79	0	01:04	0.0427	0.0741	0.000
2	JUNCTION	0.67	0.67	0	00:40	0.0153	0.0153	0.000
3	JUNCTION	0.59	0.59	0	00:40	0.0155	0.0155	0.000

Existing 100-YR Storm

Node Inflow Summary

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Day of Maximum Inflow	Hour of Maximum Inflow	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal	Flow Balance Error %
1	JUNCTION	144.77	245.13	0	00:54	4.51	7.66	0.000
2	JUNCTION	39.05	39.05	0	00:45	1.02	1.02	0.000
3	JUNCTION	67.83	67.83	0	00:50	2.09	2.09	0.000

RAINGAGE-1



Printouts for Storm Hydrographs

Proposed 2-yr Storm

flow in cfs

time in minutes	PR-1	PR-2	PR-3
5	0.00	0.00	0.00
10	0.00	0.00	0.00
15	0.02	0.01	0.00
20	0.20	0.08	0.01
25	0.92	0.37	0.11
30	2.53	0.92	0.36
35	3.92	1.08	0.54
40	4.48	1.08	0.59
45	4.50	0.97	0.57
50	4.19	0.86	0.52
55	3.78	0.76	0.46
60	3.46	0.67	0.41
65	3.16	0.61	0.37
70	2.89	0.54	0.33
75	2.66	0.48	0.30
80	2.46	0.42	0.28
85	2.27	0.36	0.25
90	2.08	0.32	0.22
95	1.90	0.29	0.20
100	1.72	0.27	0.17
105	1.55	0.25	0.15
110	1.41	0.23	0.14
115	1.32	0.20	0.13
120	1.23	0.17	0.12
125	1.14	0.14	0.11
130	1.03	0.11	0.10
135	0.93	0.08	0.09
140	0.83	0.06	0.08
145	0.74	0.04	0.07
150	0.65	0.03	0.06
155	0.56	0.02	0.05
160	0.48	0.02	0.04
165	0.39	0.02	0.03
170	0.31	0.01	0.02
175	0.23	0.01	0.01
180	0.16	0.01	0.01
185	0.11	0.01	0.00
190	0.09	0.01	0.00
195	0.07	0.00	0.00
200	0.06	0.00	0.00
205	0.05	0.00	0.00
210	0.04	0.00	0.00
215	0.04	0.00	0.00
220	0.03	0.00	0.00
225	0.03	0.00	0.00
230	0.02	0.00	0.00
235	0.02	0.00	0.00
240	0.01	0.00	0.00
245	0.01	0.00	0.00
250	0.01	0.00	0.00
255	0.00	0.00	0.00
260	0.00	0.00	0.00
265	0.00	0.00	0.00
270	0.00	0.00	0.00
275	0.00	0.00	0.00
280	0.00	0.00	0.00
285	0.00	0.00	0.00

Printouts for Storm Hydrographs

Proposed 100-yr Storm

flow in cfs

time in minutes	PR-1	PR-2	PR-3
5	0.00	0.00	0.00
10	0.00	0.00	0.00
15	0.13	0.06	0.01
20	0.49	0.16	0.02
25	4.02	1.81	0.61
30	43.22	22.21	21.67
35	98.02	35.26	47.56
40	132.11	39.90	61.31
45	147.86	39.91	67.15
50	151.72	38.56	67.83
55	146.63	36.14	65.28
60	140.62	33.71	62.41
65	134.80	31.92	59.65
70	125.57	28.53	54.88
75	114.51	25.00	49.73
80	104.01	21.48	44.96
85	93.93	18.20	40.42
90	84.43	15.50	36.20
95	75.66	13.47	32.24
100	67.17	11.84	28.38
105	58.97	10.39	24.65
110	51.65	9.07	21.73
115	46.22	7.86	19.48
120	41.81	6.71	17.58
125	37.89	5.62	15.89
130	34.29	4.56	14.34
135	30.96	3.51	12.90
140	27.83	2.48	11.55
145	24.92	1.59	10.30
150	22.17	1.05	9.07
155	19.44	0.69	7.84
160	16.72	0.45	6.62
165	14.02	0.28	5.39
170	11.32	0.16	4.17
175	8.63	0.08	2.95
180	5.98	0.04	1.85
185	3.86	0.03	1.18
190	2.55	0.02	0.76
195	1.70	0.02	0.47
200	1.10	0.01	0.27
205	0.68	0.01	0.14
210	0.39	0.01	0.05
215	0.20	0.00	0.01
220	0.11	0.00	0.01
225	0.08	0.00	0.01
230	0.06	0.00	0.01
235	0.05	0.00	0.00
240	0.04	0.00	0.00
245	0.03	0.00	0.00
250	0.02	0.00	0.00
255	0.01	0.00	0.00
260	0.01	0.00	0.00
265	0.00	0.00	0.00
270	0.00	0.00	0.00
275	0.00	0.00	0.00
280	0.00	0.00	0.00
285	0.00	0.00	0.00

Phantom Creek Ranch
2N Project No: 22010
Date: 12-05-2022
Phase I Drainage Report

SWMM 5.1
Proposed Hydrology

Proposed Basin Characteristics

PR-1				
Area	136.45	ac	5943718.44	sq.ft.
Width	1646.586	ft	width=	area
% Slope	3.02%			avg max flowpath
% Imperv	9.43%			
Flowpaths				
# 1	1786.06	ft		
# 2	3813.38	ft		
# 3	**4740.83**	**ft**		
# 4	3892.92	ft		
# 5	3815.42	ft		
Average	3609.72	*ft*		
*Bold is Longest Flow Length				
PR-2				
Area	30.44	ac	1326074.583	sq.ft.
Width	923.48	ft	width=	area
% Slope	4.16%			avg max flowpath
% Imperv	8.25%			
Flowpaths				
# 1	1121.84	ft		
# 2	1289.28	ft		
# 3	1657.13	ft		
# 4	**1853.45**	**ft**		
# 5	1258.05	ft		
Average	1435.95	*ft*		
*Bold is Longest Flow Length				
PR-3				
Area	63.35	ac	2759598.82	sq.ft.
Width	1249.51	ft	width=	area
% Slope	3.99%			avg max flowpath
% Imperv	2.68%			
Flowpaths				
# 1	1134.30	ft		
# 2	1595.84	ft		
# 3	1967.69	ft		
# 4	**3763.48**	ft		
# 5	2581.37	ft		
Average	2208.54	*ft*		
*Bold is Longest Flow Length				

Phantom Creek Ranch
2N Project No: 22010
Date: 12-05-2022
Phase I Drainage Report

SWMM 5.1
Proposed Hydrology

Proposed Flowpaths

Average Slope for PR-1

Path # 1		**Path # 2**		**Path # 3**		**Path # 4**		**Path # 5**	
Length	*% Slope*	*Length*	*% Slope*	*Length*	*% Slope*	*Length*	*% Slope*	*Length*	*% Slope*
482	9.5	528	6.5	205	4.1	180	7.9	122	8.1
248	2	400	3.8	221	5.5	194	4.5	145	8.7
322	1.2	297	5.7	402	4.7	205	4.4	466	7.2
288	1.3	277	1.6	293	2.8	433	2.2	226	9.8
331	0.3	150	1.5	206	1.9	196	2.5	387	6
		279	1	223	1.5	207	4.2	280	3.3
		166	0.1	335	1.6	206	4.8	680	3
		427	2	156	1.5	156	1.5	314	2.5
		275	1.2	365	1	365	1	168	3.1
		363	1.3	150	0.1	150	0.1	230	1.3
		305	0.3	440	2	440	2	285	1.7
				275	1.2	275	1.2	343	1.1
				363	1.3	363	1.3		
				305	0.3	305	0.3		
Weighted Slope	3.55	Weighted Slope	2.70	Weighted Slope	2.14	Weighted Slope	2.42	Weighted Slope	4.27
Average Weighted Slope:		**3.02**							

Average Slope for PR-2

Path # 1		**Path # 2**		**Path # 3**		**Path # 4**		**Path # 5**	
Length	*% Slope*	*Length*	*% Slope*	*Length*	*% Slope*	*Length*	*% Slope*	*Length*	*% Slope*
135	4.9	290	12.1	384	2.5	410	6.1	118	2.2
227	10.2	114	2.3	373	2	373	2	243	7.6
140	6.3	255	2.2	255	2.2	255	2.2	260	4.5
210	4.5	210	4.5	210	4.5	210	4.5	210	4.5
276	2	276	2	276	2	276	2	276	2
Weighted Slope	5.42	Weighted Slope	5.09	Weighted Slope	2.51	Weighted Slope	3.48	Weighted Slope	4.31
Average Weighted Slope:		**4.16**							

Average Slope for PR-3

Path # 1		**Path # 2**		**Path # 3**		**Path # 4**		**Path # 5**	
Length	*% Slope*	*Length*	*% Slope*	*Length*	*% Slope*	*Length*	*% Slope*	*Length*	*% Slope*
150	10	193	5.8	230	15.1	400	5.8	103	3.6
127	4.4	213	13.5	590	1.4	652	8.2	88	3.4
100	10.2	325	5.2	296	1.1	345	3.6	306	6.4
425	2.9	708	1.1	708	1.1	233	3.2	260	7.8
232	1.4	166	1.1	166	1.1	236	6	433	4.2
						345	7.5	437	6.5
						296	1.1	708	1.1
						708	1.1	166	1.1
						166	1.1		
Weighted Slope	4.48	Weighted Slope	4.14	Weighted Slope	2.81	Weighted Slope	4.42	Weighted Slope	4.11
Average Weighted Slope		**3.99**							

Phantom Creek Ranch
2N Project No: 22010
Date: 12-05-2022
Phase I Drainage Report

SWMM 5.1
Proposed Hydrology

Junction

Junction Name	*Inflow*	*Invert Elevation*	
1	None	6324	ft
2	None	6356	ft
3	None	6365	ft

Conduit

Conduit Name	*Inlet Node*	*Outlet Node*	*Shape*	*Max. Depth*	*Length*	*Roughness*	*Initial Flow*	*Transect Name*
Channel-1	2	1	Irregular	11.96	2071	0.035	0	PHANTOM-CREEK
Channel-2	3	1	Irregular	11.96	2554	0.035	0	PHANTOM-CREEK

Transect

Transect Name
PHANTOM-CREEK

Station	*Elevation*
0	6340
15	6337.82
30	6335.41
45	6333.88
60	6333.01
75	6331.79
90	6330.44
105	6329.16
120	6328.04
135	6328.34
150	6328.8
165	6331.16
180	6333.3
195	6334.01
210	6334.55
225	6334.49
240	6334.49
245.86	6334.55
255	6334.61
270	6334.64
285	6334.71
300	6334.69
315	6334.73
330	6334.86
345.63	6335

Roughness

Left Station	0.035
Right Station	0.035
Channel	0.035

Bank Stations

Left	60
Right	175

Phantom Creek Ranch
2N Project No: 22010
Date: 09-01-2023
Phase I Drainage Report

SWMM 5.1
Proposed Hydrology

COMPOSITE IMPERVIOUS VALUES

Basin PR-1		
Surface	*% Impervious*	*Acreage*
Road - Asphalt	100%	1.12
Road - Gravel	40%	3.87
Open Space/Historic	2%	55.76
Single Family - 10 ac	12%	75.70
Sum Area =		136.45
Weighted I% =	**9.43%**	

Basin PR-2		
Surface	*% Impervious*	*Acreage*
Road - Asphalt	100%	0.83
Road - Gravel	40%	0.42
Single Family - 10 ac	12%	9.23
Open Space/Historic	2%	19.95
Sum Area =		30.44
Weighted I% =	**8.25%**	

Basin PR-3		
Surface	% Impervious	*Acreage*
Road - Asphalt	100%	*0*
Road - Gravel	40%	0
Single Family - 10 ac	12%	4.32
Open Space/Historic	2%	59.04
Sum Area =		63.36
Weighted I% =	**2.68%**	

Proposed 2-YR Storm

Node Inflow Summary

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Day of Maximum Inflow	Hour of Maximum Inflow	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal	Flow Balance Error %
1	JUNCTION	4.50	4.72	0	00:45	0.136	0.179	0.000
2	JUNCTION	1.08	1.08	0	00:40	0.0259	0.0259	0.000
3	JUNCTION	0.59	0.59	0	00:40	0.0155	0.0155	0.000

Proposed 100-YR Storm

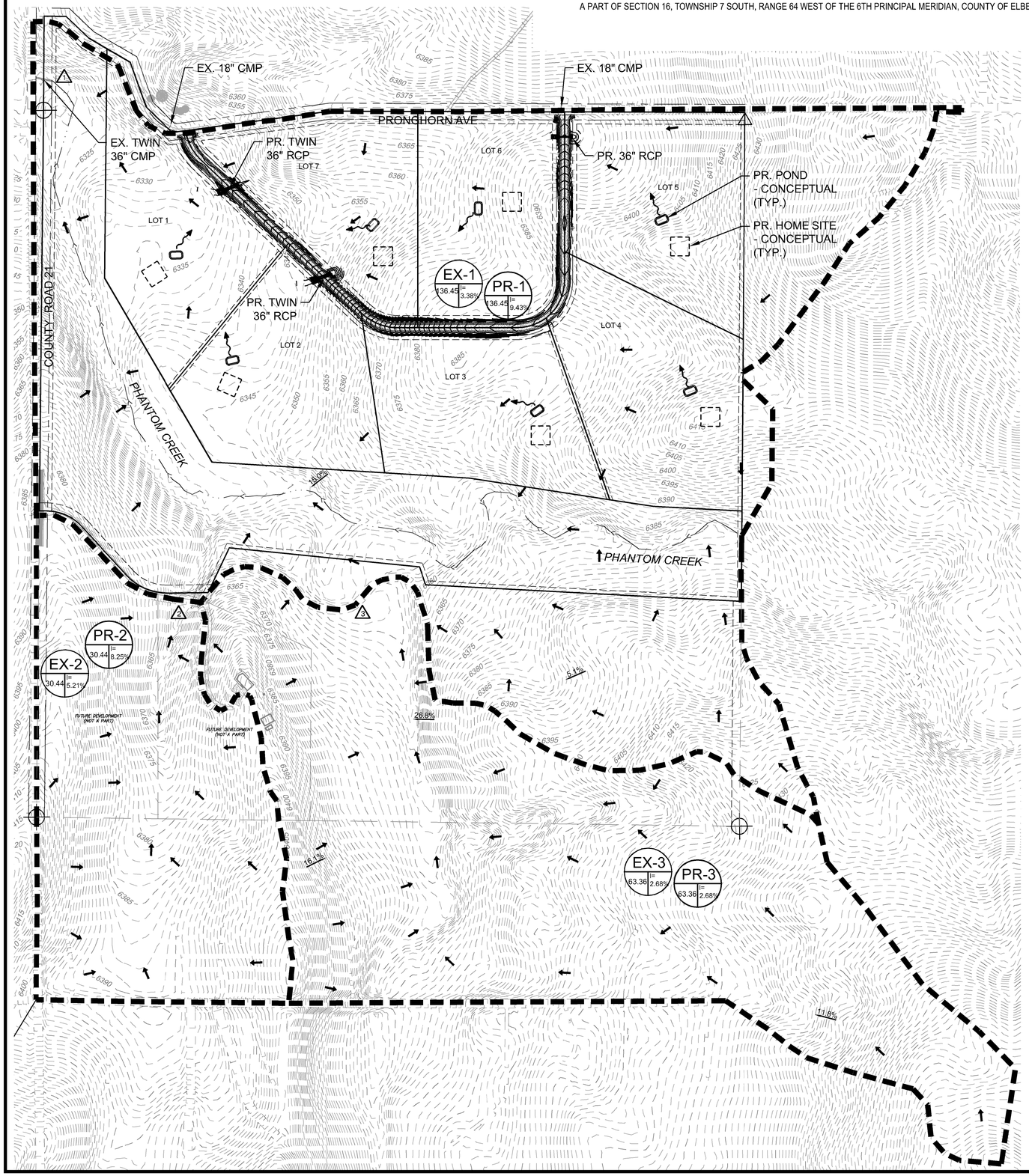
Node Inflow Summary

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Day of Maximum Inflow	Hour of Maximum Inflow	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal	Flow Balance Error %
1	JUNCTION	151.72	252.38	0	00:53	4.78	7.95	0.000
2	JUNCTION	39.91	39.91	0	00:45	1.05	1.05	0.000
3	JUNCTION	67.83	67.83	0	00:50	2.09	2.09	0.000

Appendix C
Drainage Basin Map

DRAINAGE BASIN MAP

A PART OF SECTION 16, TOWNSHIP 7 SOUTH, RANGE 64 WEST OF THE 6TH PRINCIPAL MERIDIAN, COUNTY OF ELBERT, STATE OF COLORADO



LEGEND

- EXISTING MAJOR CONTOUR (6550)
- EXISTING MINOR CONTOUR (6551)
- PROPOSED MAJOR CONTOUR (6551)
- PROPOSED MINOR CONTOUR (6551)
- EX/PR DRAINAGE BASIN LINES
- BASIN NAME (EX-1)
- BASIN AREA (ac) (1.76)
- BASIN COMPOSITE %I (i= 27.6%)
- BASIN DESIGN POINT
- PR. HOME SITE (CONCEPTUAL)
- PR. POND LOCATION (CONCEPTUAL)
- PR. POND DISCHARGE LOCATION & OVERFLOW DIRECTION (CONCEPTUAL)

BASIN SUMMARY TABLE

BASIN	DESIGN POINT	2-YEAR RUNOFF FLOW (cfs)	100-YEAR RUNOFF FLOW (cfs)	2-YEAR ROUTED FLOW (cfs)	100-YEAR ROUTED FLOW (cfs)
EX-1	1	1.55	144.77	1.79	245.13
EX-2	2	0.67	39.05	0.67	39.05
EX-3	3	0.59	67.83	0.59	67.83
PR-1	1	4.50	151.72	4.72	252.38
PR-2	2	1.08	39.91	1.08	39.91
PR-3	3	0.59	67.83	0.59	67.83

0 200' 400'

SCALE: 1" = 200'

NOTE: TOPOGRAPHY WAS ACQUIRED FROM PUBLIC SOURCES ASSUMED TO BE USGS AND SHOULD NOT BE RELIED ON FOR ANY CONSTRUCTION ACTIVITIES.

2N CIVIL
303.925.0544
www.2ncivil.com

PREPARED FOR:
PHANTOM CREEK
DEVLOPMENT, LLC
39622 COUNTY ROAD 21
MILLIKEN, CO 80543

DRAINAGE BASIN MAP
PHASE 1 DRAINAGE REPORT
PHANTOM CREEK RANCH
ELBERT COUNTY, COLORADO

REVISIONS: 1. 2. 3. 4.
BY: DATE:

PROJECT NUMBER: 22010
ISSUED DATE: 06-14-2024
DESIGNED BY: TEW
REVIEWED BY: EPT

BASIN MAP

1

J:\Projects\22\22010\Dwg\PHASE 1 - EX BASIN MAP.dwg 6/6/2024

Appendix D
Roadway Culvert Calculations

Phantom Creek - Stormwater Calculations

Proposed Conditions - Composite % Impervious Value

1-Sep-23

Basin PR-A

Land Use	Area	% I
Gravel (packed)	0.56	40%
Historic	0.70	2%
Single Family (2.5 ac or greater)	13.93	12%
Sum Area =	15.20	
Composite % =		12.57%

Basin PR-B

Land Use	Area	% I
Gravel (packed)	0.75	40%
Historic	0.72	2%
Single Family (2.5 ac or greater)	9.50	12%
Sum Area =	10.96	
Composite % =		13.25%

Basin PR-C

Land Use	Area	% I
Gravel (packed)	0.54	40%
Historic	0.56	2%
Single Family (2.5 ac or greater)	7.91	12%
Sum Area =	9.01	
Composite % =		13.05%

Basin OS-1

Land Use	Area	% I
Gravel (packed)	0.55	40%
Historic	27.71	2%
Sum Area =	28.26	
Composite % =		2.74%

Basin OS-2

Land Use	Area	% I
Gravel (packed)	0.81	40%
Historic	8.15	2%
Roof	0.09	90%
Sum Area =	9.04	
Composite % =		6.22%

Table 6-3. Recommended percentage imperviousness values

Land Use or Surface Characteristics	Percentage Imperviousness (%)
Business:	
Downtown Areas	95
Suburban Areas	75
Residential lots (lot area only)**:**	
Single-family	
2.5 acres or larger	12
0.75 – 2.5 acres	20
0.25 – 0.75 acres	30
0.25 acres or less	45
Apartments	75
Industrial:	
Light areas	80
Heavy areas	90
Parks, cemeteries	10
Playgrounds	25
Schools	55
Railroad yard areas	50
Undeveloped Areas:	
Historic flow analysis	2
Greenbelts, agricultural	2
Off-site flow analysis (when land use not defined)	45
Streets:	
Paved	100
Gravel (packed)	40
Drive and walks	90
Roofs	90
Lawns, sandy soil	2
Lawns, clayey soil	2

Calculation of Peak Runoff using Rational Method

Designer: TEW
Company: 2N Civil
Date: 11/13/2023
Project: Phantom Creek
Location: Elbert County, Colorado

Version 2.00 released May 2017

Cells of this color are for required user-input
Cells of this color are for optional override values
Cells of this color are for calculated results based on overrides

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_i^{0.33}}$$

$$t_t = \frac{L_t}{60K\sqrt{S_t}} = \frac{L_t}{60V_t}$$

Computed $t_c = t_i + t_t$

Regional $t_c = (26 - 17i) + \frac{L_t}{60(14i + 9)\sqrt{S_t}}$

$t_{minimum}$ = 5 (urban)
$t_{minimum}$ = 10 (non-urban)

Selected $t_c = \max\{t_{minimum}, \min(\text{Computed } t_c, \text{Regional } t_c)\}$

Select UDFCD location for NOAA Atlas 14 Rainfall Depths from the pulldown list OR enter your own depths obtained from the NOAA website (click this link)

	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
1-hour rainfall depth, P1 (in) =	1.00	1.42	1.68		2.35	2.71	
	a	b	c				
Rainfall Intensity Equation Coefficients =	28.50	10.00	0.786				

$$I(in/hr) = \frac{a * P_1}{(b + t_c)^c}$$

$$Q(cfs) = CIA$$

Subcatchment Name	Area (ac)	NRCS Hydrologic Soil Group	Percent Imperviousness	Runoff Coefficient, C							Overland (Initial) Flow Time					Channelized (Travel) Flow Time							Time of Concentration			Rainfall Intensity, I (in/hr)							Peak Flow, Q (cfs)						
				2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)	Overland Flow Time t_i (min)	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Velocity V_t (ft/sec)	Channelized Flow Time t_t (min)	Computed t_c (min)	Regional t_c (min)	Selected t_c (min)	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
PR-A	15.20	B	12.6	0.07	0.09	0.16	0.33	0.40	0.48	0.58	300.00	6484.00	6465.87	0.060	17.45	1173.00	6465.87	6378.50	0.074	7	1.91	10.23	27.68	30.52	27.68	1.64	2.34	2.76		3.86	4.46		1.85	3.19	6.65		23.38	32.81	
PR-B	10.96	B	13.3	0.08	0.10	0.16	0.33	0.40	0.49	0.58	300.00	6378.50	6369.88	0.029	22.18	877.32	6369.88	6349.00	0.024	7	1.08	13.54	35.72	32.48	32.48	1.50	2.13	2.51		3.52	4.06		1.29	2.21	4.52		15.49	21.67	
PR-C	5.06	B	13.1	0.08	0.09	0.16	0.33	0.40	0.49	0.58	300.00	6365.43	6356.14	0.031	21.68	777.14	6356.14	6336.00	0.026	7	1.13	11.49	33.17	31.21	31.21	1.53	2.18	2.57		3.60	4.15		0.60	1.03	2.11		7.30	10.22	
OS-1	28.26	B	2.7	0.01	0.02	0.08	0.27	0.34	0.44	0.55	300.00	6459.00	6442.00	0.057	19.10	1202.72	6442.00	6379.44	0.052	7	1.60	12.56	31.66	34.90	31.66	1.52	2.16	2.55		3.57	4.12		0.53	1.04	5.71		34.64	51.06	
OS-2	9.04	B	6.2	0.03	0.04	0.11	0.29	0.36	0.45	0.56	300.00	6435.00	6420.00	0.050	19.46	1751.62	6420.00	6333.90	0.049	7	1.55	18.81	38.27	38.28	38.27	1.35	1.92	2.27		3.18	3.67		0.40	0.73	2.20		10.43	15.09	
PR-A1	1.06	B	15.5	0.09	0.11	0.18	0.35	0.41	0.50	0.59	201.77	6405.00	6391.00	0.069	13.37	333.41	6391.00	6378.54	0.037	7	1.35	4.11	17.47	25.95	17.47	2.11	2.99	3.54		4.95	5.71		0.21	0.36	0.68		2.18	3.02	
PR-B1	0.90	B	21.0	0.13	0.16	0.23	0.38	0.45	0.52	0.61	23.00	6388.05	6386.00	0.089	3.97	778.72	6386.00	6357.00	0.037	7	1.35	9.61	13.57	28.05	13.57	2.38	3.38	3.99		5.59	6.44		0.29	0.48	0.82		2.24	3.04	
PR-C1	0.22	B	19.5	0.12	0.14	0.21	0.37	0.44	0.52	0.61	23.00	6351.67	6349.62	0.089	4.02	177.24	6349.62	6343.80	0.033	7	1.27	2.33	6.35	24.07	10.00	2.71	3.84	4.55		6.36	7.33		0.07	0.12	0.22		0.62	0.85	

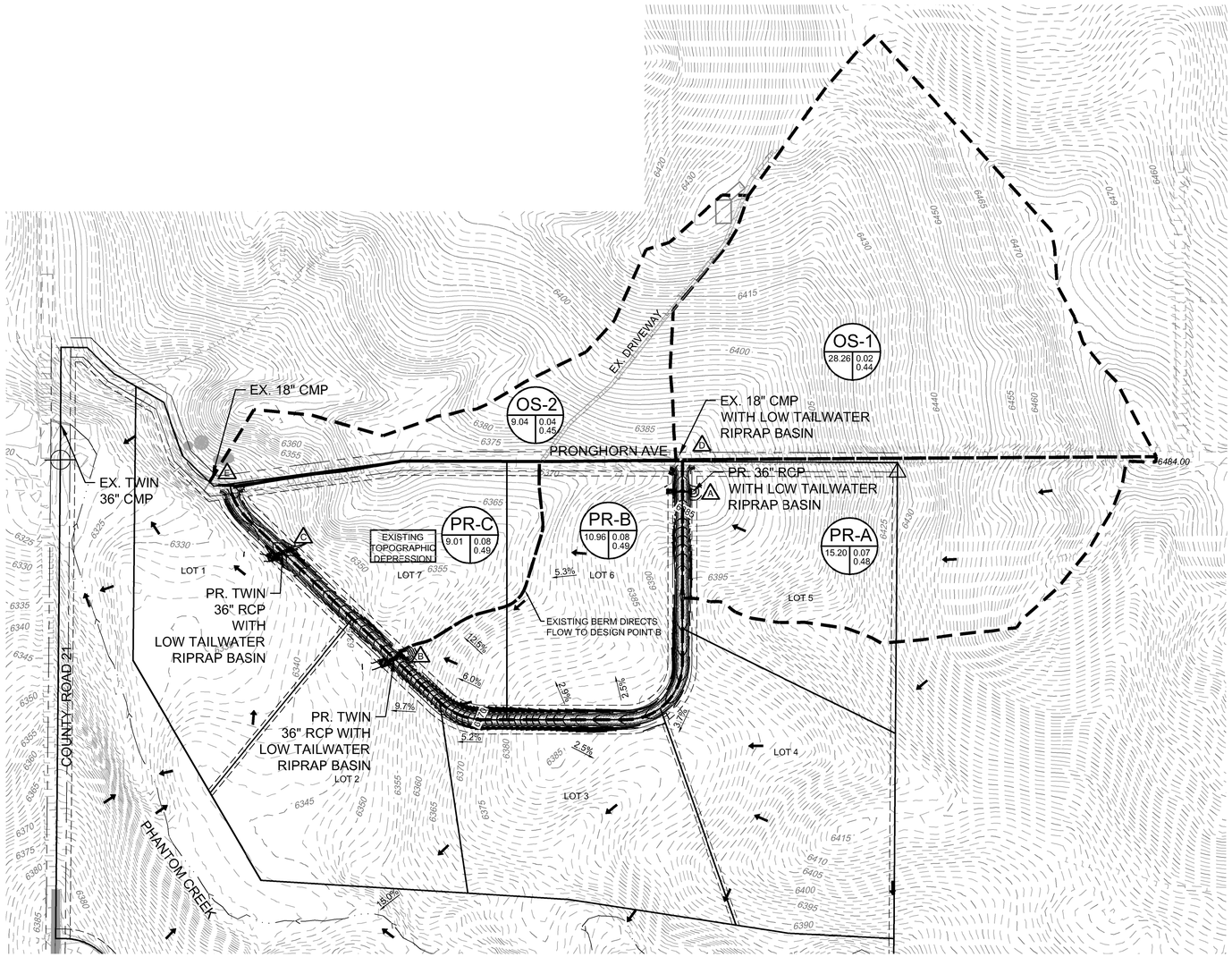
SUB-BASIN MAP 1

PROPOSED CONDITIONS

A PART OF SECTION 16, TOWNSHIP 7 SOUTH, RANGE 64 WEST OF THE 6TH PRINCIPAL MERIDIAN, COUNTY OF ELBERT, STATE OF COLORADO.

LEGEND

- 6550 — EXISTING MAJOR CONTOUR
- 6551 — EXISTING MINOR CONTOUR
- 6551 — PROPOSED MAJOR CONTOUR
- 6551 — PROPOSED MINOR CONTOUR
- EX/PR DRAINAGE BASIN LINES
- PR-A (BASIN NAME); BASIN AREA (ac) 1.76; 2 YR RUNOFF COEFFICIENT 0.08; 100 YR RUNCFF COEFFICIENT 0.48
- 1 BASIN DESIGN POINT



Summary Runoff Table - Proposed Conditions

DESIGN POINT	CONTRIBUTING BASIN(S)	CONTRIBUTING AREA (AC)	Q_2 (cfs)	Q_{100} (cfs)	NOTES:
A	PR-A	15.20	1.85	32.81	Flows to Phantom Creek
B	PR-A, PR-B	26.16	3.14	54.48	Flows to Phantom Creek
C	PR-C, OS-1	37.27	1.60	69.27	Flows to Phantom Creek
D	OS-1	28.26	0.53	51.06	Flows to Phantom Creek
E	OS-2	9.04	0.40	15.09	Flows to Phantom Creek

N

0 200' 400'

SCALE: 1" = 200'

NOTE: TOPOGRAPHY WAS ACCUIRED FROM PUBLIC SOURCES ASSUMED TO BE USGS AND SHOULD NOT BE RELIED ON FOR ANY CONSTRUCTION ACTIVITIES.

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www.2ncivil.com

PREPARED FOR:
PHANTOM CREEK
DEVLOPMENT, LLC
39622 COUNTY ROAD 21
MILLIKEN, CO 80543

DRAINAGE BASIN MAP
PHASE 1 DRAINAGE REPORT
PHANTOM CREEK RANCH
ELBERT COUNTY, COLORADO

REVISIONS: BY: DATE:
1.
2.
3.
4.

PROJECT NUMBER: 22010
ISSUED DATE: 06-14-2024
DESIGNED BY: TEW
REVIEWED BY: EPT

SUB-BASIN MAP 1

1

J:\Projects\22\22010\dwg\CD\PR BASIN MAP 1.dwg 6/6/2024

Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Aug 24 2023

Design Point A - 36in RCP Crossing Q2

Q2 with 20% clogging factor

Invert Elev Dn (ft)	=	78.25
Pipe Length (ft)	=	58.00
Slope (%)	=	0.50
Invert Elev Up (ft)	=	78.54
Rise (in)	=	36.0
Shape	=	Circular
Span (in)	=	36.0
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)	=	83.24
Top Width (ft)	=	32.00
Crest Width (ft)	=	10.00

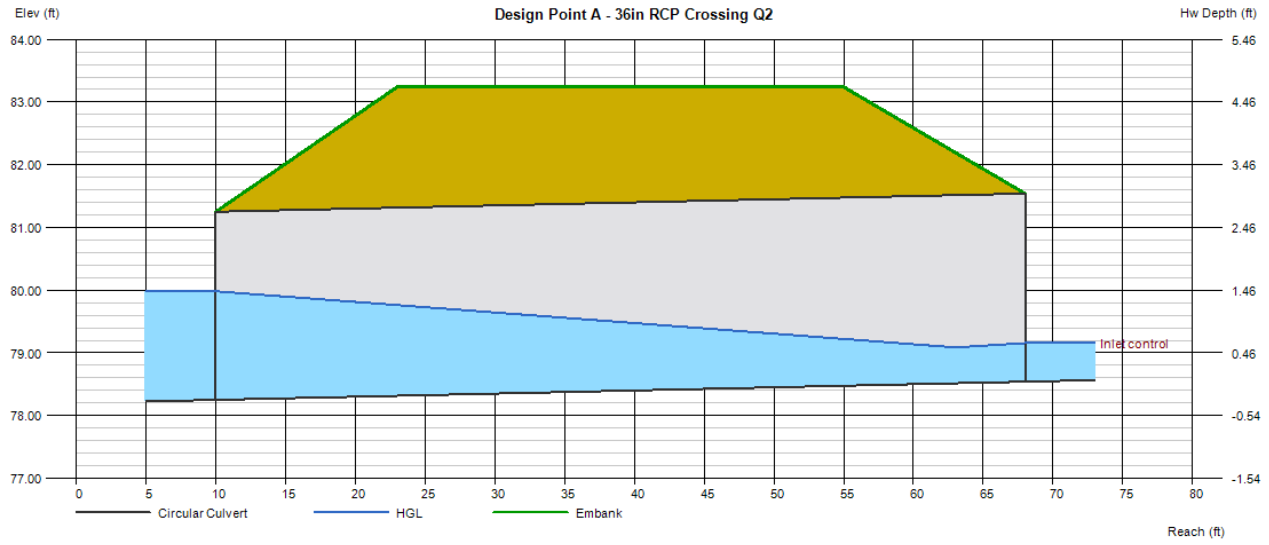
Calculations

Qmin (cfs)	=	2.22
Qmax (cfs)	=	2.22
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	2.22
Qpipe (cfs)	=	2.22
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	0.53
Veloc Up (ft/s)	=	3.21
HGL Dn (ft)	=	79.98
HGL Up (ft)	=	79.00
Hw Elev (ft)	=	79.16
Hw/D (ft)	=	0.21
Flow Regime	=	Inlet Control

Hw/D < 1.5



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc.

Thursday, Aug 24 2023

Design Point A - 36in RCP Crossing Q100

Q100 with 20% clogging factor

Invert Elev Dn (ft)	= 78.25
Pipe Length (ft)	= 58.00
Slope (%)	= 0.50
Invert Elev Up (ft)	= 78.54
Rise (in)	= 36.0
Shape	= Circular
Span (in)	= 36.0
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)	= 83.24
Top Width (ft)	= 32.00
Crest Width (ft)	= 10.00

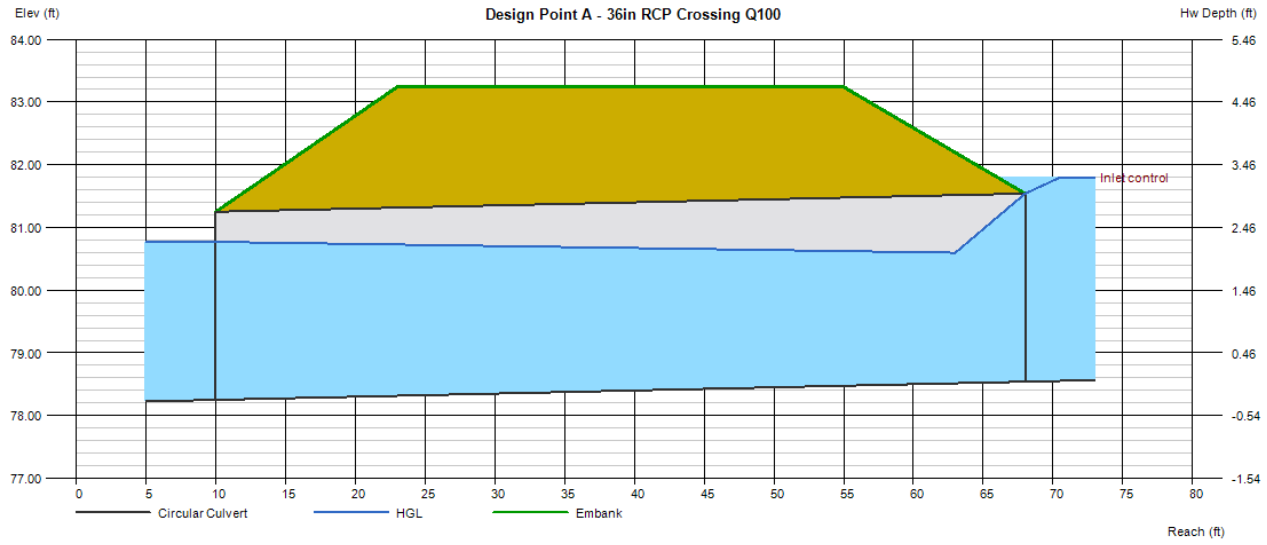
Calculations

Qmin (cfs)	= 39.37
Qmax (cfs)	= 39.37
Tailwater Elev (ft)	= (dc+D)/2

Highlighted

Qtotal (cfs)	= 39.37
Qpipe (cfs)	= 39.37
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 6.21
Veloc Up (ft/s)	= 7.69
HGL Dn (ft)	= 80.77
HGL Up (ft)	= 80.58
Hw Elev (ft)	= 81.80
Hw/D (ft)	= 1.09
Flow Regime	= Inlet Control

Hw/D < 1.5



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Aug 24 2023

Q2 with 20% clogging factor

Design Point B - Twin 36in RCP Crossing Q2

Invert Elev Dn (ft)	=	46.70
Pipe Length (ft)	=	60.00
Slope (%)	=	0.80
Invert Elev Up (ft)	=	47.18
Rise (in)	=	36.0
Shape	=	Circular
Span (in)	=	36.0
No. Barrels	=	2
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)	=	52.03
Top Width (ft)	=	32.00
Crest Width (ft)	=	10.00

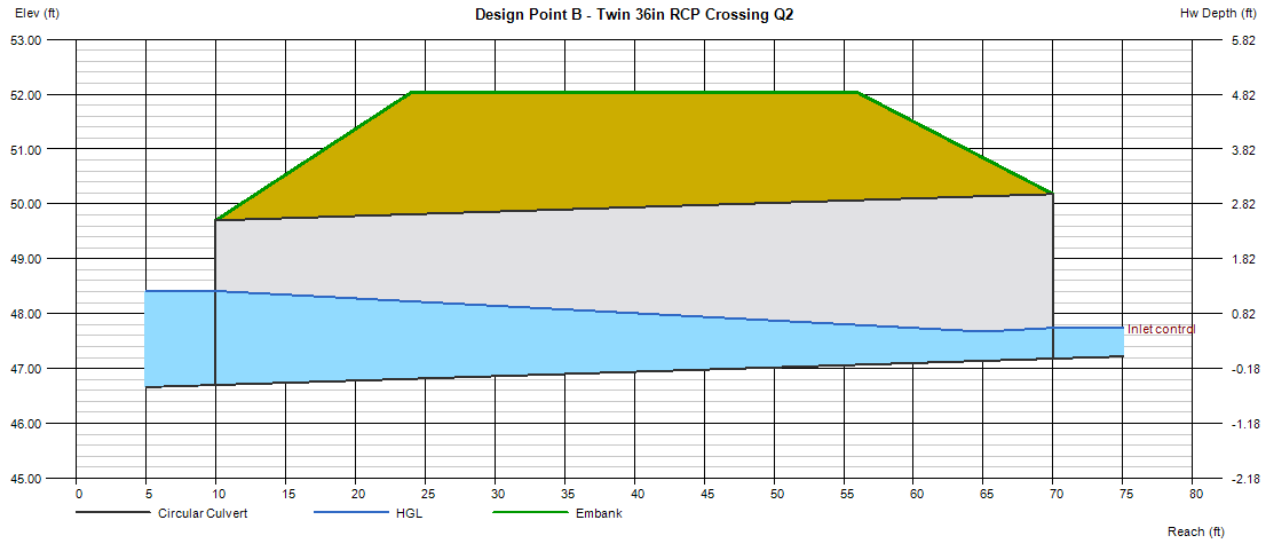
Calculations

Qmin (cfs)	=	3.77
Qmax (cfs)	=	3.77
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	3.77
Qpipe (cfs)	=	3.77
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	0.45
Veloc Up (ft/s)	=	3.07
HGL Dn (ft)	=	48.41
HGL Up (ft)	=	47.61
Hw Elev (ft)	=	47.74
Hw/D (ft)	=	0.19
Flow Regime	=	Inlet Control

Hw/D < 1.5



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Aug 24 2023

Design Point B - Twin 36in RCP Crossing Q100

Q100 with 20% clogging factor

Invert Elev Dn (ft)	= 46.70
Pipe Length (ft)	= 60.00
Slope (%)	= 0.80
Invert Elev Up (ft)	= 47.18
Rise (in)	= 36.0
Shape	= Circular
Span (in)	= 36.0
No. Barrels	= 2
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)	= 52.03
Top Width (ft)	= 32.00
Crest Width (ft)	= 10.00

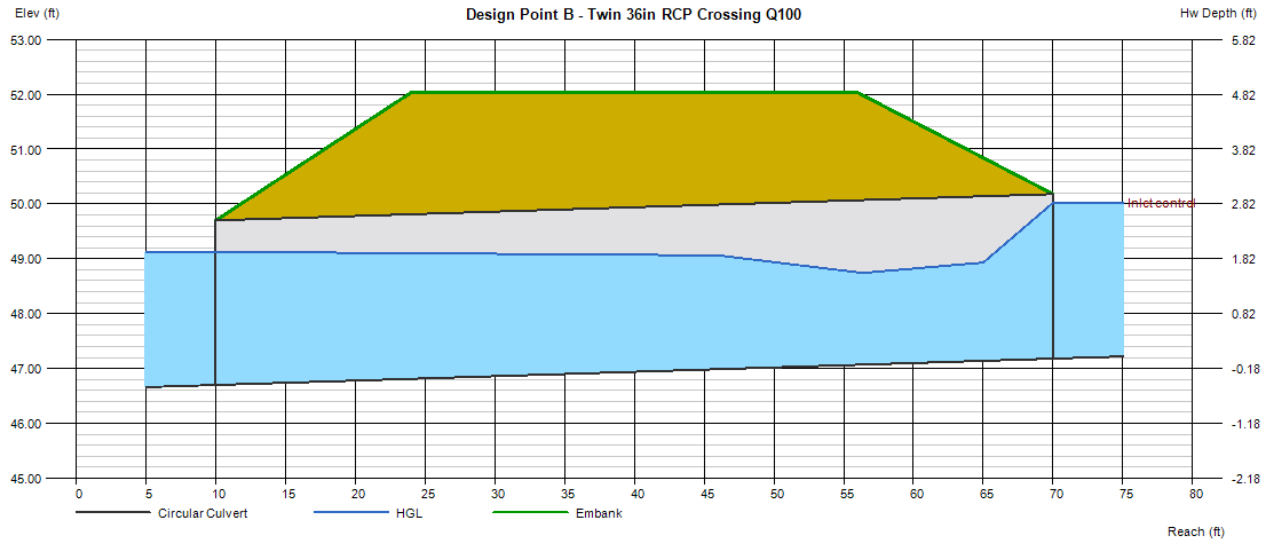
Calculations

Qmin (cfs)	= 65.38
Qmax (cfs)	= 65.38
Tailwater Elev (ft)	= (dc+D)/2

Highlighted

Qtotal (cfs)	= 65.38
Qpipe (cfs)	= 65.38
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 5.34
Veloc Up (ft/s)	= 7.10
HGL Dn (ft)	= 49.13
HGL Up (ft)	= 49.04
Hw Elev (ft)	= 50.02
Hw/D (ft)	= 0.95
Flow Regime	= Inlet Control

Hw/D < 1.5



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Aug 24 2023

Design Point C - Twin 36in RCP Crossing Q2

Q2 with 20% clogging factor

Invert Elev Dn (ft)	=	33.47
Pipe Length (ft)	=	63.70
Slope (%)	=	0.50
Invert Elev Up (ft)	=	33.79
Rise (in)	=	36.0
Shape	=	Circular
Span (in)	=	36.0
No. Barrels	=	2
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)	=	38.78
Top Width (ft)	=	32.00
Crest Width (ft)	=	10.00

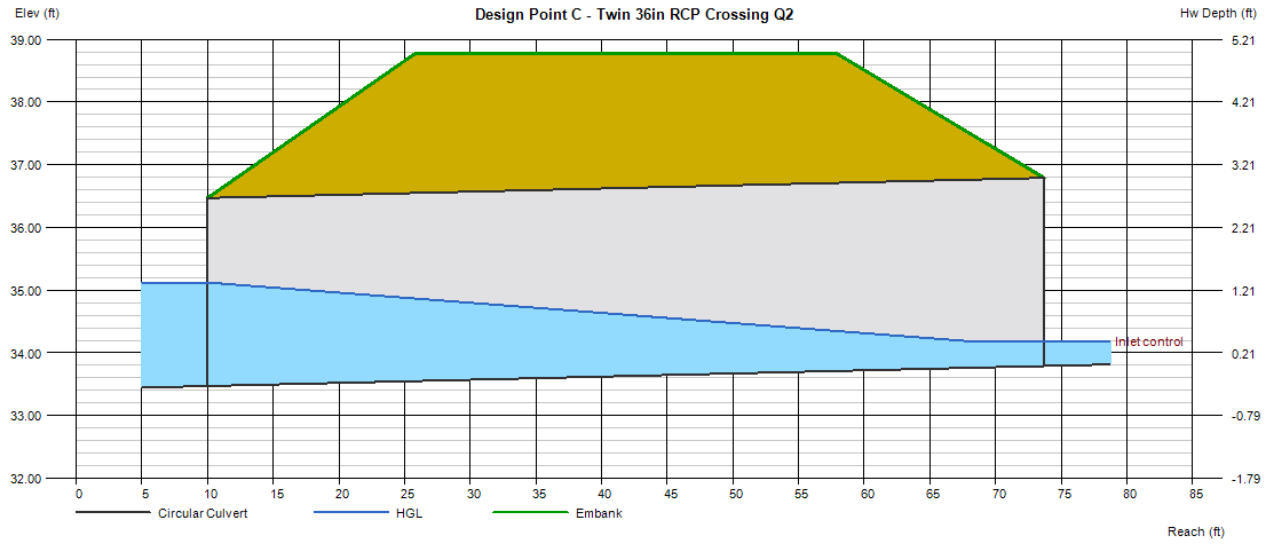
Calculations

Qmin (cfs)	=	1.92
Qmax (cfs)	=	1.92
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	1.92
Qpipe (cfs)	=	1.92
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	0.24
Veloc Up (ft/s)	=	2.58
HGL Dn (ft)	=	35.12
HGL Up (ft)	=	34.09
Hw Elev (ft)	=	34.19
Hw/D (ft)	=	0.13
Flow Regime	=	Inlet Control

Hw/D < 1.5



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Aug 24 2023

Design Point C - Twin 36in RCP Crossing Q100

Q100 with 20% clogging factor

Invert Elev Dn (ft)	=	33.47
Pipe Length (ft)	=	63.70
Slope (%)	=	0.50
Invert Elev Up (ft)	=	33.79
Rise (in)	=	36.0
Shape	=	Circular
Span (in)	=	36.0
No. Barrels	=	2
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)	=	38.78
Top Width (ft)	=	32.00
Crest Width (ft)	=	10.00

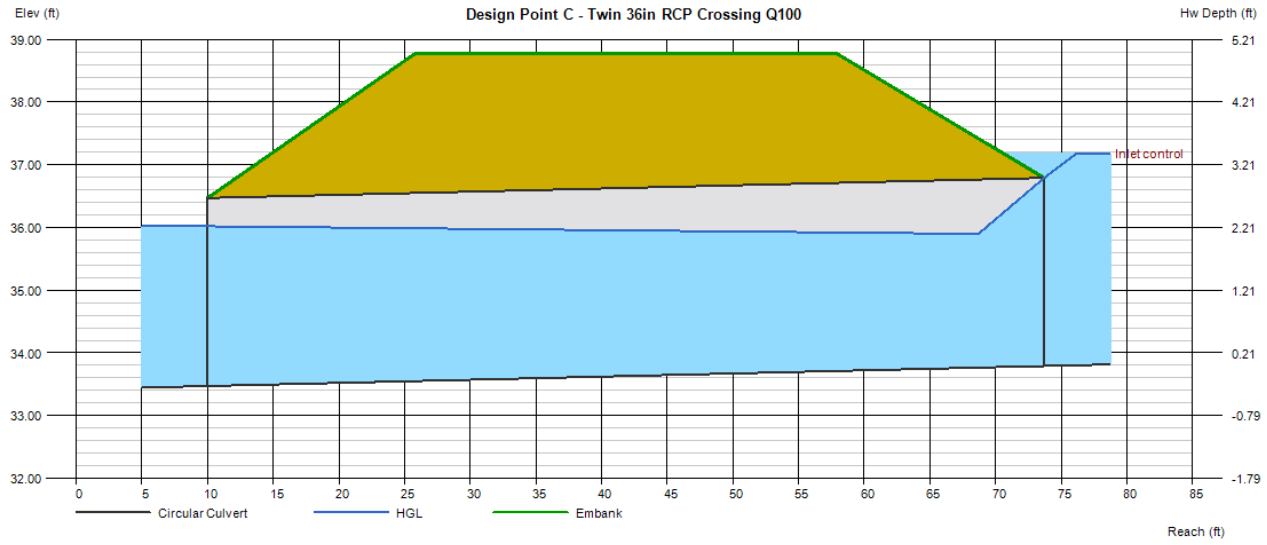
Calculations

Qmin (cfs)	=	83.12
Qmax (cfs)	=	83.12
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	83.12
Qpipe (cfs)	=	83.12
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	6.49
Veloc Up (ft/s)	=	7.87
HGL Dn (ft)	=	36.02
HGL Up (ft)	=	35.89
Hw Elev (ft)	=	37.18
Hw/D (ft)	=	1.13
Flow Regime	=	Inlet Control

Hw/D < 1.5



3.2.3 Rock Sizing for Riprap Apron and Low Tailwater Basin

Scour resulting from highly turbulent, rapidly decelerating flow is a common problem at conduit outlets. The following section summarizes the method for sizing riprap protection for both riprap aprons (Section 3.2.1) and low tailwater basins (Section 3.2.2).

Use Figure 9-38 to determine the required rock size for circular conduits and Figure 9-39 for rectangular conduits. Figure 9-38 is valid for $Q/D_c^{2.5}$ of 6.0 or less and Figure 9-39 is valid for $Q/WH^{1.5}$ of 8.0 or less. The parameters in these two figures are:

1. $Q/D^{1.5}$ or $Q/WH^{0.5}$ in which Q is the design discharge in cfs, D_c is the diameter of a circular conduit in feet, and W and H are the width and height of a rectangular conduit in feet.

2. Y_t/D_c or Y_t/H in which Y_t is the tailwater depth in feet, D_c is the diameter of a circular conduit in feet, and H is the height of a rectangular conduit in feet. In cases where Y_t is unknown or a hydraulic jump is suspected downstream of the outlet, use $Y_t/D_t = Y_t/H = 0.40$ when using Figures 9-38 and 9-39.

3. The riprap size requirements in Figures 9-38 and 9-39 are based on the non-dimensional parametric Equations 9-16 and 9-17 (Steven, Simons, and Watts 1971 and Smith 1975).

Circular culvert:

$$d_{50} = \frac{0.023Q}{Y_t^{1.2} D_c^{0.3}} \qquad \text{Equation 9-16}$$

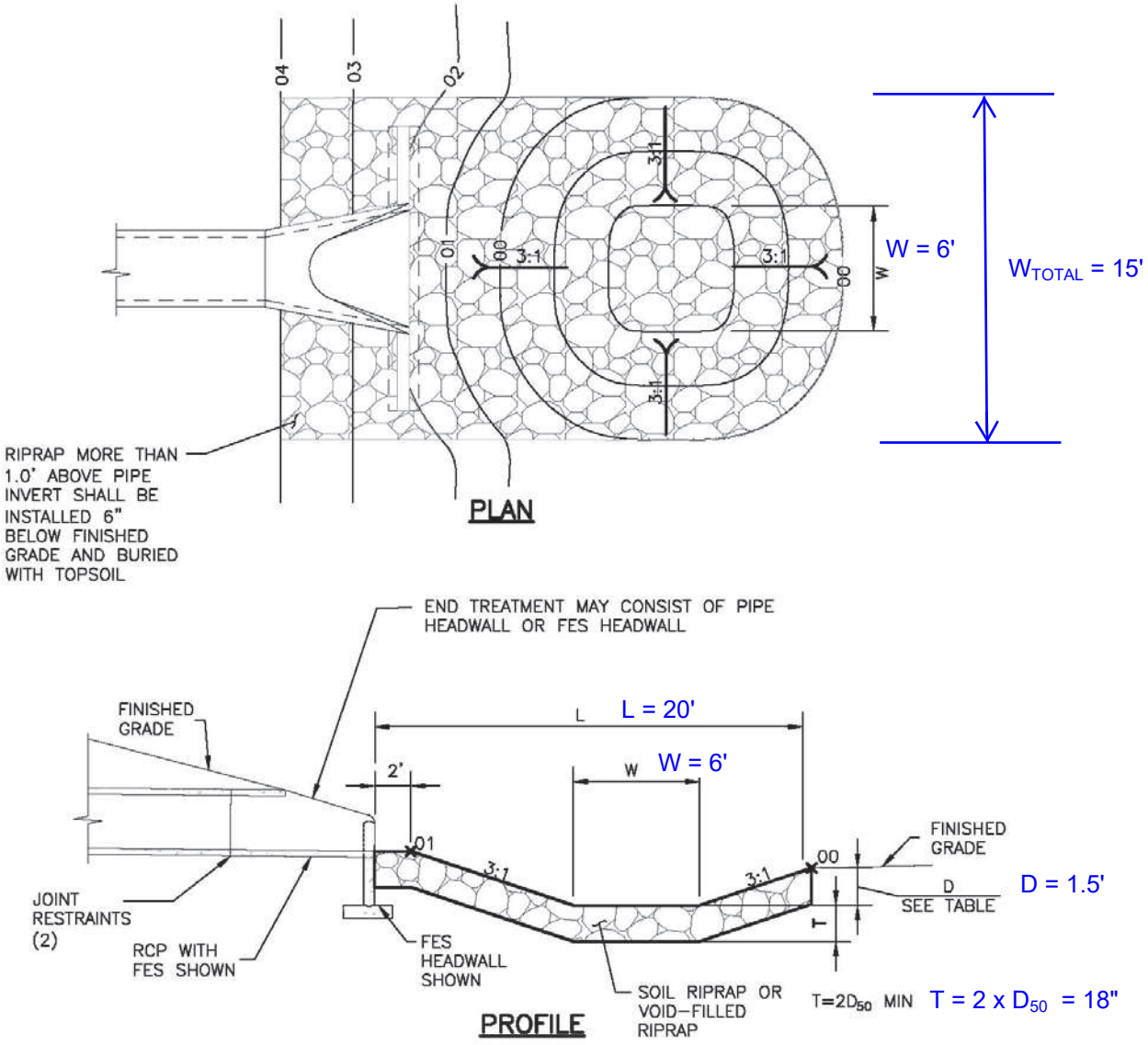
Rectangular culvert:

$$d_{50} = \frac{0.014H^{0.5}Q}{Y_t W} \qquad \text{Equation 9-17}$$

These rock size requirements assume that the flow in the culvert is subcritical. It is possible to use Equations 9-16 and 9-17 when the flow in the culvert is supercritical (and less than full) if the value of D_c or H is modified for use in Figures 9-38 and 9-39. Note that rock sizes referenced in these figures are defined in the *Open Channels* chapter. Whenever the flow is supercritical in the culvert, substitute D_a for D_c and H_a for H, in which D_a is defined as:

$$D_a = \frac{(D_c + Y_n)}{2} \qquad \text{Equation 9-18}$$

Where the maximum value of D_a shall not exceed D_c, and



PIPE SIZE OR BOX HEIGHT	D	W*	L
18" – 24"	1'–0"	4'	15'
30" – 36"	1'–6"	6'	20'
42" – 48"	2'–0"	7'	24'
54" – 60"	2'–6"	8'	28'
66" – 72"	3'–0"	9'	32'

* IF OUTLET PIPE IS A BOX CULVERT WITH A WIDTH GREATER THAN W, THEN W = CULVERT WIDTH

Figure 9-37. Low tailwater riprap basin

$$H_a = \frac{(H + Y_n)}{2}$$ Equation 9-19

Where the maximum value of H_a shall not exceed H, and:

D_a = parameter to use in place of D in Figure 9-38 when flow is supercritical (ft)

D_c = diameter of circular culvert (ft)

H_a = parameter to use in place of H in Figure 9-39 when flow is supercritical (ft)

H = height of rectangular culvert (ft)

Y_n = normal depth of supercritical flow in the culvert (ft)

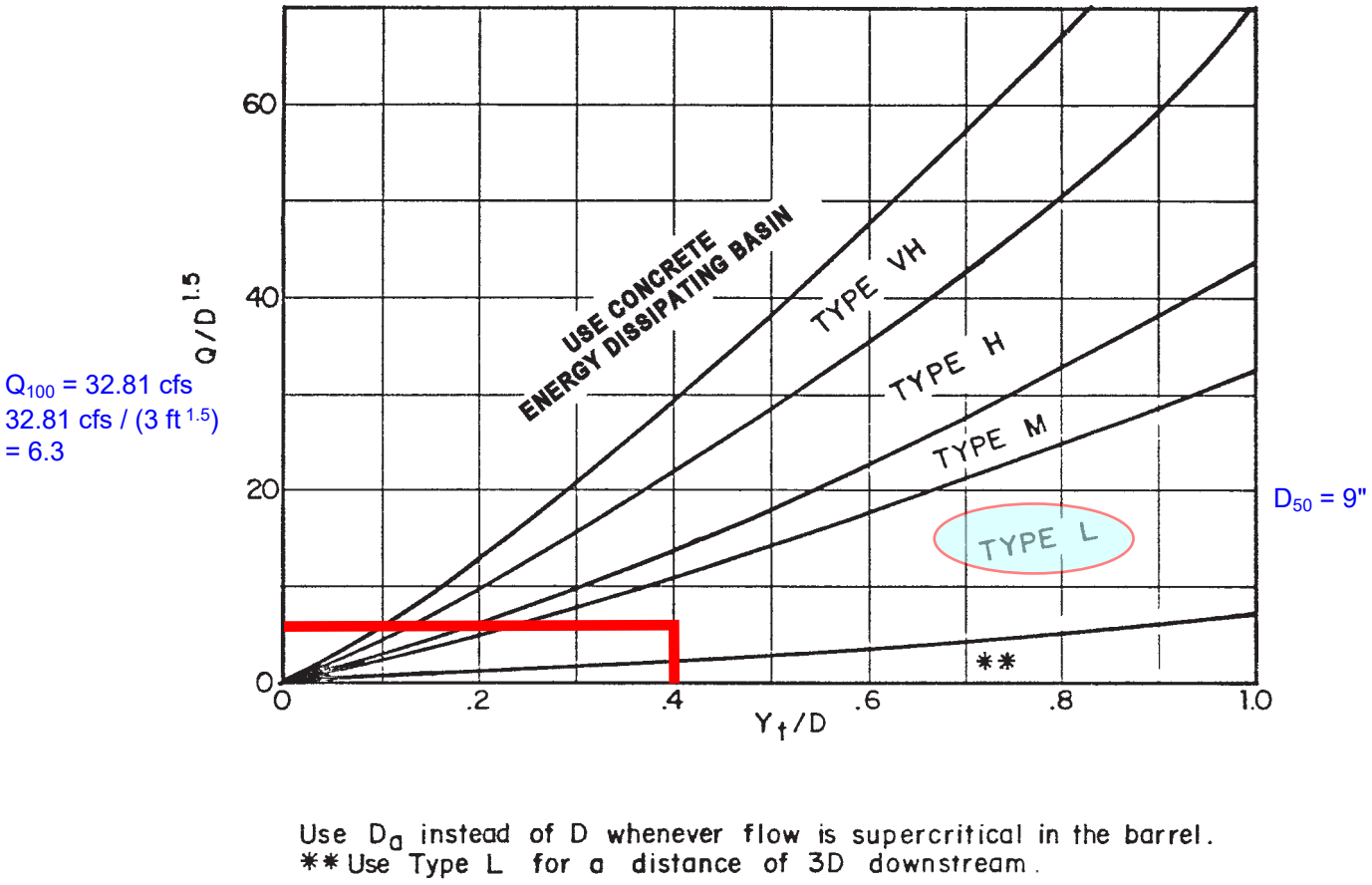
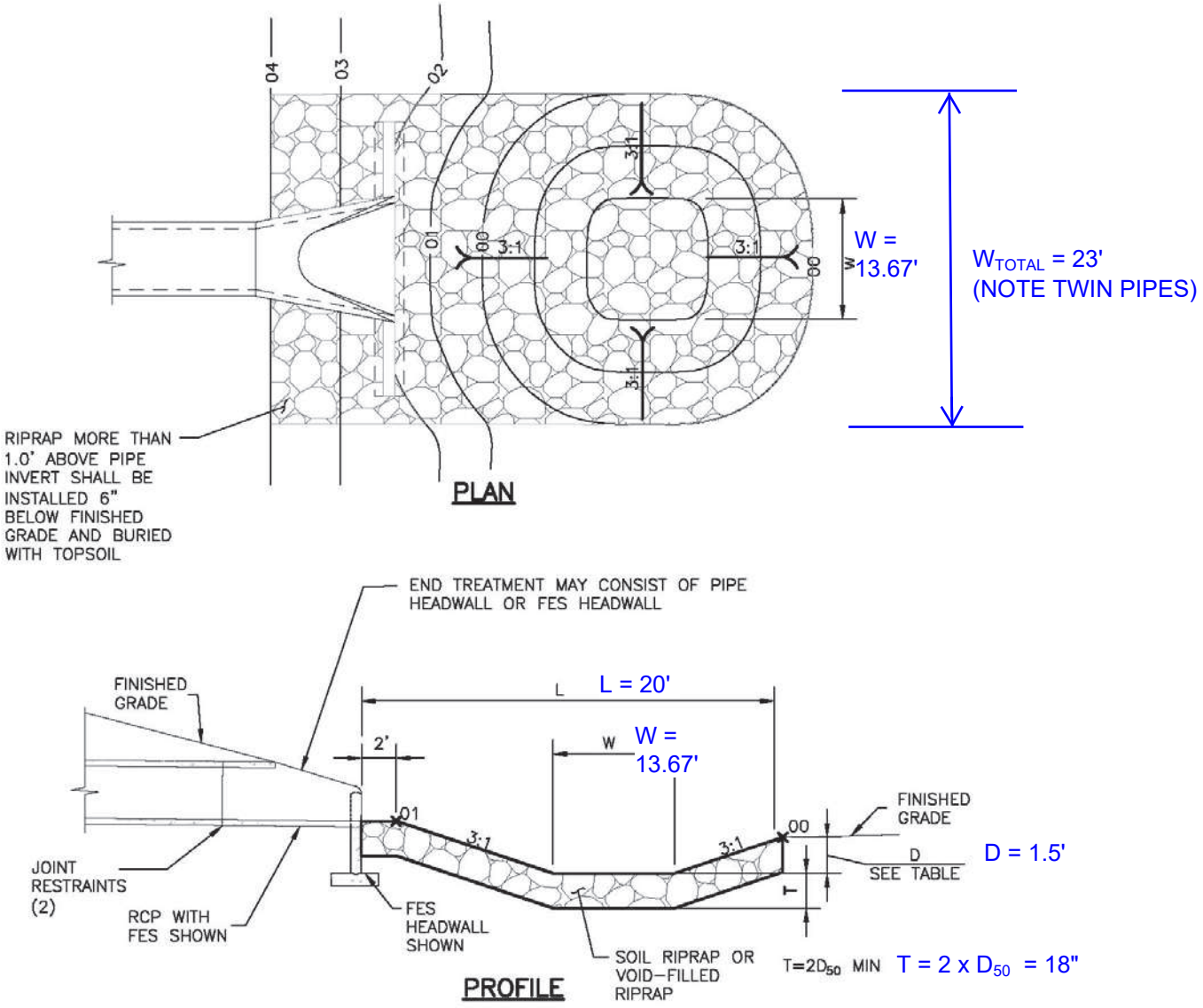


Figure 9-38. Riprap erosion protection at circular conduit outlet (valid for Q/D2.5 ≤ 6.0)



PIPE SIZE OR BOX HEIGHT	D	W*	L
18" – 24"	1'–0"	4'	15'
30" – 36"	1'–6"	6'	20'
42" – 48"	2'–0"	7'	24'
54" – 60"	2'–6"	8'	28'
66" – 72"	3'–0"	9'	32'

* IF OUTLET PIPE IS A BOX CULVERT WITH A WIDTH GREATER THAN W, THEN W = CULVERT WIDTH

Figure 9-37. Low tailwater riprap basin

$$H_a = \frac{(H + Y_n)}{2}$$ Equation 9-19

Where the maximum value of H_a shall not exceed H, and:

D_a = parameter to use in place of D in Figure 9-38 when flow is supercritical (ft)

D_c = diameter of circular culvert (ft)

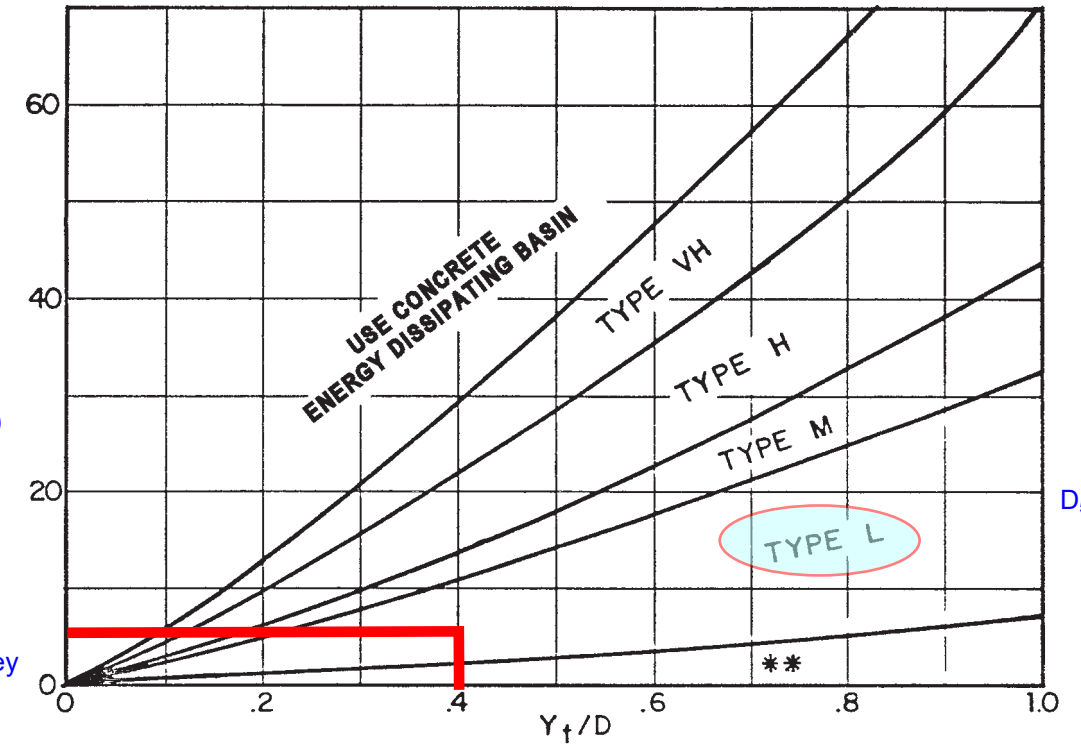
H_a = parameter to use in place of H in Figure 9-39 when flow is supercritical (ft)

H = height of rectangular culvert (ft)

Y_n = normal depth of supercritical flow in the culvert (ft)

Q_{100}*= 27.24 cfs
27.24 cfs / (3 ft $^{1.5}$)
= 5.24

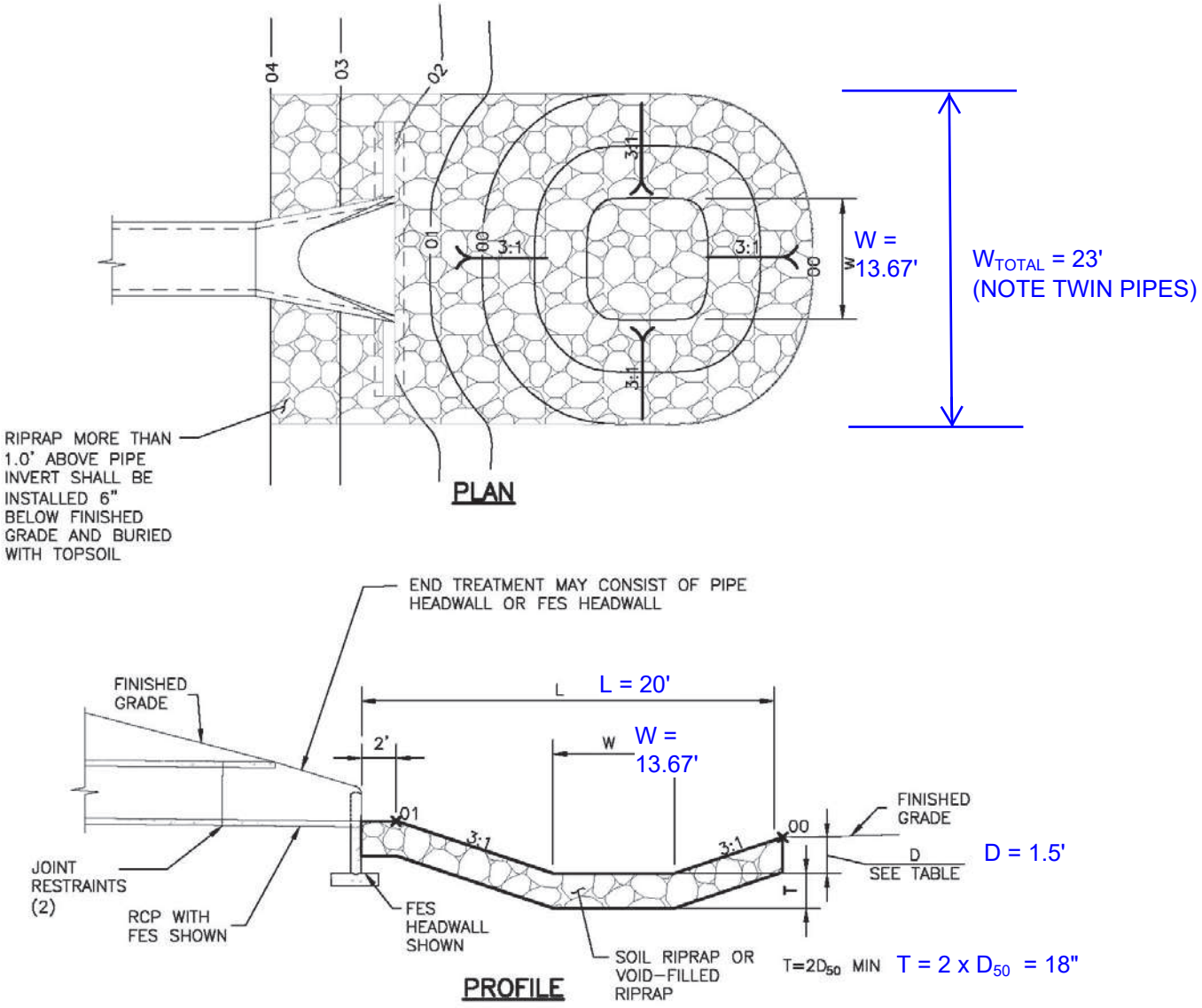
Q_{100} = 54.48 cfs divided by 2 to represent twin pipes, each assumed to convey 1/2 the flow



D_{50} = 9"

Use D_a instead of D whenever flow is supercritical in the barrel.
** Use Type L for a distance of 3D downstream.

Figure 9-38. Riprap erosion protection at circular conduit outlet (valid for Q/D2.5 ≤ 6.0)



PIPE SIZE OR BOX HEIGHT	D	W*	L
18" – 24"	1'–0"	4'	15'
30" – 36"	1'–6"	6'	20'
42" – 48"	2'–0"	7'	24'
54" – 60"	2'–6"	8'	28'
66" – 72"	3'–0"	9'	32'

* IF OUTLET PIPE IS A BOX CULVERT WITH A WIDTH GREATER THAN W, THEN W = CULVERT WIDTH

Figure 9-37. Low tailwater riprap basin

$$H_a = \frac{(H + Y_n)}{2}$$ Equation 9-19

Where the maximum value of H_a shall not exceed H, and:

D_a = parameter to use in place of D in Figure 9-38 when flow is supercritical (ft)

D_c = diameter of circular culvert (ft)

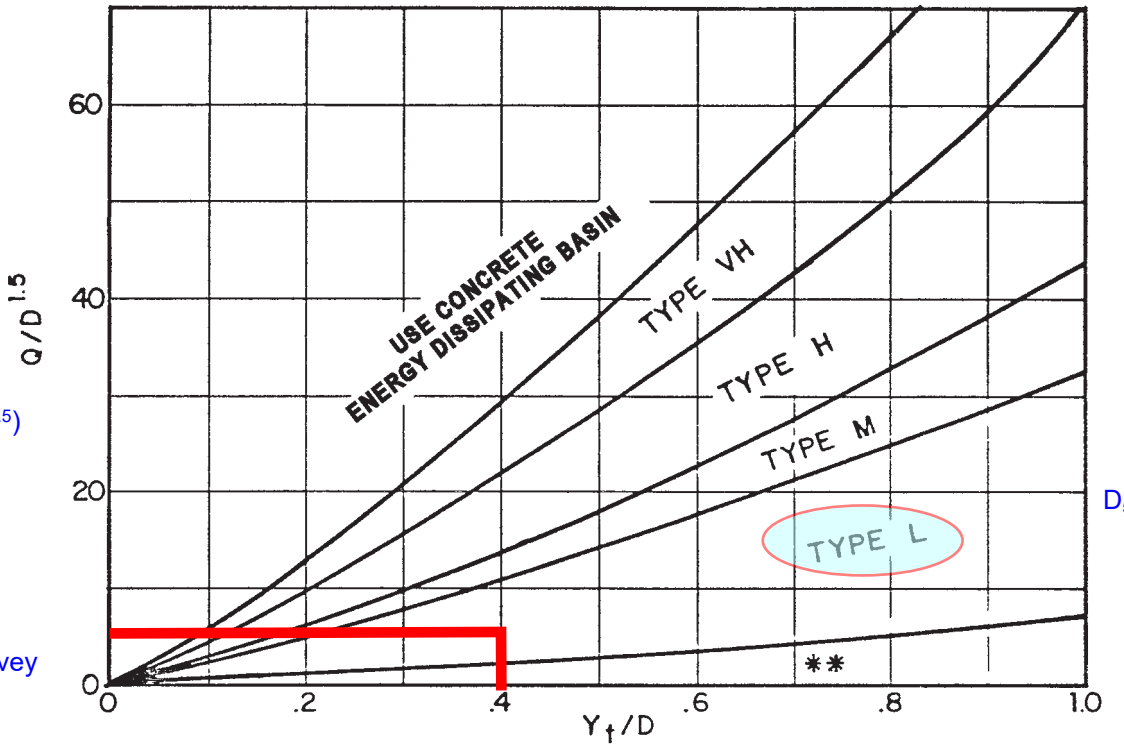
H_a = parameter to use in place of H in Figure 9-39 when flow is supercritical (ft)

H = height of rectangular culvert (ft)

Y_n = normal depth of supercritical flow in the culvert (ft)

Q_{100}*= 34.64 cfs
34.64 cfs / (3 ft $^{1.5}$)
= 6.67

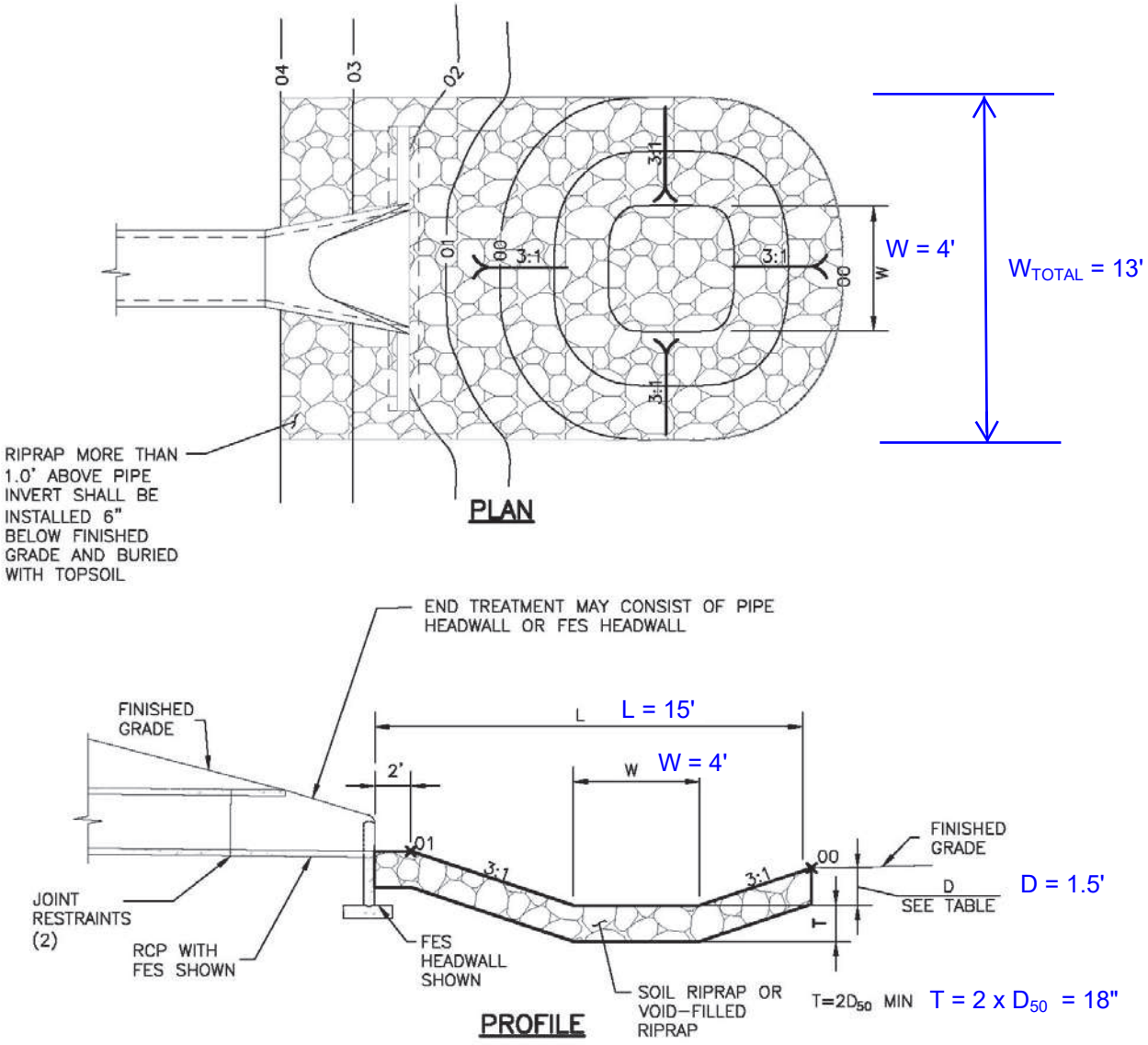
Q_{100} = 69.27 cfs divided by 2 to represent twin pipes, each assumed to convey 1/2 the flow



D_{50} = 9"

Use D_a instead of D whenever flow is supercritical in the barrel.
** Use Type L for a distance of 3D downstream.

Figure 9-38. Riprap erosion protection at circular conduit outlet (valid for Q/D2.5 ≤ 6.0)



PIPE SIZE OR BOX HEIGHT	D	W*	L
18" – 24"	1'–0"	4'	15'
30" – 36"	1'–6"	6'	20'
42" – 48"	2'–0"	7'	24'
54" – 60"	2'–6"	8'	28'
66" – 72"	3'–0"	9'	32'

* IF OUTLET PIPE IS A BOX CULVERT WITH A WIDTH GREATER THAN W, THEN W = CULVERT WIDTH

Figure 9-37. Low tailwater riprap basin

Culvert Report

18in CMP Max Q Capacity

$Q_{CAPACITY(MAX)}$ = 14.35 cfs
FOR USE ON NEXT PAGE

Invert Elev Dn (ft)	=	78.62
Pipe Length (ft)	=	46.24
Slope (%)	=	1.77
Invert Elev Up (ft)	=	79.44
Rise (in)	=	18.0
Shape	=	Circular
Span (in)	=	18.0
No. Barrels	=	2
n-Value	=	0.013
Culvert Type	=	Circular Corrugate Metal Pipe
Culvert Entrance	=	Mitered to slope (C)
Coeff. K,M,c,Y,k	=	0.021, 1.33, 0.0463, 0.75, 0.7

Embankment

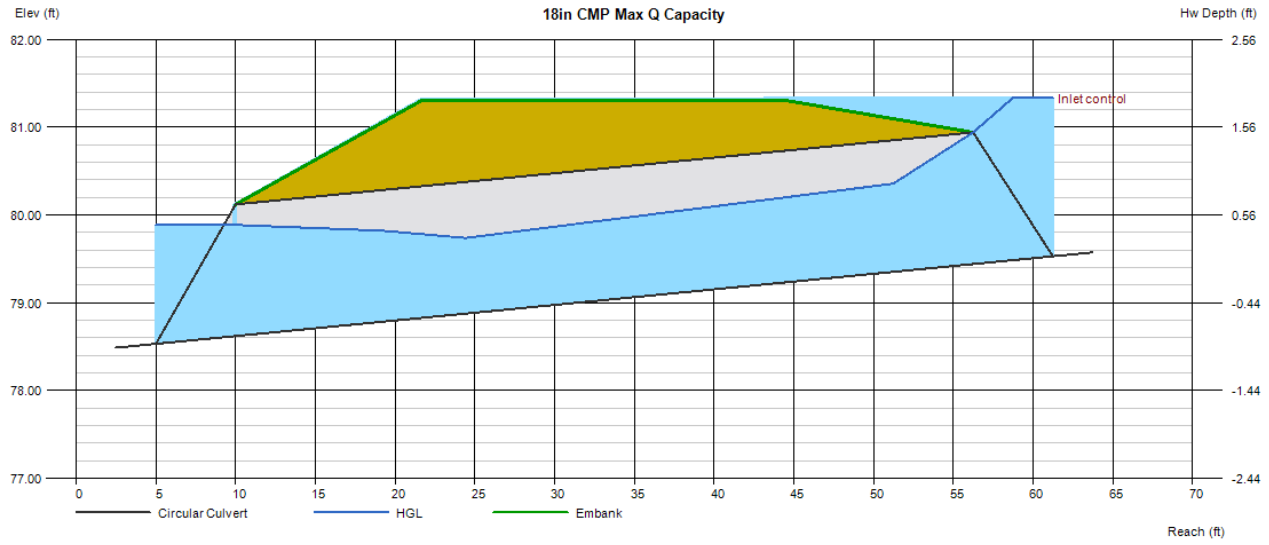
Top Elevation (ft)	=	81.30
Top Width (ft)	=	23.00
Crest Width (ft)	=	10.00

Calculations

Qmin (cfs)	=	14.35
Qmax (cfs)	=	14.35
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	14.35
Qpipe (cfs)	=	14.23
Qovertop (cfs)	=	0.12
Veloc Dn (ft/s)	=	4.47
Veloc Up (ft/s)	=	5.49
HGL Dn (ft)	=	79.89
HGL Up (ft)	=	80.47
Hw Elev (ft)	=	81.33
Hw/D (ft)	=	1.26
Flow Regime	=	Inlet Control



$$H_a = \frac{(H + Y_n)}{2}$$ Equation 9-19

Where the maximum value of H_a shall not exceed H, and:

D_a = parameter to use in place of D in Figure 9-38 when flow is supercritical (ft)

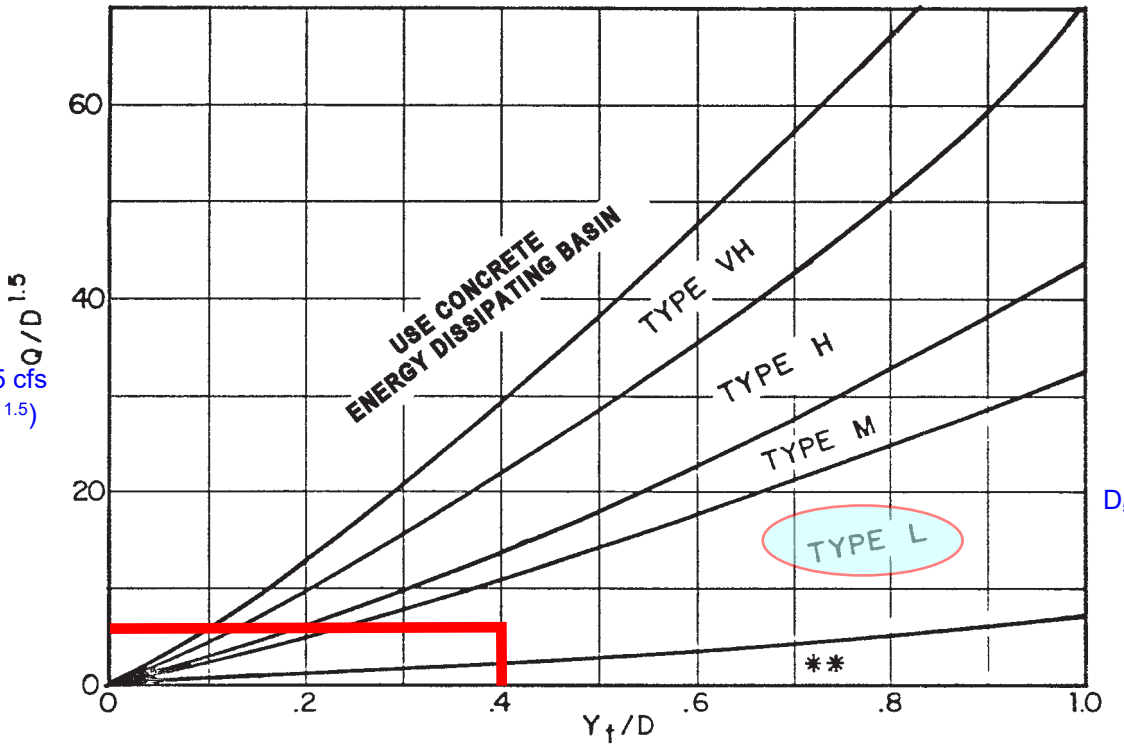
D_c = diameter of circular culvert (ft)

H_a = parameter to use in place of H in Figure 9-39 when flow is supercritical (ft)

H = height of rectangular culvert (ft)

Y_n = normal depth of supercritical flow in the culvert (ft)

$Q_{CAPACITY}$ = 14.35 cfs
14.35 cfs / (1.5 ft $^{1.5}$)
= 7.8



D_{50} = 9"

Use D_a instead of D whenever flow is supercritical in the barrel.
** Use Type L for a distance of 3D downstream.

Figure 9-38. Riprap erosion protection at circular conduit outlet (valid for Q/D2.5 ≤ 6.0)

SUB-BASIN MAP 2

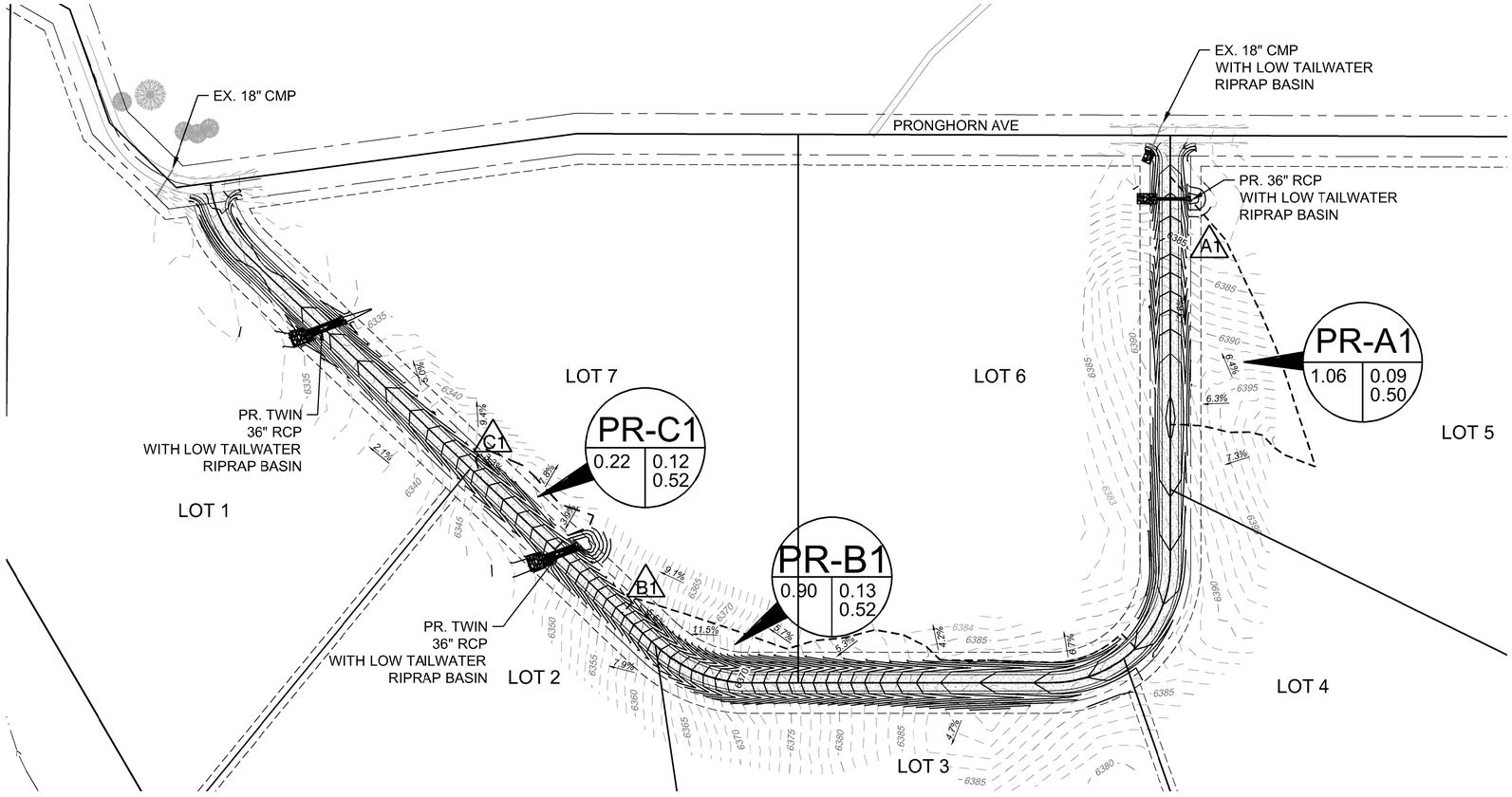
PROPOSED CONDITIONS

A PART OF SECTION 16, TOWNSHIP 7 SOUTH, RANGE 64 WEST OF THE 6TH PRINCIPAL MERIDIAN, COUNTY OF ELBERT, STATE OF COLORADO.

LEGEND

- 6550 — EXISTING MAJOR CONTOUR
- 6551 — EXISTING MINOR CONTOUR
- 6551 — PROPOSED MAJOR CONTOUR
- 6551 — PROPOSED MINOR CONTOUR
- EX/PR DRAINAGE BASIN LINES

PR-A
BASIN AREA (ac): 1.76
2 YR RUNOFF COEFFICIENT: 0.08
100 YR RUNCFF COEFFICIENT: 0.49
BASIN NAME
BASIN DESIGN POINT: 1



Summary Runoff Table - Proposed Conditions, Roadside Swale

DESIGN POINT	CONTRIBUTING BASIN(S)	CONTRIBUTING AREA (AC)	Q_2 (cfs)	Q_{100} (cfs)	NOTES:
A1	A1	1.06	0.21	3.02	Flows to Roadside Swale
B1	B1	0.90	0.29	3.04	Flows to Roadside Swale
C1	C1	0.22	0.07	0.85	Flows to Roadside Swale

0 100' 200'
SCALE: 1" = 100'

2N CIVIL
303.925.0544
www.2ncivil.com

PREPARED FOR:
PHANTOM CREEK
DEVLOPMENT, LLC
39622 COUNTY ROAD 21
MILLIKEN, CO 80543

DRAINAGE BASIN MAP
PHASE 1 DRAINAGE REPORT
PHANTOM CREEK RANCH
ELBERT COUNTY, COLORADO

DATE:
BY:
REVISIONS:
1.
2.
3.
4.

PROJECT NUMBER: 22010
ISSUED DATE: 06-14-2024
DESIGNED BY: TEW
REVIEWED BY: EPT

SUB-BASIN MAP 2

1

J:\Projects\22\22010\Dwg\CD\PR BASIN MAP 2.dwg 6/6/2024

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Nov 13 2023

Roadside Swale Design Point A1 - Q2

Triangular

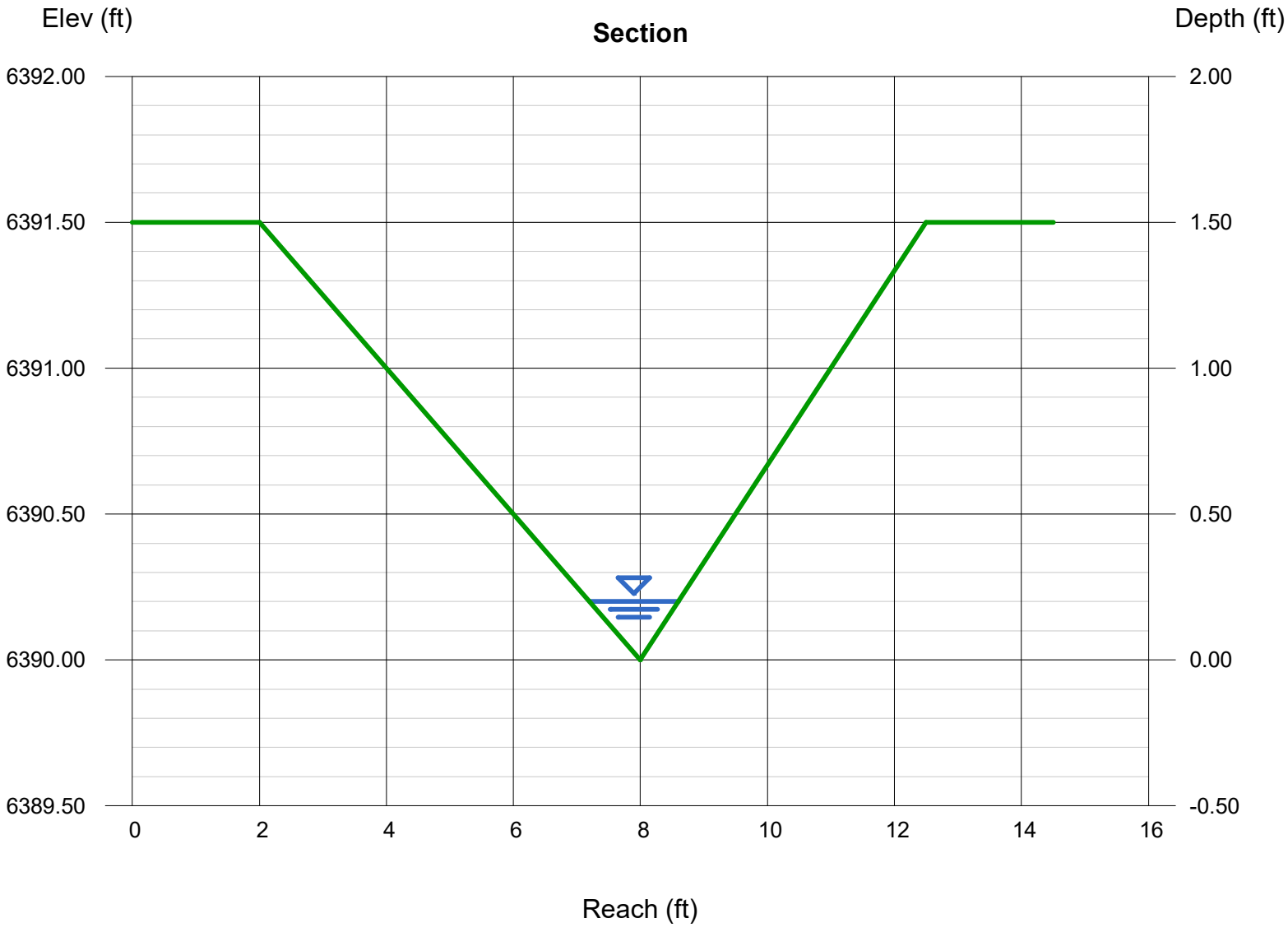
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 1.50
Invert Elev (ft)	= 6390.00
Slope (%)	= 3.66
N-Value	= 0.035

Calculations

Compute by:	Known Q
Known Q (cfs)	= 0.21

Highlighted

Depth (ft)	= 0.20
Q (cfs)	= 0.210
Area (sqft)	= 0.14
Velocity (ft/s)	= 1.50
Wetted Perim (ft)	= 1.46
Crit Depth, Yc (ft)	= 0.19
Top Width (ft)	= 1.40
EGL (ft)	= 0.23



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Nov 13 2023

Roadside Swale Design Point A1 - Q100

Triangular

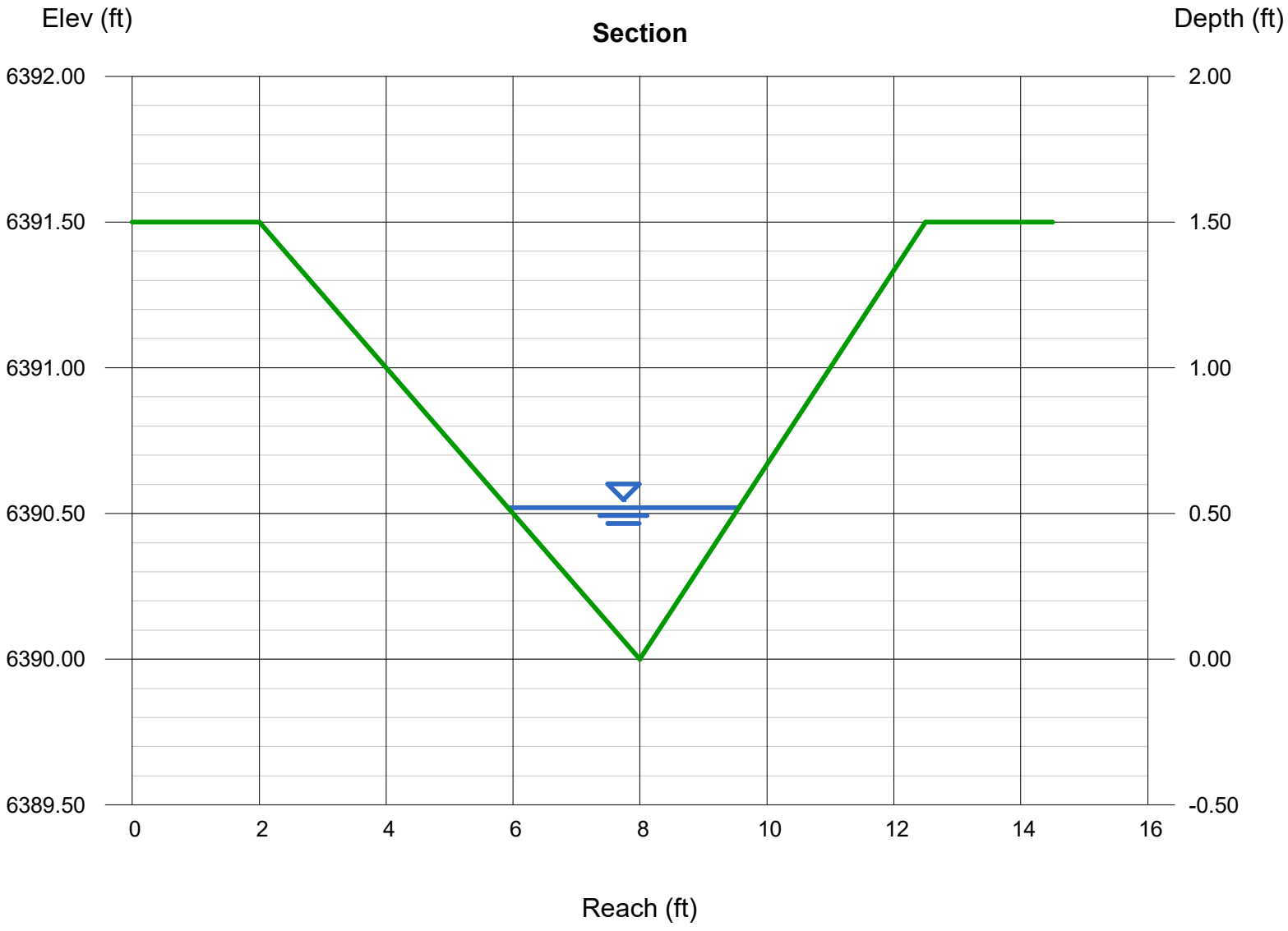
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 1.50
Invert Elev (ft)	= 6390.00
Slope (%)	= 3.66
N-Value	= 0.035

Calculations

Compute by:	Known Q
Known Q (cfs)	= 3.02

Highlighted

Depth (ft)	= 0.52
Q (cfs)	= 3.020
Area (sqft)	= 0.95
Velocity (ft/s)	= 3.19
Wetted Perim (ft)	= 3.79
Crit Depth, Yc (ft)	= 0.55
Top Width (ft)	= 3.64
EGL (ft)	= 0.68



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Nov 13 2023

Roadside Swale Design Point B1 - Q2

Triangular

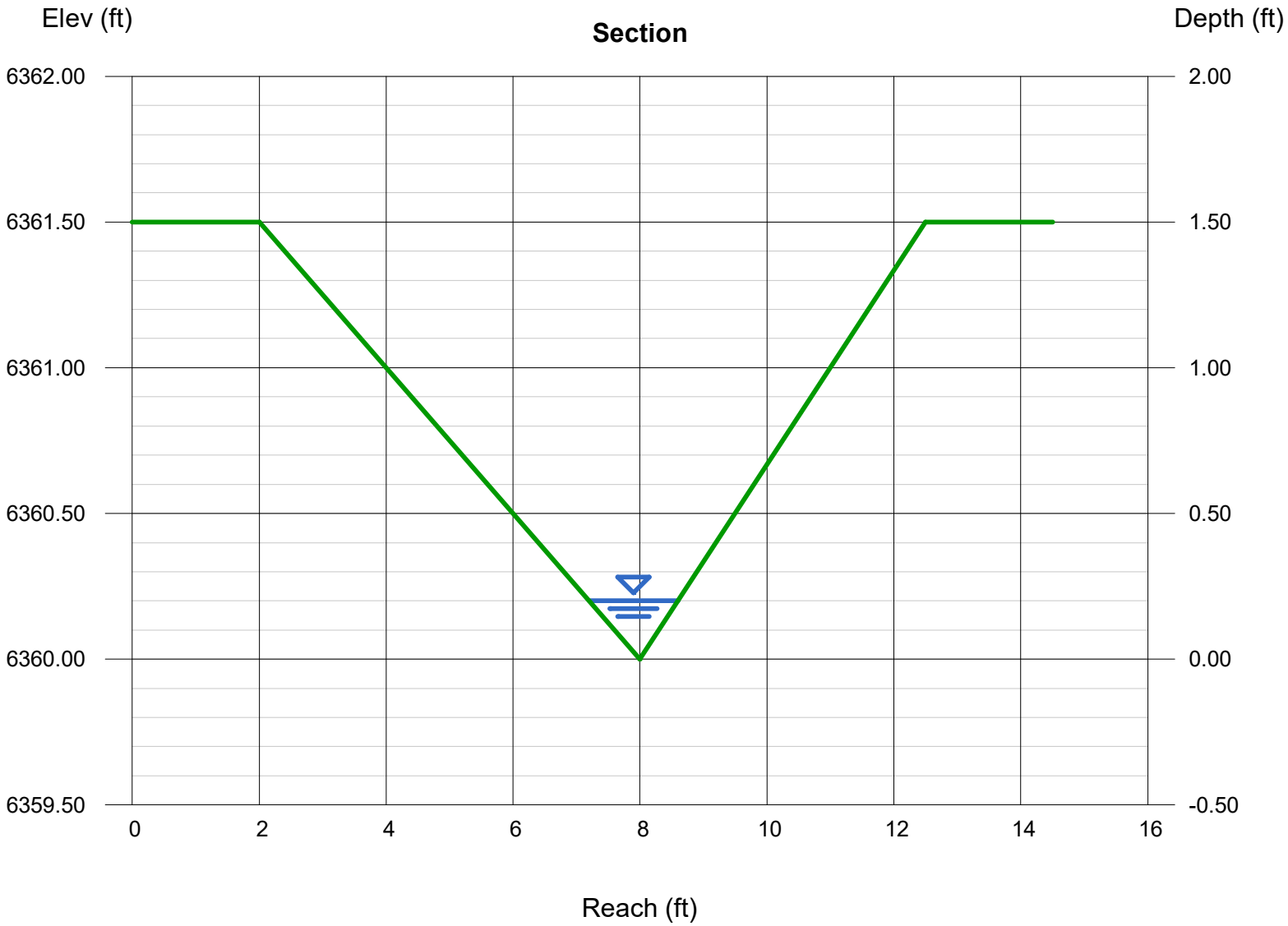
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 1.50
Invert Elev (ft)	= 6360.00
Slope (%)	= 5.50
N-Value	= 0.035

Calculations

Compute by:	Known Q
Known Q (cfs)	= 0.29

Highlighted

Depth (ft)	= 0.20
Q (cfs)	= 0.290
Area (sqft)	= 0.14
Velocity (ft/s)	= 2.07
Wetted Perim (ft)	= 1.46
Crit Depth, Yc (ft)	= 0.22
Top Width (ft)	= 1.40
EGL (ft)	= 0.27



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Nov 13 2023

Roadside Swale Design Point B1 - Q100

Triangular

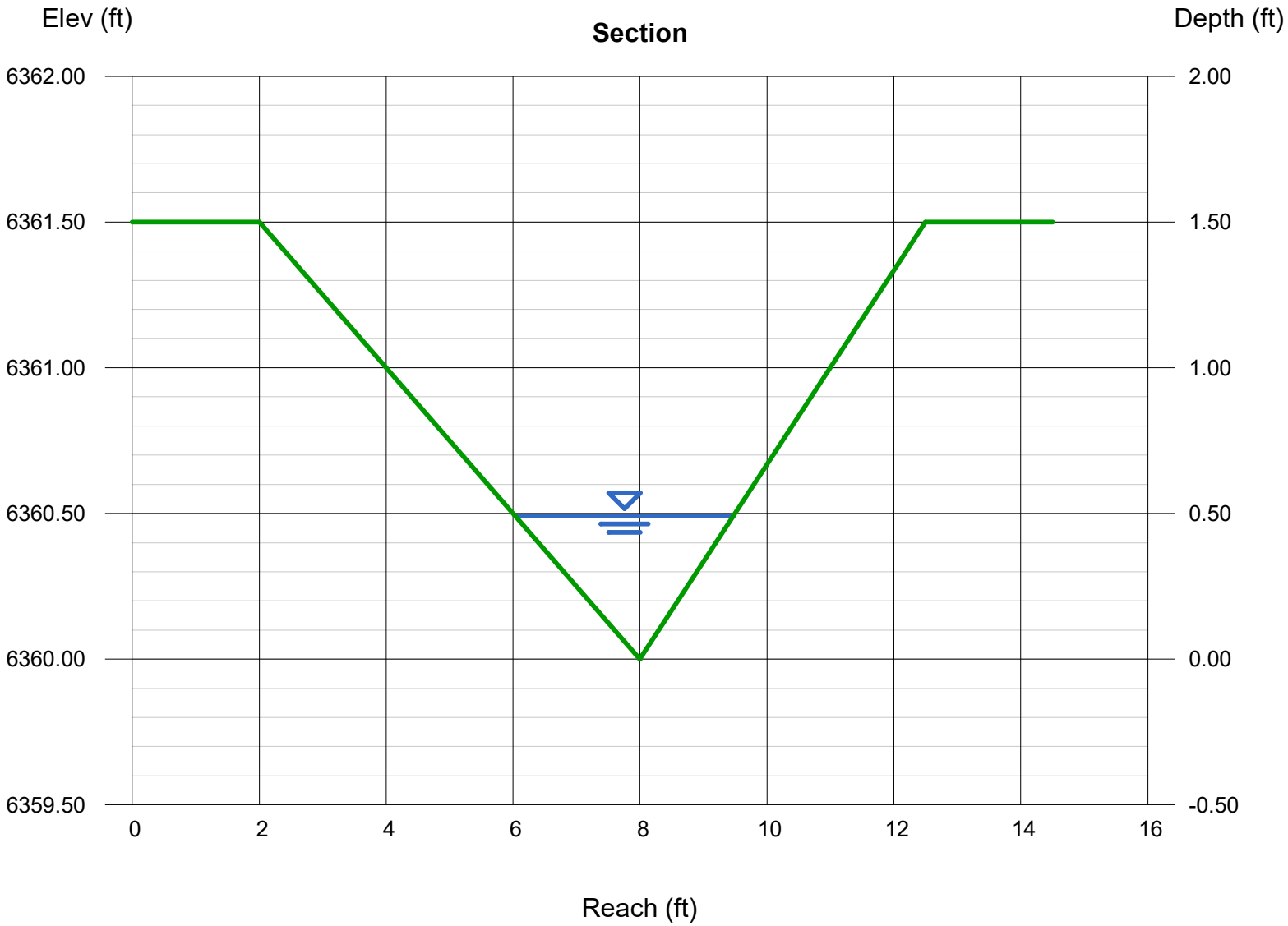
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 1.50
Invert Elev (ft)	= 6360.00
Slope (%)	= 5.50
N-Value	= 0.035

Calculations

Compute by:	Known Q
Known Q (cfs)	= 3.04

Highlighted

Depth (ft)	= 0.49
Q (cfs)	= 3.040
Area (sqft)	= 0.84
Velocity (ft/s)	= 3.62
Wetted Perim (ft)	= 3.57
Crit Depth, Yc (ft)	= 0.55
Top Width (ft)	= 3.43
EGL (ft)	= 0.69



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Nov 13 2023

Roadside Swale Design Point C1 - Q2

Triangular

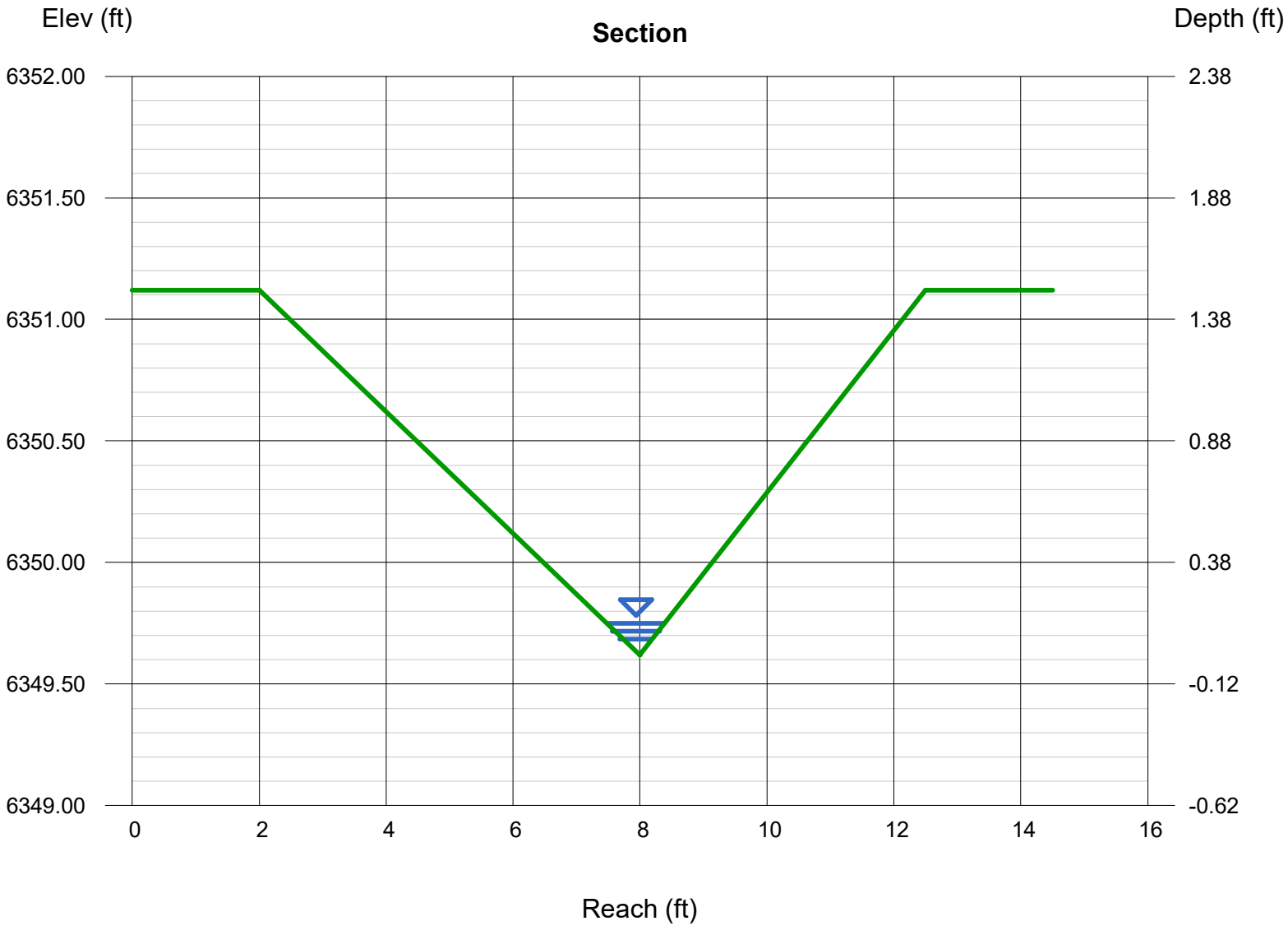
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 1.50
Invert Elev (ft)	= 6349.62
Slope (%)	= 3.33
N-Value	= 0.035

Calculations

Compute by:	Known Q
Known Q (cfs)	= 0.07

Highlighted

Depth (ft)	= 0.13
Q (cfs)	= 0.070
Area (sqft)	= 0.06
Velocity (ft/s)	= 1.18
Wetted Perim (ft)	= 0.95
Crit Depth, Yc (ft)	= 0.12
Top Width (ft)	= 0.91
EGL (ft)	= 0.15



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Nov 13 2023

Roadside Swale Design Point C1 - Q100

Triangular

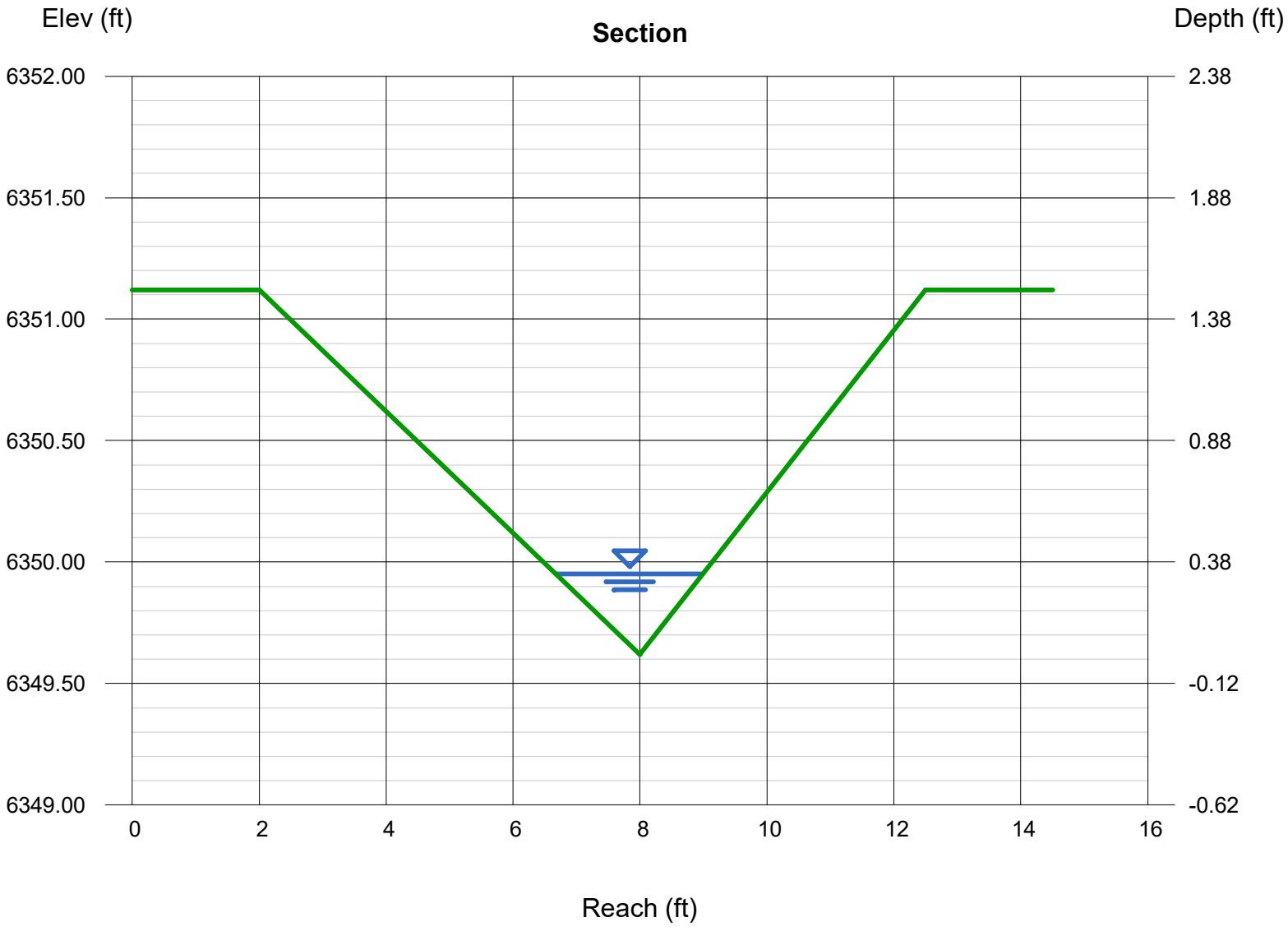
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 1.50
Invert Elev (ft)	= 6349.62
Slope (%)	= 3.33
N-Value	= 0.035

Calculations

Compute by:	Known Q
Known Q (cfs)	= 0.85

Highlighted

Depth (ft)	= 0.33
Q (cfs)	= 0.850
Area (sqft)	= 0.38
Velocity (ft/s)	= 2.23
Wetted Perim (ft)	= 2.40
Crit Depth, Yc (ft)	= 0.33
Top Width (ft)	= 2.31
EGL (ft)	= 0.41



Appendix E
Conceptual Pond Calculations

Phantom Creek - Stormwater Calculations

Proposed Conditions - Composite %I for Conceptual Pond Sizing

14-Jun-24

Lot 1

Land Use	Area (sf)	Area (ac)	% I
Roof	5,000	0.11	90%
Gravel driveway (packed)	2,400	0.06	40%
Native/Landsaped Area	2,000	0.05	2%
Gravel access road (packed)	9,221	0.21	40%
Sum Area =	18,621	0.43	
Composite % =			49.34%

Lot 2

Land Use	Area (sf)	Area (ac)	% I
Roof	5,000	0.11	90%
Gravel driveway (packed)	2,400	0.06	40%
Native/Landsaped Area	2,000	0.05	2%
Gravel access road (packed)	6,173	0.14	40%
Sum Area =	15,573	0.36	
Composite % =			51.17%

Lot 3

Land Use	Area (sf)	Area (ac)	% I
Roof	5,000	0.11	90%
Gravel driveway (packed)	2,400	0.06	40%
Native/Landsaped Area	2,000	0.05	2%
Gravel access road (packed)	11,374	0.26	40%
Sum Area =	20,774	0.48	
Composite % =			48.38%

Lot 4

Land Use	Area (sf)	Area (ac)	% I
Roof	5,000	0.11	90%
Gravel driveway (packed)	2,400	0.06	40%
Native/Landsaped Area	2,000	0.05	2%
Gravel access road (packed)	4,426	0.10	40%
Sum Area =	13,826	0.32	
Composite % =			52.58%

Phantom Creek - Stormwater Calculations

Proposed Conditions - Composite %I for Conceptual Pond Sizing

14-Jun-24

Lot 5

Land Use	Area (sf)	Area (ac)	% I
Roof	5,000	0.11	90%
Gravel driveway (packed)	2,400	0.06	40%
Native/Landsaped Area	2,000	0.05	2%
Gravel access road (packed)	8,399	0.19	40%
Sum Area =	17,799	0.41	
Composite % =			49.78%

Lot 6

Land Use	Area (sf)	Area (ac)	% I
Roof	5,000	0.11	90%
Gravel driveway (packed)	2,400	0.06	40%
Native/Landsaped Area	2,000	0.05	2%
Gravel access road (packed)	20,263	0.47	40%
Sum Area =	29,663	0.68	
Composite % =			45.87%

Lot 7

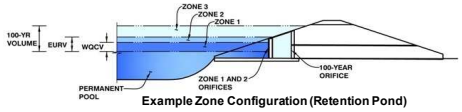
Land Use	Area (sf)	Area (ac)	% I
Roof	5,000	0.11	90%
Gravel driveway (packed)	2,400	0.06	40%
Native/Landsaped Area	2,000	0.05	2%
Gravel access road (packed)	18,672	0.43	40%
Sum Area =	28,072	0.64	
Composite % =			46.20%

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Phantom Creek Ranch**

Basin ID: **Conceptual Detention Design for Lot 1 (Type A Soils)**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	0.43	acres
Watershed Length =	200	ft
Watershed Length to Centroid =	100	ft
Watershed Slope =	0.050	ft/ft
Watershed Imperviousness =	49.34%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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) =	0.007	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.024	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1 in.) =	0.014	acre-feet	1.00	inches
5-yr Runoff Volume (P1 = 1.42 in.) =	0.021	acre-feet	1.42	inches
10-yr Runoff Volume (P1 = 1.68 in.) =	0.026	acre-feet	1.68	inches
25-yr Runoff Volume (P1 = 1.69 in.) =	0.027	acre-feet		inches
50-yr Runoff Volume (P1 = 1.99 in.) =	0.034	acre-feet		inches
100-yr Runoff Volume (P1 = 2.71 in.) =	0.056	acre-feet	2.71	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	0.070	acre-feet		inches
Approximate 2-yr Detention Volume =	0.013	acre-feet		
Approximate 5-yr Detention Volume =	0.020	acre-feet		
Approximate 10-yr Detention Volume =	0.024	acre-feet		
Approximate 25-yr Detention Volume =	0.026	acre-feet		
Approximate 50-yr Detention Volume =	0.030	acre-feet		
Approximate 100-yr Detention Volume =	0.042	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.007	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.017	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.017	acre-feet
Total Detention Basin Volume =	0.042	acre-feet
Initial Surcharge Volume (ISV) =	1	ft^3
Initial Surcharge Depth (ISD) =		ft
Total Available Detention Depth (H_{total}) =		ft
Depth of Trickle Channel (H_{TC}) =		ft
Slope of Trickle Channel (S_{TC}) =		ft/ft
Slopes of Main Basin Sides (S_{main}) =		H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =		

Initial Surcharge Area (A_{ISV}) =		ft^2
Surcharge Volume Length (L_{ISV}) =		ft
Surcharge Volume Width (W_{ISV}) =		ft
Depth of Basin Floor (H_{FLOOR}) =		ft
Length of Basin Floor (L_{FLOOR}) =		ft
Width of Basin Floor (W_{FLOOR}) =		ft
Area of Basin Floor (A_{FLOOR}) =		ft^2
Volume of Basin Floor (V_{FLOOR}) =		ft^3
Depth of Main Basin (H_{MAIN}) =		ft
Length of Main Basin (L_{MAIN}) =		ft
Width of Main Basin (W_{MAIN}) =		ft
Area of Main Basin (A_{MAIN}) =		ft^2
Volume of Main Basin (V_{MAIN}) =		ft^3
Calculated Total Basin Volume (V_{total}) =		acre-feet

Depth Increment = ft

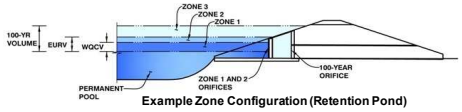
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool									

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Phantom Creek Ranch**

Basin ID: **Conceptual Detention Design for Lot 2 (Type A Soils)**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	0.36	acres
Watershed Length =	200	ft
Watershed Length to Centroid =	100	ft
Watershed Slope =	0.050	ft/ft
Watershed Imperviousness =	51.17%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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) =	0.006	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.021	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1 in.) =	0.012	acre-feet	1.00	inches
5-yr Runoff Volume (P1 = 1.42 in.) =	0.019	acre-feet	1.42	inches
10-yr Runoff Volume (P1 = 1.68 in.) =	0.023	acre-feet	1.68	inches
25-yr Runoff Volume (P1 = 1.69 in.) =	0.023	acre-feet		inches
50-yr Runoff Volume (P1 = 1.99 in.) =	0.030	acre-feet		inches
100-yr Runoff Volume (P1 = 2.71 in.) =	0.048	acre-feet	2.71	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	0.060	acre-feet		inches
Approximate 2-yr Detention Volume =	0.012	acre-feet		
Approximate 5-yr Detention Volume =	0.017	acre-feet		
Approximate 10-yr Detention Volume =	0.021	acre-feet		
Approximate 25-yr Detention Volume =	0.023	acre-feet		
Approximate 50-yr Detention Volume =	0.027	acre-feet		
Approximate 100-yr Detention Volume =	0.036	acre-feet		

Define Zones and Basin Geometry

Select Zone 1 Storage Volume (Required) =	0.006	acre-feet
Select Zone 2 Storage Volume (Optional) =	0.015	acre-feet
Select Zone 3 Storage Volume (Optional) =	0.015	acre-feet
Total Detention Basin Volume =	0.036	acre-feet
Initial Surcharge Volume (ISV) =	1	ft^3
Initial Surcharge Depth (ISD) =		ft
Total Available Detention Depth (H_{total}) =		ft
Depth of Trickle Channel (H_{TC}) =		ft
Slope of Trickle Channel (S_{TC}) =		ft/ft
Slopes of Main Basin Sides (S_{main}) =		H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =		

Initial Surcharge Area (A_{ISV}) =		ft^2
Surcharge Volume Length (L_{ISV}) =		ft
Surcharge Volume Width (W_{ISV}) =		ft
Depth of Basin Floor (H_{FLOOR}) =		ft
Length of Basin Floor (L_{FLOOR}) =		ft
Width of Basin Floor (W_{FLOOR}) =		ft
Area of Basin Floor (A_{FLOOR}) =		ft^2
Volume of Basin Floor (V_{FLOOR}) =		ft^3
Depth of Main Basin (H_{MAIN}) =		ft
Length of Main Basin (L_{MAIN}) =		ft
Width of Main Basin (W_{MAIN}) =		ft
Area of Main Basin (A_{MAIN}) =		ft^2
Volume of Main Basin (V_{MAIN}) =		ft^3
Calculated Total Basin Volume (V_{total}) =		acre-feet

Depth Increment = ft

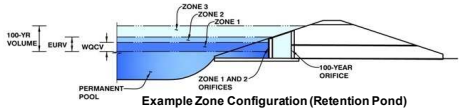
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool									

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Phantom Creek Ranch**

Basin ID: **Conceptual Detention Design for Lot 3 (Type B Soils)**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	0.48	acres
Watershed Length =	200	ft
Watershed Length to Centroid =	100	ft
Watershed Slope =	0.050	ft/ft
Watershed Imperviousness =	48.38%	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 =	User Input	

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) =	0.008	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.025	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1 in.) =	0.017	acre-feet	1.00	inches
5-yr Runoff Volume (P1 = 1.42 in.) =	0.029	acre-feet	1.42	inches
10-yr Runoff Volume (P1 = 1.68 in.) =	0.037	acre-feet	1.68	inches
25-yr Runoff Volume (P1 = 1.69 in.) =	0.040	acre-feet		inches
50-yr Runoff Volume (P1 = 1.99 in.) =	0.051	acre-feet		inches
100-yr Runoff Volume (P1 = 2.71 in.) =	0.080	acre-feet	2.71	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	0.097	acre-feet		inches
Approximate 2-yr Detention Volume =	0.016	acre-feet		
Approximate 5-yr Detention Volume =	0.024	acre-feet		
Approximate 10-yr Detention Volume =	0.033	acre-feet		
Approximate 25-yr Detention Volume =	0.032	acre-feet		
Approximate 50-yr Detention Volume =	0.035	acre-feet		
Approximate 100-yr Detention Volume =	0.047	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.008	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.017	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.022	acre-feet
Total Detention Basin Volume =	0.047	acre-feet
Initial Surcharge Volume (ISV) =	1	ft^3
Initial Surcharge Depth (ISD) =		ft
Total Available Detention Depth (H_{total}) =		ft
Depth of Trickle Channel (H_{TC}) =		ft
Slope of Trickle Channel (S_{TC}) =		ft/ft
Slopes of Main Basin Sides (S_{main}) =		H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =		

Initial Surcharge Area (A_{ISV}) =		ft^2
Surcharge Volume Length (L_{ISV}) =		ft
Surcharge Volume Width (W_{ISV}) =		ft
Depth of Basin Floor (H_{FLOOR}) =		ft
Length of Basin Floor (L_{FLOOR}) =		ft
Width of Basin Floor (W_{FLOOR}) =		ft
Area of Basin Floor (A_{FLOOR}) =		ft^2
Volume of Basin Floor (V_{FLOOR}) =		ft^3
Depth of Main Basin (H_{MAIN}) =		ft
Length of Main Basin (L_{MAIN}) =		ft
Width of Main Basin (W_{MAIN}) =		ft
Area of Main Basin (A_{MAIN}) =		ft^2
Volume of Main Basin (V_{MAIN}) =		ft^3
Calculated Total Basin Volume (V_{total}) =		acre-feet

Depth Increment = ft

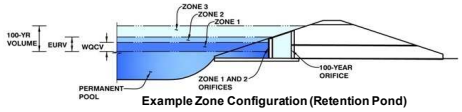
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool									

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Phantom Creek Ranch**

Basin ID: **Conceptual Detention Design for Lot 4 (Type B Soils)**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	0.32	acres
Watershed Length =	200	ft
Watershed Length to Centroid =	100	ft
Watershed Slope =	0.050	ft/ft
Watershed Imperviousness =	52.58%	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 =	User Input	

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) =	0.006	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.018	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1 in.) =	0.012	acre-feet	1.00	inches
5-yr Runoff Volume (P1 = 1.42 in.) =	0.021	acre-feet	1.42	inches
10-yr Runoff Volume (P1 = 1.68 in.) =	0.027	acre-feet	1.68	inches
25-yr Runoff Volume (P1 = 1.69 in.) =	0.028	acre-feet		inches
50-yr Runoff Volume (P1 = 1.99 in.) =	0.036	acre-feet		inches
100-yr Runoff Volume (P1 = 2.71 in.) =	0.055	acre-feet	2.71	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	0.066	acre-feet		inches
Approximate 2-yr Detention Volume =	0.012	acre-feet		
Approximate 5-yr Detention Volume =	0.018	acre-feet		
Approximate 10-yr Detention Volume =	0.024	acre-feet		
Approximate 25-yr Detention Volume =	0.023	acre-feet		
Approximate 50-yr Detention Volume =	0.025	acre-feet		
Approximate 100-yr Detention Volume =	0.033	acre-feet		

Define Zones and Basin Geometry

Select Zone 1 Storage Volume (Required) =	0.006	acre-feet
Select Zone 2 Storage Volume (Optional) =	0.012	acre-feet
Select Zone 3 Storage Volume (Optional) =	0.015	acre-feet
Total Detention Basin Volume =	0.033	acre-feet
Initial Surcharge Volume (ISV) =	1	ft^3
Initial Surcharge Depth (ISD) =		ft
Total Available Detention Depth (H_{total}) =		ft
Depth of Trickle Channel (H_{TC}) =		ft
Slope of Trickle Channel (S_{TC}) =		ft/ft
Slopes of Main Basin Sides (S_{main}) =		H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =		

Initial Surcharge Area (A_{ISV}) =		ft^2
Surcharge Volume Length (L_{ISV}) =		ft
Surcharge Volume Width (W_{ISV}) =		ft
Depth of Basin Floor (H_{FLOOR}) =		ft
Length of Basin Floor (L_{FLOOR}) =		ft
Width of Basin Floor (W_{FLOOR}) =		ft
Area of Basin Floor (A_{FLOOR}) =		ft^2
Volume of Basin Floor (V_{FLOOR}) =		ft^3
Depth of Main Basin (H_{MAIN}) =		ft
Length of Main Basin (L_{MAIN}) =		ft
Width of Main Basin (W_{MAIN}) =		ft
Area of Main Basin (A_{MAIN}) =		ft^2
Volume of Main Basin (V_{MAIN}) =		ft^3
Calculated Total Basin Volume (V_{total}) =		acre-feet

Depth Increment = ft

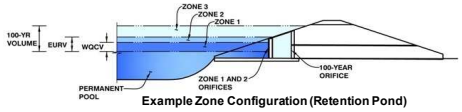
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool									

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Phantom Creek Ranch**

Basin ID: **Conceptual Detention Design for Lot 5 (Type B Soils)**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	0.41	acres
Watershed Length =	200	ft
Watershed Length to Centroid =	100	ft
Watershed Slope =	0.050	ft/ft
Watershed Imperviousness =	49.78%	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 =	User Input	

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) =	0.007	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.022	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1 in.) =	0.015	acre-feet	1.00	inches
5-yr Runoff Volume (P1 = 1.42 in.) =	0.025	acre-feet	1.42	inches
10-yr Runoff Volume (P1 = 1.68 in.) =	0.033	acre-feet	1.68	inches
25-yr Runoff Volume (P1 = 1.69 in.) =	0.035	acre-feet		inches
50-yr Runoff Volume (P1 = 1.99 in.) =	0.044	acre-feet		inches
100-yr Runoff Volume (P1 = 2.71 in.) =	0.069	acre-feet	2.71	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	0.083	acre-feet		inches
Approximate 2-yr Detention Volume =	0.014	acre-feet		
Approximate 5-yr Detention Volume =	0.021	acre-feet		
Approximate 10-yr Detention Volume =	0.029	acre-feet		
Approximate 25-yr Detention Volume =	0.028	acre-feet		
Approximate 50-yr Detention Volume =	0.030	acre-feet		
Approximate 100-yr Detention Volume =	0.041	acre-feet		

Define Zones and Basin Geometry

Select Zone 1 Storage Volume (Required) =	0.007	acre-feet
Select Zone 2 Storage Volume (Optional) =	0.015	acre-feet
Select Zone 3 Storage Volume (Optional) =	0.019	acre-feet
Total Detention Basin Volume =	0.041	acre-feet
Initial Surcharge Volume (ISV) =	1	ft^3
Initial Surcharge Depth (ISD) =		ft
Total Available Detention Depth (H_{total}) =		ft
Depth of Trickle Channel (H_{TC}) =		ft
Slope of Trickle Channel (S_{TC}) =		ft/ft
Slopes of Main Basin Sides (S_{main}) =		H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =		

Initial Surcharge Area (A_{ISV}) =		ft^2
Surcharge Volume Length (L_{ISV}) =		ft
Surcharge Volume Width (W_{ISV}) =		ft
Depth of Basin Floor (H_{FLOOR}) =		ft
Length of Basin Floor (L_{FLOOR}) =		ft
Width of Basin Floor (W_{FLOOR}) =		ft
Area of Basin Floor (A_{FLOOR}) =		ft^2
Volume of Basin Floor (V_{FLOOR}) =		ft^3
Depth of Main Basin (H_{MAIN}) =		ft
Length of Main Basin (L_{MAIN}) =		ft
Width of Main Basin (W_{MAIN}) =		ft
Area of Main Basin (A_{MAIN}) =		ft^2
Volume of Main Basin (V_{MAIN}) =		ft^3
Calculated Total Basin Volume (V_{total}) =		acre-feet

Depth Increment = ft

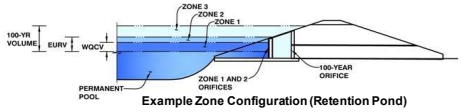
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool									

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Phantom Creek Ranch**

Basin ID: **Conceptual Detention Design for Lot 6 (Type B Soils)**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	0.68	acres
Watershed Length =	200	ft
Watershed Length to Centroid =	100	ft
Watershed Slope =	0.050	ft/ft
Watershed Imperviousness =	45.87%	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 =	User Input	

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) =	0.011	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.033	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1 in.) =	0.022	acre-feet	1.00	inches
5-yr Runoff Volume (P1 = 1.42 in.) =	0.039	acre-feet	1.42	inches
10-yr Runoff Volume (P1 = 1.68 in.) =	0.051	acre-feet	1.68	inches
25-yr Runoff Volume (P1 = 1.69 in.) =	0.055	acre-feet		inches
50-yr Runoff Volume (P1 = 1.99 in.) =	0.071	acre-feet		inches
100-yr Runoff Volume (P1 = 2.71 in.) =	0.111	acre-feet	2.71	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	0.134	acre-feet		inches
Approximate 2-yr Detention Volume =	0.021	acre-feet		
Approximate 5-yr Detention Volume =	0.032	acre-feet		
Approximate 10-yr Detention Volume =	0.044	acre-feet		
Approximate 25-yr Detention Volume =	0.043	acre-feet		
Approximate 50-yr Detention Volume =	0.047	acre-feet		
Approximate 100-yr Detention Volume =	0.064	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.011	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.022	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.031	acre-feet
Total Detention Basin Volume =	0.064	acre-feet
Initial Surcharge Volume (ISV) =	1	ft^3
Initial Surcharge Depth (ISD) =		ft
Total Available Detention Depth (H_{total}) =		ft
Depth of Trickle Channel (H_{TC}) =		ft
Slope of Trickle Channel (S_{TC}) =		ft/ft
Slopes of Main Basin Sides (S_{main}) =		H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =		

Initial Surcharge Area (A_{ISV}) =		ft^2
Surcharge Volume Length (L_{ISV}) =		ft
Surcharge Volume Width (W_{ISV}) =		ft
Depth of Basin Floor (H_{FLOOR}) =		ft
Length of Basin Floor (L_{FLOOR}) =		ft
Width of Basin Floor (W_{FLOOR}) =		ft
Area of Basin Floor (A_{FLOOR}) =		ft^2
Volume of Basin Floor (V_{FLOOR}) =		ft^3
Depth of Main Basin (H_{MAIN}) =		ft
Length of Main Basin (L_{MAIN}) =		ft
Width of Main Basin (W_{MAIN}) =		ft
Area of Main Basin (A_{MAIN}) =		ft^2
Volume of Main Basin (V_{MAIN}) =		ft^3
Calculated Total Basin Volume (V_{total}) =		acre-feet

Depth Increment = ft

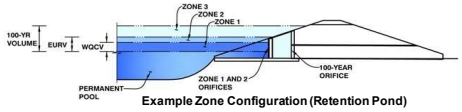
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool									

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Phantom Creek Ranch**

Basin ID: **Conceptual Detention Design for Lot 7 (Type B Soils)**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	0.64	acres
Watershed Length =	200	ft
Watershed Length to Centroid =	100	ft
Watershed Slope =	0.050	ft/ft
Watershed Imperviousness =	46.20%	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 =	User Input	

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) =	0.010	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.031	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1 in.) =	0.021	acre-feet	1.00	inches
5-yr Runoff Volume (P1 = 1.42 in.) =	0.037	acre-feet	1.42	inches
10-yr Runoff Volume (P1 = 1.68 in.) =	0.048	acre-feet	1.68	inches
25-yr Runoff Volume (P1 = 1.69 in.) =	0.052	acre-feet		inches
50-yr Runoff Volume (P1 = 1.99 in.) =	0.067	acre-feet		inches
100-yr Runoff Volume (P1 = 2.71 in.) =	0.105	acre-feet	2.71	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	0.127	acre-feet		inches
Approximate 2-yr Detention Volume =	0.020	acre-feet		
Approximate 5-yr Detention Volume =	0.031	acre-feet		
Approximate 10-yr Detention Volume =	0.042	acre-feet		
Approximate 25-yr Detention Volume =	0.041	acre-feet		
Approximate 50-yr Detention Volume =	0.044	acre-feet		
Approximate 100-yr Detention Volume =	0.061	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.010	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.021	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.029	acre-feet
Total Detention Basin Volume =	0.061	acre-feet
Initial Surcharge Volume (ISV) =	1	ft^3
Initial Surcharge Depth (ISD) =		ft
Total Available Detention Depth (H_{total}) =		ft
Depth of Trickle Channel (H_{TC}) =		ft
Slope of Trickle Channel (S_{TC}) =		ft/ft
Slopes of Main Basin Sides (S_{main}) =		H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =		

Initial Surcharge Area (A_{ISV}) =		ft^2
Surcharge Volume Length (L_{ISV}) =		ft
Surcharge Volume Width (W_{ISV}) =		ft
Depth of Basin Floor (H_{FLOOR}) =		ft
Length of Basin Floor (L_{FLOOR}) =		ft
Width of Basin Floor (W_{FLOOR}) =		ft
Area of Basin Floor (A_{FLOOR}) =		ft^2
Volume of Basin Floor (V_{FLOOR}) =		ft^3
Depth of Main Basin (H_{MAIN}) =		ft
Length of Main Basin (L_{MAIN}) =		ft
Width of Main Basin (W_{MAIN}) =		ft
Area of Main Basin (A_{MAIN}) =		ft^2
Volume of Main Basin (V_{MAIN}) =		ft^3
Calculated Total Basin Volume (V_{total}) =		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									