

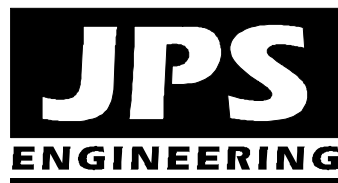
FINAL DRAINAGE REPORT
for
ROLLIN RIDGE FILING NO. 1

Prepared for:

TC&C LLC
17572 Colonial Park Drive
Monument, CO 80132

October 21, 2019
Revised February 28, 2020
Revised May 13, 2020

Prepared by:



19 E. Willamette Avenue
Colorado Springs, CO 80903
(719)-477-9429
www.jpsengr.com

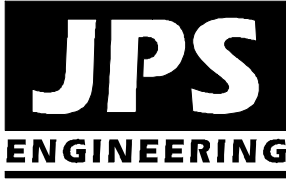
JPS Project No. 081702
PCD File No.: SF-19-022

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FINAL DRAINAGE REPORT
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ROLLIN RIDGE FILING NO. 1 – FINAL DRAINAGE REPORT EXECUTIVE SUMMARY

A. Background

- Rollin Ridge Estates is a proposed subdivision of a 57-acre property located at the southwest corner of Hodgen Road and State Highway 83 in northern El Paso County.
- Rollin Ridge Filing No. 1 consists of 16 rural residential lots with 2.5-acre minimum lot sizes, along with a detention pond tract and a tract for future commercial development.
- Rollin Ridge Estates is located within the West Cherry Creek Drainage Basin, which comprises a total drainage area in excess of 30 square miles. The Rollin Ridge Estates property represents less than 0.3 percent of the total basin area.

B. General Drainage Concept

- Developed drainage within the site will be conveyed along paved streets with roadside ditches and culverts, as well as grass-lined channels through drainage easements, following historic drainage patterns.
- Developed flows from the subdivision will be detained to historic levels through on-site full-spectrum stormwater detention ponds.
- Subdivision drainage improvements will be designed and constructed to meet El Paso County standards,

C. Drainage Impacts

- The proposed detention ponds will mitigate developed drainage impacts from the subdivision, ensuring no significant adverse developed drainage impacts on downstream properties.
- Drainage facilities within public road rights-of-way will be dedicated to the County for maintenance. The proposed private stormwater detention ponds will be maintained by the subdivision HOA.

DRAINAGE STATEMENT

Engineer's Statement:

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

John P. Schwab, P.E. #29891



Developer's Statement:

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

By:

Printed Name: Carl Turse, Manager, TC&C, LLC
17572 Colonial Park Drive, Monument, CO 80132

Date

El Paso County's Statement

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

Jennifer Irvine, P.E.
County Engineer / ECM Administrator

Date

Conditions:

I. GENERAL LOCATION AND DESCRIPTION

A. Background

Rollin Ridge Estates is a proposed subdivision of a 57-acre property located in northeastern El Paso County, Colorado. The Rollin Ridge Estates property is comprised of two parcels (El Paso County Assessor's Number 61270-00-064 and 61270-00-065) is located at the southwest corner of State Highway 83 (SH83) and Hodgen Road, as shown in Figure A1 (Appendix E). Rollin Ridge Filing No. 1 consists of 16 rural residential lots (2.5-acre minimum size), along with a detention pond tract and a 5.3-acre tract for future commercial development.

B. Scope

This report is intended to fulfill the El Paso County requirements for a Final Drainage Report (FDR) for submittal with the Filing No. 1 Final Plat application. JPS Engineering previously prepared the "Preliminary Drainage Report (PDR) for Rollin Ridge Estates" dated March 15, 2019, which was approved by El Paso County in support of the Preliminary Plan application.

The report provides a summary of site drainage issues impacting the proposed development, including analysis of impacts from upstream drainage areas, site-specific developed drainage patterns, and impacts on downstream facilities. This PDR report has been prepared based on the guidelines and criteria presented in the El Paso County Drainage Criteria Manual.

C. Site Location and Description

The Rollin Ridge Estates parcel is located in the North Half of Section 27, Township 11 South, Range 66 West of the 6th Principal Meridian. The site is currently a vacant meadow tract, with the exception of one existing residence and several accessory ranch structures.

The property is currently zoned RR-5 (Rural Residential; 5-acre minimum lots), and the proposed subdivision will include re-zoning the property to RR-2.5 (Rural Residential; 2.5-acre minimum lots). The proposed development will be served by individual wells and septic systems.

The north boundary of the property borders Hodgen Road, which is a fully improved principal arterial public street, and the east boundary of the property adjoins SH83 which is a fully improved state highway. The existing Rollin Ridge Rancheros Subdivision adjoins the south boundary of the site. The west boundary of the property adjoins unplatted property zoned Rural Residential (RR-5).

Access through Rollin Ridge Estates Subdivision will be provided by extension of a new public street (Cherry Crossing Drive) extending south from Hodgen Road into the property, aligning with the existing Cherry Crossing Drive on the north side of Hodgen Road.

An additional public street (Bark Tree Trail) will extend southwesterly from Cherry Crossing Drive to a cul-de-sac within the subdivision.

Infrastructure improvements will include paving of new public roadways through the site, as well as grading, drainage, and utility service improvements for the proposed residential lots. Internal subdivision streets will generally be classified as rural local roads, with 60-foot rights-of-way and paved widths of 28-feet.

Ground elevations within the parcel range from a low point of approximately 7,523 feet above mean sea level at the west boundary of the parcel, to a high point of 7,590 feet.

This site is located in the West Cherry Creek drainage basin. Surface drainage from the property flows northerly towards tributaries of West Cherry Creek. The terrain is rolling with slopes ranging from 2% to 8%. Existing vegetation is typical eastern Colorado prairie grass.

D. General Soil Conditions

According to the Soil Survey of El Paso County prepared by the Soil Conservation Service, on-site soils are comprised of the following soil types (see Appendix A):

- Type 21 – Cruckton sandy loam: Hydrologic Group B
- Type 28 – Ellicott loamy coarse sand: Hydrologic Group A (30%)
- Type 41 – Kettle gravelly loamy sand: Hydrologic Group B
- Type 68 – Peyton-Pring complex: Hydrologic Group B

E. References

City of Colorado Springs, “Drainage Criteria Manual, Volumes 1 and 2,” revised May, 2014.

El Paso County “Engineering Criteria Manual,” January 9, 2006.

FEMA, Flood Insurance Rate Map (FIRM) Number 08041C0285-G, December 7, 2018.

JPS Engineering, Inc., “Master Development Drainage Plan (MDDP) and Preliminary Drainage Report for Walden Preserve Subdivision,” December 10, 2004 (approved by EPC 12/20/04).

JPS Engineering, Inc., “Final Drainage Report for Majestic Pines Subdivision,” July 17, 2014 (approved by El Paso County 9/2/14).

JPS Engineering, Inc., “Final Drainage Report for Settlers Ranch Subdivision Filing No. 1,” October 18, 2005 (approved by El Paso County 10/19/05).

JPS Engineering, Inc., “Final Drainage Report for Settlers Ranch Subdivision Filing No. 2,” May 30, 2008 (approved by El Paso County 3/31/09).

JPS Engineering, Inc., “Final Drainage Report for Walden Preserve Subdivision Filing No. 1,” May 11, 2005.

JPS Engineering, Inc., “Preliminary Drainage Report (PDR) for Rollin Ridge Estates,” March 15, 2019 (approved by El Paso County 5/16/19).

Kiowa Engineering Corporation, “Master Development Drainage Plan for the Cherry Creek Crossing Development,” September, 1998 (approved by El Paso County 10/13/98).

Kiowa Engineering Corporation, “Final Drainage Plan and Erosion Control Plan, Filing No. 1, Cherry Creek Crossing Subdivision,” November, August 18, 2005 (approved by EPC 9/1/05).

Kiowa Engineering Corporation, “Preliminary and Final Drainage Report, Cherry Creek Crossing Filing No. 2,” Development,” August 18, 2005 (approved by El Paso County 9/1/05).

II. DRAINAGE BASINS AND SUB-BASINS

A. Major Basin Description

The proposed development lies within the West Cherry Creek Drainage Basin (CYCY 0400) as classified by El Paso County. Drainage from the site flows northerly to a tributary channel of West Cherry Creek. Downstream areas generally drain northerly towards the main channel of West Cherry Creek.

No drainage planning study has been completed for this drainage basin or any adjacent drainage basins. In the absence of plans for regional drainage facilities, El Paso County generally requires new developments to provide stormwater detention to maintain historic runoff flows leaving developed areas.

The major drainage basins lying in and around the proposed development are depicted in Figure EX1. The Rollin Ridge Estates parcel is located near the southerly limits of the West Cherry Creek Drainage Basin, which comprises a total drainage area in excess of 30 square miles. As such, the proposed 57-acre Rollin Ridge Estates Subdivision represents 0.3 percent of the total basin area, which is primarily ranch land.

B. Floodplain Impacts

The proposed development area is located beyond the limits of any 100-year floodplain delineated by the Federal Emergency Management Agency (FEMA). The floodplain limits in the vicinity of the site are shown in Flood Insurance Rate Map (FIRM) Panel Number 08041C0285-G, dated December 7, 2018, as shown in Figure FIRM (Appendix E).

C. Sub-Basin Description

The existing drainage basins lying in and around the proposed development are depicted in Figure EX1 (Appendix E). The existing on-site topography has been delineated as several sub-basins draining to design points at the north and south boundaries of the site.

The developed drainage basins lying within the proposed development are depicted on Figure D1.1. The developed site layout has been divided into sub-basins based on the proposed road layout within the site. The natural drainage patterns will be impacted through development by site grading and concentration of runoff in subdivision roadside ditches and channels.

On-site flows will be diverted to the existing natural drainage swales and channels running through the property, following historic drainage paths.

III. DRAINAGE DESIGN CRITERIA

A. Development Criteria Reference

No Drainage Basin Planning Study (DBPS) has been completed for the West Cherry Creek Drainage Basin. Previous drainage reports for completed subdivision filings have proposed to provide on-site detention for mitigation of developed flows.

B. Hydrologic Criteria

In accordance with the El Paso County Drainage Criteria Manual, Rational Method procedures were utilized for hydrologic calculations since the tributary drainage basins are below 100 acres.

Rational Method hydrologic calculations were based on the following assumptions:

- | | | |
|---|--|-------------|
| • Design storm (minor) | 5-year | |
| • Design storm (major) | 100-year | |
| • Time of Concentration – Overland Flow | “Airport” equation (300’ max. developed) | |
| • Time of Concentration – Gutter/Ditch Flow | “SCS Upland” equation | |
| • Rainfall Intensities | El Paso County I-D-F Curve | |
| • Hydrologic soil type | B | |
| | <u>C5</u> | <u>C100</u> |
| • Runoff Coefficients - undeveloped: | | |
| Existing pasture/range areas | 0.08 | 0.35 |
| • Runoff Coefficients - developed: | | |
| Proposed lot areas (2.5-acre lots) | 0.170 | 0.417 |

Hydrologic calculations are enclosed in Appendix A, and peak design flows are identified on the drainage basin drawings.

IV. DRAINAGE PLANNING FOUR STEP PROCESS

El Paso County Drainage Criteria require drainage planning to include a Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainageways, and implementing long-term source controls.

As stated in DCM Volume 2, the Four Step Process is applicable to all new and re-development projects with construction activities that disturb 1 acre or greater or that disturb less than 1 acre but are part of a larger common plan of development. The Four Step Process has been implemented as follows in the planning of this project:

Step 1: Employ Runoff Reduction Practices

- **Minimize Impacts:** The proposed rural residential subdivision development with 2.5-acre minimum lot sizes provides for inherently minimal drainage impacts based on the limited impervious areas associated with rural residential development.
- **Minimize Directly Connected Impervious Areas (MDCIA):** The rural residential development will have roadside ditches along all roads, providing for impervious areas to drain across pervious areas. Based on the roadside ditches throughout the subdivision, the subdivision is classified as MDCIA Level One.
- **Grass Swales:** The proposed rural residential roads will have grass-lined roadside ditches to encourage stormwater infiltration.

Step 2: Stabilize Drainageways

- Proper erosion control measures will be implemented along the roadside ditches and grass-lined drainage channels to provide stabilized drainageways within the site.

Step 3: Provide Water Quality Capture Volume (WQCV)

- **FSD:** Full-Spectrum Detention Ponds will be provided at the north boundary of the site. On-site drainage will be routed through the extended detention basins, which will capture and slowly release the WQCV over an extended release period.

Step 4: Consider Need for Industrial and Commercial BMPs

- No industrial land uses are proposed within this rural residential subdivision.
- The proposed commercial development area will implement a Stormwater Management Plan (SWMP) incorporating proper housekeeping procedures.
- On-site drainage will be routed through the private Full-Spectrum Detention (FSD) basins to minimize introduction of contaminants to the County's public drainage system.

V. GENERAL DRAINAGE RECOMMENDATIONS

The developed drainage plan for the site is to provide and maintain positive drainage away from structures and conform to the established drainage patterns for the overall site. JPS Engineering recommends that positive drainage be established and maintained away from all structures within the site in conformance with applicable building codes and geotechnical engineering recommendations.

Site grading and drainage improvements performed as a part of subdivision infrastructure development includes limited overlot grading and subdivision drainage improvements depicted on the subdivision construction drawings. Individual lot grading is the sole responsibility of the individual builders and property owners. Final grading of each home site should establish proper protective slopes and positive drainage in accordance with HUD guidelines and building codes. In general, main floor elevations for each home should be established a minimum of 2 feet above the top of curb (finished grade) of the adjoining street.

In general, we recommend a minimum of 6 inches clearance from the top of concrete foundation walls to adjacent finished site grades. Positive drainage slopes should be maintained away from all structures, with a minimum recommended slope of 5 percent for the first 10 feet away from buildings in landscaped areas, a minimum recommended slope of 2 percent for the first 10 feet away from buildings in paved areas, and a minimum slope of 1 percent for paved areas beyond buildings.

VI. DRAINAGE FACILITY DESIGN

A. General Concept

Development of the Rollin Ridge Estates Subdivision will require site grading and paving, resulting in additional impervious areas across the site. The general drainage pattern will consist of grading away from home sites to swales and roadside ditches along the internal roads within the subdivision, conveying runoff flows through the site. Runoff from the site will flow by roadside ditches to cross culverts at low points in the road profiles, and grass-lined channels connecting to existing natural swales at the site boundaries.

The stormwater management concept for the Rollin Ridge Estates development will be to provide roadside ditches and natural swales as required to convey developed drainage through the site to existing natural outfalls. Individual lot grading will provide positive drainage away from building sites, and direct developed flows into the system of roadside ditches and drainage swales running through the subdivision.

Stormwater detention ponds will be constructed at the north boundary of the subdivision to mitigate the impact of developed flows and maintain historic peak flows downstream of the property.

B. Specific Details

1. Existing Drainage Conditions

Historic drainage conditions within the site are depicted in Figure EX1. Basin A comprises the eastern side of the property, and this basin receives off-site drainage from Basin OA1, which consists of developed 5-acre lots in the Rollin Ridge Rancheros Subdivision adjoining the south boundary of this property. Off-site flows from Basin OA1 combine with Basin A and drain to an existing natural swale flowing to an existing 48-inch CMP culvert crossing Hodgen Road at the north property boundary. Flows from Basins OA1 and A combine at Design Point #1, with historic peak flows calculated as $Q_5 = 11.5$ cfs and $Q_{100} = 84.7$ cfs (Rational Method).

The Master Development Drainage Plan for Cherry Creek Crossing by Kiowa Engineering identified peak flows of $Q_5 = 75$ cfs and $Q_{100} = 161$ cfs (SCS Method) for the existing 48" CMP culvert crossing Hodgen Road.

Basin B comprises the northwest part of the site, which sheet flows to the northwest corner of the property, draining to an existing 42-inch CMP culvert crossing Hodgen Road just west of the site boundary. Historic peak flows at Design Point #2 are calculated as $Q_5 = 2.9$ cfs and $Q_{100} = 20.9$ cfs (Rational Method).

Off-site Basin OB1 represents the off-site area west of this site which also contributes flow to the existing culvert at Design Point #2.1. Flows from Basins OB1 and B combine at Design Point #2.1, with historic peak flows calculated as $Q_5 = 7.2$ cfs and $Q_{100} = 53.2$ cfs (Rational Method).

The southwest corner of the property has been delineated as Basin C, which sheet flows to the southwest corner of the property. Flows from Basin C drain to Design Point #3, with historic peak flows calculated as $Q_5 = 3.1$ cfs and $Q_{100} = 15.1$ cfs (Rational Method).

2. Developed Drainage Conditions

The developed drainage basins and projected flows are shown in Figure D1, and hydrologic calculations are enclosed in Appendix B.

The east side of the property has been delineated as Sub-Basins A1-A5 in the developed condition, and these basins will continue to flow northerly towards the existing culvert crossing Hodgen Road at Design Point #1. Developed drainage impacts will be mitigated by routing developed flows through Detention Pond A prior to discharging to the existing Hodgen Road culvert.

Sub-Basin A1 comprises the majority of the south-central part of the site between the two proposed cul-de-sacs. Sub-Basin A1 flows northerly to a proposed public culvert crossing Cherry Crossing Court south of the internal street intersection. Off-site flows from Basin OA1 combine with flows from Sub-Basin A1 at Design Point #A1, with developed peak flows calculated as $Q_5 = 16.4$ cfs and $Q_{100} = 71.7$ cfs. A 36-inch culvert will convey the flow from DP-A1 across Cherry Crossing Court into Sub-Basin A3.

Sub-Basins A2 and A3 comprise the residential (Sub-Basin A2) and commercial (Sub-Basin A3) areas on the east side of Cherry Crossing Court. These basins flow northwesterly to Detention Pond A. Sub-Basin A2 flows to Design Point #A2, with developed peak flows calculated as $Q_5 = 3.2$ cfs and $Q_{100} = 13.3$ cfs. An 18-inch culvert will convey the flow from DP-A2 across the southern commercial tract access drive into Sub-Basin A3.

Developed flows from Basins OA1, A1, and A2 combine at Design Point #A2.1, with developed peak flows calculated as $Q_5 = 18.9$ cfs and $Q_{100} = 81.9$ cfs. A 48-inch culvert will convey the flow from DP-A2.1 across the northern commercial tract access drive into Detention Pond A.

Future commercial development within Tract B will include storm inlets and storm sewer improvements to convey developed flows from Basin A3 directly into Detention Pond A. As noted on Sh. D1.1, the impervious area of the future commercial development within Basin A3 has been calculated as 66 percent, and Detention Pond A has been sized based on this assumption. Developed flows from Basins OA1, A1, A2, and A3 combine at Design Point #A3, with developed peak flows calculated as $Q_5 = 27.4$ cfs and $Q_{100} = 96.8$ cfs.

Sub-Basin A4 comprises the area southwest of the intersection of Cherry Crossing Court and Hodgen Road. This area sheet flows easterly to a proposed 24-inch culvert crossing Cherry Crossing Court and flowing into Detention Pond A. Sub-Basin A4 flows to Design Point #A4, with developed peak flows calculated as $Q_5 = 2.9$ cfs and $Q_{100} = 11.8$ cfs.

Sub-Basin A5 comprises the landscape buffer area on the north side of the Commercial Tract, including Detention Pond A. Developed flows from Basins OA1 and A1-A5 combine at Design Point #1, with developed flows calculated as $Q_5 = 29.4$ cfs and $Q_{100} = 107.0$ cfs. Design Point #1 represents the flow entering Detention Pond A, and the subdivision streets and commercial center will drain to this pond. As detailed in Appendix B and C, after routing developed flows through full-spectrum Detention Pond A, the calculated detained flow at Design Point #1d will be reduced to $Q_5 = 0.4$ cfs and $Q_{100} = 63.5$ cfs, which is well below the calculated historic flow.

The discharge from Detention Basin A flows into the existing CMP culvert crossing Hodgen Road at the north boundary of the site, and then flows northerly in existing drainage channels through the Cherry Creek Crossing Subdivision.

Developed Basin B will continue to sheet flow to Design Point #2 at the northwest corner of the property, with developed peak flows calculated as $Q_5 = 6.1$ cfs and $Q_{100} = 25.2$ cfs. Off-site flows from Basin OB1 will combine with Basin B at the existing culvert crossing Hodgen Road at Design Point #2.1, with developed peak flows calculated as $Q_5 = 13.9$ cfs and $Q_{100} = 62.7$ cfs.

Based on SCS Method hydrologic calculations, the Master Development Drainage Plan for Cherry Creek Crossing by Kiowa Engineering identified peak flows of $Q_5 = 10$ cfs and $Q_{100} = 30.7$ cfs for the existing 42" CMP culvert crossing Hodgen Road. This Drainage Report for Rollin Ridge Subdivision utilizes Rational Method hydrology as required by current County drainage criteria for basins under 100 acres, resulting in more conservative flow calculations.

Developed drainage impacts from Basin B will be mitigated by routing developed flows through full-spectrum Detention Pond B at the northwest corner of the subdivision prior to discharging to the existing culvert crossing Hodgen Road. As detailed in Appendix B and C, after routing developed flows through Detention Pond B, the calculated detained flow at Design Point #2.1 will be reduced to $Q_5 = 7.8$ cfs and $Q_{100} = 47.7$ cfs, well below the calculated historic flow.

Developed Basin C will continue to sheet flow to the southwest corner of the property. Basin C will flow to Design Point #3, with developed peak flows calculated as $Q_5 = 4.3$ cfs and $Q_{100} = 16.8$ cfs, representing an insignificant increase in comparison to historic flows. As noted on the enclosed Developed Drainage Plan, the homes within Basin C should direct downspouts so as to not adversely impact downstream properties.

C. Comparison of Developed to Historic Discharges

Based on the hydrologic calculations in Appendix B, the proposed development will result in calculated developed flows exceeding historic flows. However, the increase in developed flows will be mitigated through on-site stormwater detention facilities. The comparison of developed to historic discharges at key design points is summarized as follows:

Design Point	Historic Flow			Developed Flow			Comparison of Developed to Historic Flow ($Q_5\%/Q_{100}\%$)
	Area (ac)	Q_5 (cfs)	Q_{100} (cfs)	Area (ac)	Q_5 (cfs)	Q_{100} (cfs)	
1	54.3	11.5	84.7	54.6	29.4	107.0	+17.9 cfs / +22.3 cfs (increase)
1d	54.3	11.5	84.7	54.6	0.4	62.5	-11.1 cfs / -22.2 cfs (decrease)
2	12.2	2.9	20.9	11.8	6.1	25.2	+3.2 cfs / +4.3 cfs (increase)
2d	12.2	2.9	20.9	11.8	0.1	10.4	-2.8 cfs / -10.5 cfs (decrease)
3	5.5	3.1	15.1	5.5	4.3	16.8	+1.2 cfs / +1.7 cfs (negligible increase)

D. Detention Ponds

The Developed storm runoff downstream of the proposed subdivision will be maintained at historic levels by routing flows through two proposed detention ponds at the north boundary of the property. Detention Ponds A and B will be constructed as Full-Spectrum Detention (FSD) Ponds to mitigate developed flow and water quality impacts from the proposed subdivision. The pond outlet structures have been designed to detain the full spectrum of storm events, as well as provide water quality.

As noted in the previously approved “Preliminary Drainage Report (PDR) for Rollin Ridge Estates,” Basin C comprises a small area of rural residential lots in the southwest corner of the subdivision which is not anticipated to have any significant developed drainage impact. Maintenance of existing vegetated buffer strips along the south boundary of the site will provide adequate water quality protection for this limited area. With the protection of existing vegetated buffer strips, additional water quality facilities are not required within Basin C as this part of the site meets exclusions listed in the revised El Paso County Engineering Criteria Manual (ECM). Section I.7.1.B.5 of the ECM identifies “Large Lot Single Family Sites” as excluded sites under the following definition: “A single-family residential lot, or agricultural zoned lands, greater than or equal to 2.5 acres in size per dwelling and having a total lot impervious area of less than 10 percent.” The subdivision area within Basin C is limited to the south sides of Lots 6-8, and Lot 8 is previously developed with an existing home site. As such, the new development within Basin C will be limited to the back side of two home sites, which is equivalent in drainage impact to a single-family rural residential lot. The lots within Basin C are larger than 2.5-acres, and a note has been added to the Developed Drainage Plan stating that “Lots Within Basin C May Not Exceed a Total Lot Impervious Area of 10 Percent.”

The proposed detention ponds have been sized based on the impervious areas for developed Basins A and B. Detailed pond routing calculations have been performed utilizing the Denver Urban Drainage and Flood Control District “UD-Detention_v3.07” software package (see Appendix C). The pond outlet structure configuration has been designed to maintain the calculated pond discharge below the target outflow, while maintaining the maximum water surface elevation below the pond spillway.

Recognizing that Filing No. 1 of the subdivision will entail residential development only, with additional future commercial development to occur within Basin A3, Appendix C includes detention pond design calculations for both “Interim Conditions (Filing No. 1 Residential Only)” and “Ultimate Conditions (Including Commercial Area).” The Filing No. 1 Construction Drawings provide for construction of the ultimate pond volume and appurtenant facilities, but the orifice plate on the pond outlet structure has been designed for the Interim Conditions (Filing No. 1 only). Future commercial development will need to include replacing the orifice plate on the pond outlet structure for the ultimate design conditions.

Detention pond design parameters are summarized as follows:

Pond	Inflow (Q ₁₀₀ , cfs)	Outflow (Q ₁₀₀ , cfs)	100-Yr Volume (ac-ft)	Outlet Structure
Pond A	97.4	62.5	2.4	30-inch SD w/ orifice plates
Pond B	17.3	10.4	0.4	18-inch SD w/ orifice plates

Maintenance access roads meeting County drainage criteria will be provided for all stormwater detention facilities. The proposed detention ponds will be privately owned and maintained by the subdivision homeowners association (HOA).

E. On-Site Drainage Facility Design

Developed sub-basins and proposed drainage improvements are depicted in the enclosed Drainage Plan (Sheet D1.1, Appendix E). In accordance with El Paso County standards, new roadways will be graded with a minimum longitudinal slope of 1.0 percent. The typical local road section will consist of a 28-foot paved width with 2-foot gravel shoulders and 4:1 slopes to 2.5-foot ditches. On-site drainage facilities will consist of roadside ditches, grass-lined channels, and culverts. Hydraulic calculations for sizing of on-site drainage facilities are enclosed in Appendix B, and design criteria are summarized as follows:

1. Culverts

The internal road system has been graded to drain roadside ditches to low points along the road profile, where cross-culverts will convey developed flows into grass-lined channels following historic drainage paths. Culvert pipes have been specified as reinforced concrete pipe (RCP) with a minimum diameter of 18-inches. Culvert sizes have been identified based on a maximum headwater-to-depth ratio (HW/D) of 1.0 for the minor (5-year) design storm. Final culvert design calculations have been performed utilizing the FHWA HY-8 software package to perform a detailed analysis of inlet and outlet control conditions, meeting El Paso County criteria for allowable overtopping. Final culvert sizes based on allowable headwater depths are summarized in the “Culvert Sizing Summary” table in Appendix B1. Riprap protection will be provided at all culvert outlets.

The culvert analysis in Appendix B1 also includes the existing culverts crossing Hodgen Road, confirming that these existing culverts have adequate capacity to convey the detained flows from this subdivision.

2. Open Channels

Drainage easements will be dedicated along major drainage channels following historic drainage paths through the subdivision. These channels will generally be grass-lined

channels designed to convey 100-year flows, with a trapezoidal cross-section, variable bottom width and depth, 4:1 maximum side slopes, 1-foot freeboard, and a minimum slope of 0.5 percent.

The proposed drainage channels have been sized utilizing Manning's equation for open channel flow, assuming a friction factor ("n") of 0.030 for dry-land grass channels. Maximum allowable velocities will be evaluated based on El Paso County drainage criteria, typically allowing for a maximum 100-year velocity of 5 feet per second. Erosion control mats have been specified for channel segments with maximum 100-year velocities up to 8 feet per second. The proposed channels will generally be seeded with native grasses for erosion control. Erosion control blankets will be provided where required based on erosive velocities.

Ditch flows will be diverted to drainage channels at the nearest practical location to minimize excessive roadside ditch sizes. Detailed channel hydraulic calculations are enclosed in Appendix B2.

F. Anticipated Drainage Problems and Solutions

The proposed Stormwater Detention Ponds A and B have been designed to mitigate the impacts of developed drainage from this project. The overall drainage plan for the subdivision includes a system of roadside ditches, channels, and culverts to convey developed flows through the site. The primary drainage problems anticipated within this development will consist of maintenance of these drainage channels, culverts, and detention pond facilities. Care will need to be taken to implement proper erosion control measures in the proposed roadside ditches, channels, and swales. Ditches will be designed to meet allowable velocity criteria. Erosion control blankets will be installed where necessary to minimize erosion concerns. Proper construction and maintenance of the proposed detention facilities will minimize downstream drainage impacts.

Public roadway improvements and ditches within the public right-of-way will be owned and maintained by El Paso County. The proposed stormwater detention ponds will be owned and maintained by the subdivision HOA.

VII. EROSION / SEDIMENT CONTROL

The Contractor will be required to implement Best Management Practices (BMP's) for erosion control through the course of construction. Sediment control measures will include installation of silt fence at the toe of disturbed slopes and hay bales protecting drainage ditches. Cut slopes will be stabilized during excavation as necessary and vegetation will be established for stabilization of disturbed areas as soon as possible. All ditches will be designed to meet El Paso County criteria for slope and velocity. The proposed detention pond will serve as a sediment basin during the construction phase of the project.

VIII. COST ESTIMATE AND DRAINAGE FEES

A cost estimate for proposed drainage improvements is enclosed in Appendix D, with a total estimated cost of approximately \$120,266 for subdivision drainage improvements.

The developer will finance all construction costs for proposed roadway and drainage improvements, and public facilities will be owned and maintained by El Paso County upon final acceptance. Private drainage facilities will be owned and maintained by the subdivision HOA.

This parcel is located in the West Cherry Creek Drainage Basin. No drainage and bridge fees will be due at time of recordation of the final plat as the subject site is not located in a fee basin.

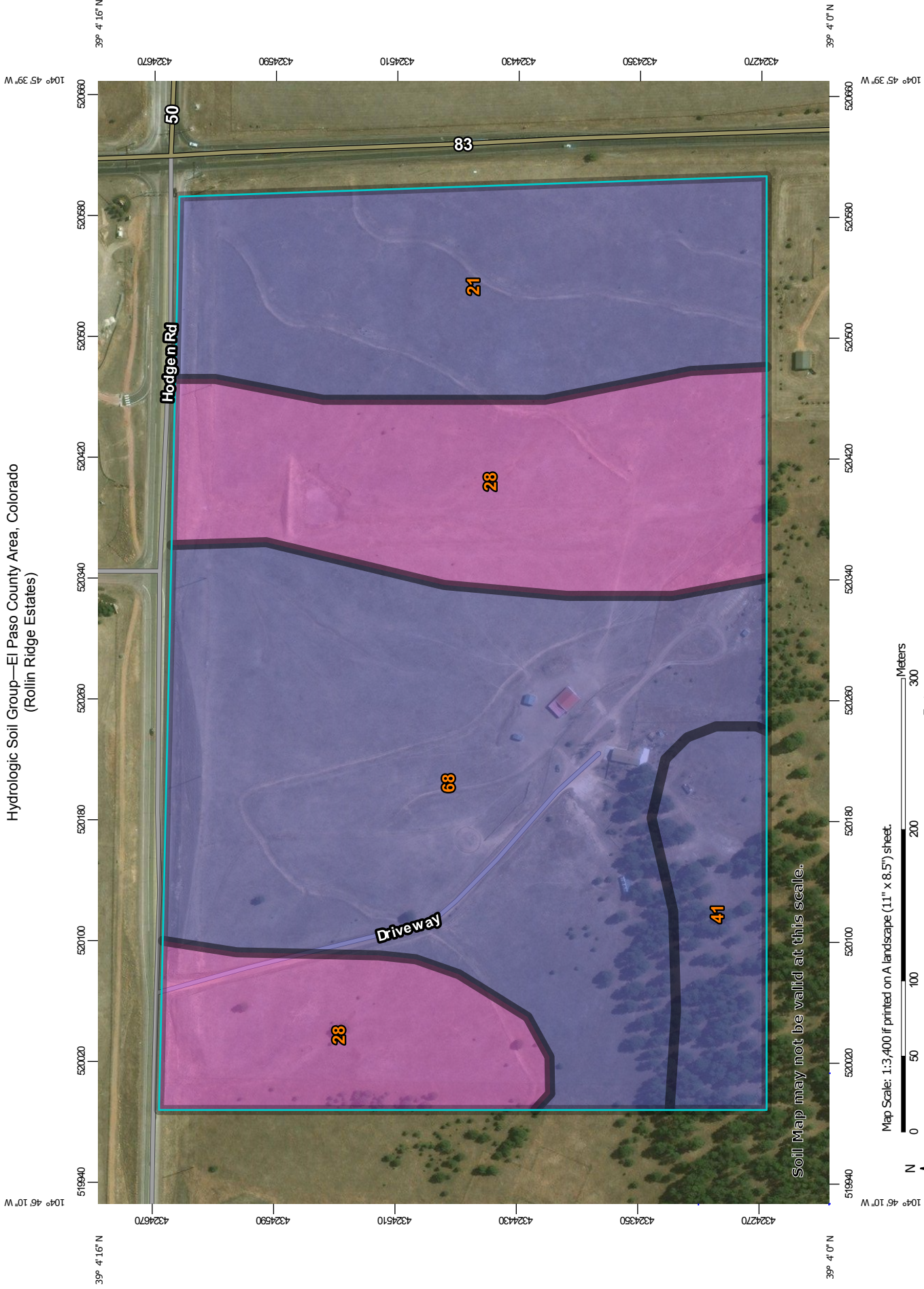
IX. SUMMARY

Rollin Ridge Filing No. 1 is a proposed residential subdivision consisting of 16 rural residential lots (2.5-acre minimum lot size) located at the southwest corner of State Highway 83 and Hodgen Road in northern El Paso County. Development of the proposed Rollin Ridge Estates Subdivision will generate an increase in developed runoff from the site, which will be mitigated through construction of on-site stormwater detention facilities. The proposed drainage patterns will remain consistent with historic conditions, and new drainage facilities constructed to El Paso County standards will safely convey runoff to suitable outfalls. Based on the implementation of on-site stormwater detention facilities, no downstream drainage improvements are proposed.

The proposed detention ponds will ensure that overall developed flows from the Rollin Ridge Estates Subdivision remain consistent with historic levels. Construction and proper maintenance of the proposed drainage and erosion control facilities will ensure that this subdivision has no significant adverse drainage impact on downstream or surrounding areas.


APPENDIX A
HYDROLOGIC CALCULATIONS

Hydrologic Soil Group—El Paso County Area, Colorado (Rollin Ridge Estates)




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


Water Features


 Streams and Canals


Transportation

 Rails


 Interstate Highways


 US Routes


 Major Roads


 Local Roads


Background

 Aerial Photography

 C

 C/D

 D

 Not rated or not available

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 14, Sep 23, 2016

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

Date(s) aerial images were photographed: Feb 22, 2014—Mar 9, 2017

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

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — El Paso County Area, Colorado (CO625)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
21	Cruckton sandy loam, 1 to 9 percent slopes	B	12.9	21.6%
28	Ellicott loamy coarse sand, 0 to 5 percent slopes	A	18.0	30.2%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	B	4.0	6.7%
68	Peyton-Pring complex, 3 to 8 percent slopes	B	24.8	41.5%
Totals for Area of Interest			59.7	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



United States
Department of
Agriculture

NRCS

Natural
Resources
Conservation
Service

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

Custom Soil Resource Report for **El Paso County Area, Colorado**



September 17, 2017

Preface

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

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

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

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

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

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

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How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

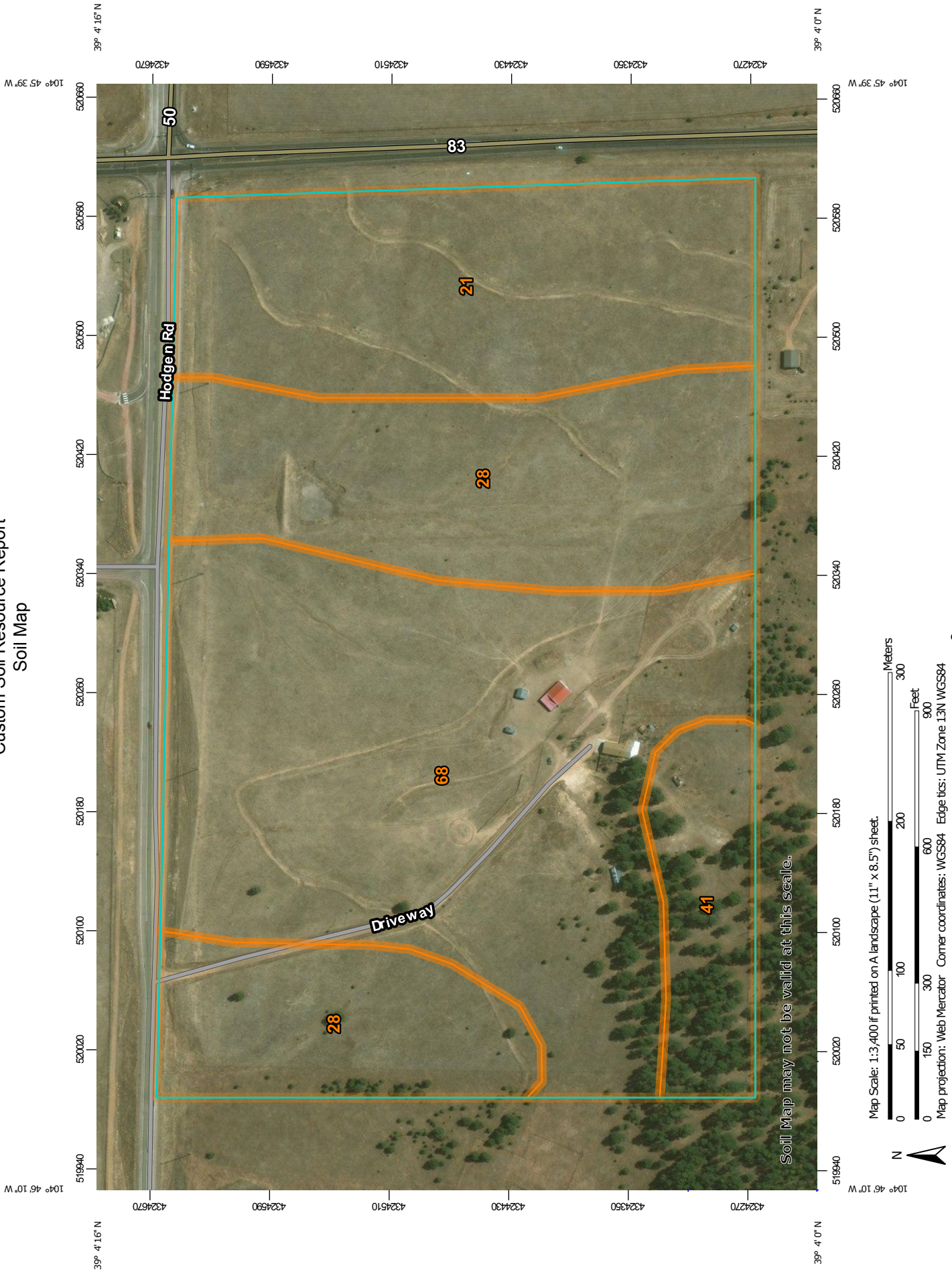
Custom Soil Resource Report

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

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

Custom Soil Resource Report
Soil Map



MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 14, Sep 23, 2016

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

Date(s) aerial images were photographed: Feb 22, 2014—Mar 9, 2017

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

Map Unit Legend

El Paso County Area, Colorado (CO625)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
21	Cruckton sandy loam, 1 to 9 percent slopes	12.9	21.6%
28	Ellicott loamy coarse sand, 0 to 5 percent slopes	18.0	30.2%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	4.0	6.7%
68	Peyton-Pring complex, 3 to 8 percent slopes	24.8	41.5%
Totals for Area of Interest		59.7	100.0%

Map Unit Descriptions

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

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

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

Custom Soil Resource Report

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

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

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

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

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

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

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

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

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

El Paso County Area, Colorado

21—Cruckton sandy loam, 1 to 9 percent slopes

Map Unit Setting

National map unit symbol: 367s
Elevation: 7,200 to 7,600 feet
Mean annual precipitation: 16 to 18 inches
Mean annual air temperature: 42 to 46 degrees F
Frost-free period: 110 to 120 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Cruckton

Setting

Landform: Flats, hills
Landform position (three-dimensional): Side slope, talus
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from arkose

Typical profile

A - 0 to 11 inches: sandy loam
Bt - 11 to 28 inches: sandy loam
C - 28 to 60 inches: loamy coarse sand

Properties and qualities

Slope: 1 to 9 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 5.9 inches)

Interpretive groups

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

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

28—Ellicott loamy coarse sand, 0 to 5 percent slopes

Map Unit Setting

National map unit symbol: 3680
Elevation: 5,500 to 6,500 feet
Mean annual precipitation: 13 to 15 inches
Mean annual air temperature: 47 to 50 degrees F
Frost-free period: 125 to 145 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Ellicott

Setting

Landform: Flood plains, stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy alluvium

Typical profile

A - 0 to 4 inches: loamy coarse sand
C - 4 to 60 inches: stratified coarse sand to sandy loam

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: Low (about 4.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7w
Hydrologic Soil Group: A
Ecological site: Sandy Bottomland LRU's A & B (R069XY031CO)
Other vegetative classification: SANDY BOTTOMLAND (069AY031CO)
Hydric soil rating: No

Minor Components

Fluvaquentic haplaquoll

Percent of map unit:

Landform: Swales

Hydric soil rating: Yes

Other soils

Percent of map unit:

Hydric soil rating: No

Pleasant

Percent of map unit:

Landform: Depressions

Hydric soil rating: Yes

41—Kettle gravelly loamy sand, 8 to 40 percent slopes

Map Unit Setting

National map unit symbol: 368h

Elevation: 7,000 to 7,700 feet

Farmland classification: Not prime farmland

Map Unit Composition

Kettle and similar soils: 85 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kettle

Setting

Landform: Hills

Landform position (three-dimensional): Side slope

Down-slope shape: Linear

Across-slope shape: Linear

Parent material: Sandy alluvium derived from arkose

Typical profile

E - 0 to 16 inches: gravelly loamy sand

Bt - 16 to 40 inches: gravelly sandy loam

C - 40 to 60 inches: extremely gravelly loamy sand

Properties and qualities

Slope: 8 to 40 percent

Depth to restrictive feature: More than 80 inches

Natural drainage class: Somewhat excessively drained

Runoff class: Medium

Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Available water storage in profile: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 7e

Hydrologic Soil Group: B

Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:

Hydric soil rating: No

Pleasant

Percent of map unit:

Landform: Depressions

Hydric soil rating: Yes

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

Map Unit Setting

National map unit symbol: 369f

Elevation: 6,800 to 7,600 feet

Farmland classification: Not prime farmland

Map Unit Composition

Peyton and similar soils: 40 percent

Pring and similar soils: 30 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Peyton

Setting

Landform: Hills

Landform position (three-dimensional): Side slope

Down-slope shape: Linear

Across-slope shape: Linear

Parent material: Arkosic alluvium derived from sedimentary rock and/or arkosic residuum weathered from sedimentary rock

Typical profile

A - 0 to 12 inches: sandy loam

Bt - 12 to 25 inches: sandy clay loam

BC - 25 to 35 inches: sandy loam

C - 35 to 60 inches: sandy loam

Properties and qualities

Slope: 3 to 5 percent

Depth to restrictive feature: More than 80 inches

Natural drainage class: Well drained

Runoff class: Low

Custom Soil Resource Report

Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Available water storage in profile: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 4c

Hydrologic Soil Group: B

Ecological site: Sandy Divide (R049BY216CO)

Hydric soil rating: No

Description of Pring

Setting

Landform: Hills

Landform position (three-dimensional): Side slope

Down-slope shape: Linear

Across-slope shape: Linear

Parent material: Arkosic alluvium derived from sedimentary rock

Typical profile

A - 0 to 14 inches: coarse sandy loam

C - 14 to 60 inches: gravelly sandy loam

Properties and qualities

Slope: 3 to 8 percent

Depth to restrictive feature: More than 80 inches

Natural drainage class: Well drained

Runoff class: Low

Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Available water storage in profile: Low (about 6.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 3e

Hydrologic Soil Group: B

Ecological site: Loamy Park (R048AY222CO)

Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:

Hydric soil rating: No

Pleasant

Percent of map unit:

Landform: Depressions

Hydric soil rating: Yes

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Table 6-6. Runoff Coefficients for Rational Method
(Source: UDFCD 2001)

Land Use or Surface Characteristics	Percent Impervious	Runoff Coefficients											
		2-year		5-year		10-year		25-year		50-year		100-year	
		HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D
Business													
Commercial Areas	95	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.87	0.87	0.88	0.88	0.89
Neighborhood Areas	70	0.45	0.49	0.49	0.53	0.53	0.57	0.58	0.62	0.60	0.65	0.62	0.68
Residential													
1/8 Acre or less	65	0.41	0.45	0.45	0.49	0.49	0.54	0.54	0.59	0.57	0.62	0.59	0.65
1/4 Acre	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
1/3 Acre	30	0.18	0.22	0.25	0.30	0.32	0.38	0.39	0.47	0.43	0.52	0.47	0.57
1/2 Acre	25	0.15	0.20	0.22	0.28	0.30	0.36	0.37	0.46	0.41	0.51	0.46	0.56
1 Acre	20	0.12	0.17	0.20	0.26	0.27	0.34	0.35	0.44	0.40	0.50	0.44	0.55
Industrial													
Light Areas	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Heavy Areas	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Parks and Cemeteries	7	0.05	0.09	0.12	0.19	0.20	0.29	0.30	0.40	0.34	0.46	0.39	0.52
Playgrounds	13	0.07	0.13	0.16	0.23	0.24	0.31	0.32	0.42	0.37	0.48	0.41	0.54
Railroad Yard Areas	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
Undeveloped Areas													
Historic Flow Analysis-- Greenbelts, Agriculture	2	0.03	0.05	0.09	0.16	0.17	0.26	0.26	0.38	0.31	0.45	0.36	0.51
Pasture/Meadow	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Forest	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Exposed Rock	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Offsite Flow Analysis (when landuse is undefined)	45	0.26	0.31	0.32	0.37	0.38	0.44	0.44	0.51	0.48	0.55	0.51	0.59
Streets													
Paved	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Gravel	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Drive and Walks	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Roofs	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Lawns	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50

3.2 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the hydraulically most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations.

For urban areas, the time of concentration (t_c) consists of an initial time or overland flow time (t_i) plus the travel time (t_r) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time (t_i) plus the time of travel in a concentrated form, such as a swale or drainageway. The travel portion (t_r) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.

$$t_c = t_i + t_t \quad (\text{Eq. 6-7})$$

Where:

t_c = time of concentration (min)

t_i = overland (initial) flow time (min)

t_t = travel time in the ditch, channel, gutter, storm sewer, etc. (min)

3.2.1 Overland (Initial) Flow Time

The overland flow time, t_i , may be calculated using Equation 6-8.

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \quad (\text{Eq. 6-8})$$

Where:

t_i = overland (initial) flow time (min)

C_5 = runoff coefficient for 5-year frequency (see Table 6-6)

L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)

S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t , which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t , can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5} \quad (\text{Eq. 6-9})$$

Where:

V = velocity (ft/s)

C_v = conveyance coefficient (from Table 6-7)

S_w = watercourse slope (ft/ft)

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

* For buried riprap, select C_v value based on type of vegetative cover.

The travel time is calculated by dividing the flow distance (in feet) by the velocity calculated using Equation 6-9 and converting units to minutes.

The time of concentration (t_c) is then the sum of the overland flow time (t_i) and the travel time (t_t) per Equation 6-7.

3.2.3 First Design Point Time of Concentration in Urban Catchments

Using this procedure, the time of concentration at the first design point (typically the first inlet in the system) in an urbanized catchment should not exceed the time of concentration calculated using Equation 6-10. The first design point is defined as the point where runoff first enters the storm sewer system.

$$t_c = \frac{L}{180} + 10 \quad (\text{Eq. 6-10})$$

Where:

t_c = maximum time of concentration at the first design point in an urban watershed (min)

L = waterway length (ft)

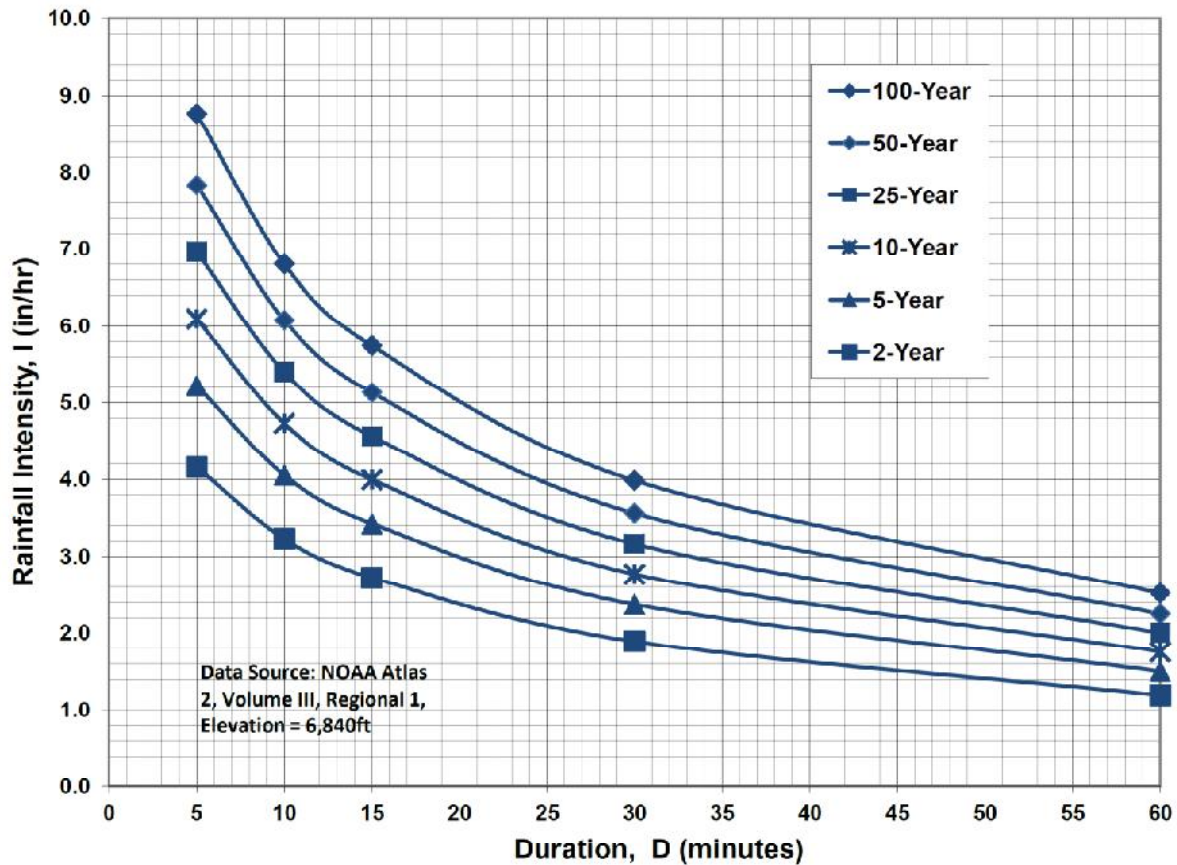
Equation 6-10 was developed using the rainfall-runoff data collected in the Denver region and, in essence, represents regional “calibration” of the Rational Method. Normally, Equation 6-10 will result in a lesser time of concentration at the first design point and will govern in an urbanized watershed. For subsequent design points, the time of concentration is calculated by accumulating the travel times in downstream drainageway reaches.

3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

3.2.5 Post-Development Time of Concentration

As Equation 6-8 indicates, the time of concentration is a function of the 5-year runoff coefficient for a drainage basin. Typically, higher levels of imperviousness (higher 5-year runoff coefficients) correspond to shorter times of concentration, and lower levels of imperviousness correspond to longer times of

Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency**IDF Equations**

$$I_{100} = -2.52 \ln(D) + 12.735$$

$$I_{50} = -2.25 \ln(D) + 11.375$$

$$I_{25} = -2.00 \ln(D) + 10.111$$

$$I_{10} = -1.75 \ln(D) + 8.847$$

$$I_5 = -1.50 \ln(D) + 7.583$$

$$I_2 = -1.19 \ln(D) + 6.035$$

Note: Values calculated by equations may not precisely duplicate values read from figure.

**ROLLIN RIDGE SUBDIVISION
COMPOSITE RUNOFF COEFFICIENTS - TYPICAL RURAL RESIDENTIAL LOTS**

DEVELOPED CONDITIONS									
5-YEAR C VALUES									
BASIN	TOTAL AREA (AC)	AREA (%)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (%)	WEIGHTED C VALUE
2.5-ACRE LOTS	2.50	11.00	BUILDING / PAVEMENT	0.90	89.00	LANDSCAPED	0.08		0.170
5-ACRE LOTS	5.00	7.00	BUILDING / PAVEMENT	0.90	93.00	LANDSCAPED	0.08		0.137
100-YEAR C VALUES									
BASIN	TOTAL AREA (AC)	AREA (%)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (%)	WEIGHTED C VALUE
2.5-ACRE LOTS	2.50	11.00	BUILDING / PAVEMENT	0.96	89.00	LANDSCAPED	0.35		0.417
5-ACRE LOTS	5.00	7.00	BUILDING / PAVEMENT	0.96	93.00	LANDSCAPED	0.35		0.393
IMPERVIOUS AREAS									
BASIN	TOTAL AREA (AC)	AREA (%)	SUB-AREA 1 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (%)	SUB-AREA 2 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (%)	WEIGHTED % IMP
2.5-ACRE LOTS	2.50	11.00	BUILDING / PAVEMENT	100	89.00	LANDSCAPED	0		11.000
5-ACRE LOTS	5.00	7.00	BUILDING / PAVEMENT	100	93.00	LANDSCAPED	0		7.000

ROLLIN RIDGE ESTATES
RATIONAL METHOD

HISTORIC FLOWS

BASIN	DESIGN POINT	AREA (AC)	C		Overland Flow			Channel flow					TOTAL Tc ⁽⁴⁾ (MIN)	INTENSITY ⁽⁵⁾		PEAK FLOW		
			5-YEAR ⁽⁷⁾	100-YEAR ⁽⁷⁾	LENGTH (FT)	SLOPE (FT/FT)	Tco ⁽¹⁾ (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT C	SLOPE (FT/FT)	SCS ⁽²⁾ VELOCITY (FT/S)	Tt ⁽³⁾ (MIN)		5-YR (IN/HR)	100-YR (IN/HR)	Q5 ⁽⁶⁾ (CFS)	Q100 ⁽⁶⁾ (CFS)	
WEST CHERRY CREEK BASIN																		
OA1	OA1	15.03	0.080	0.350	300	0.083	16.0	700	15.00	0.0486	3.31	3.5	19.5	19.5	3.13	5.25	3.76	27.62
A		39.30	0.080	0.350			0.0	1220	15.00	0.0352	2.81	7.2	7.2	7.2	4.62	7.75	14.51	106.62
OA1,A	1	54.33	0.080	0.350									26.7	26.7	2.65	4.46	11.54	84.73
B	2	12.18	0.080	0.350	300	0.053	18.5	790	15.00	0.0532	3.46	3.8	22.3	22.3	2.92	4.91	2.85	20.92
OB1	OB1	18.76	0.080	0.350	300	0.057	18.1	770	15.00	0.0468	3.24	4.0	22.1	22.1	2.94	4.93	4.41	32.40
OB1,B	2.1	30.94	0.080	0.350									22.3	22.3	2.92	4.91	7.24	53.15
C	3	5.46	0.137	0.393	100	0.080	8.8	200	15.00	0.10	4.74	0.7	9.5	9.5	4.20	7.06	3.14	15.14

1) OVERLAND FLOW Tco = (0.395*(1.1-RUNOFF COEFFICIENT)*(OVERLAND FLOW LENGTH^(0.5))/(SLOPE^(0.333)))

2) SCS VELOCITY = C * ((SLOPE(FT/FT))^0.5)

C = 2.5 FOR HEAVY MEADOW

C = 5 FOR TILLAGE/FIELD

C = 7 FOR SHORT PASTURE AND LAWNS

C = 10 FOR NEARLY BARE GROUND

C = 15 FOR GRASSED WATERWAY

C = 20 FOR PAVED AREAS AND SHALLOW PAVED SWALES

3) MANNING'S CHANNEL TRAVEL TIME = LV (WHEN CHANNEL VELOCITY IS KNOWN)

4) Tc = Tco + Tt

*** IF TOTAL TIME OF CONCENTRATION IS LESS THAN 5 MINUTES, THEN 5 MINUTES IS USED

5) INTENSITY BASED ON I-D-F EQUATIONS IN CITY OF COLORADO SPRINGS DRAINAGE CRITERIA MANUAL

$$I_5 = -1.5 * \ln(Tc) + 7.583$$

$$I_{100} = -2.52 * \ln(Tc) + 12.735$$

6) Q = C/A

**ROLLIN RIDGE SUBDIVISION
COMPOSITE RUNOFF COEFFICIENTS**

5-YEAR C-VALUES									
BASIN	TOTAL AREA (AC)	AREA (%)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (%)	WEIGHTED C VALUE
OA1	15.03	15.03	5-AC LOTS	0.137					0.137
A1	21.69	21.69	2.5-AC LOTS	0.170					0.170
OA1,A1	36.72								0.156
A2	5.12	5.12	2.5-AC LOTS	0.170					0.170
OA1,A1-A2	41.84								0.158
A3	5.70	3.74	BUILDING / PAVEMENT	0.9	1.96	MEADOW / LS	0.08		0.618
OA1,A1-A3	47.54								0.213
A4	4.74	4.74	2.5-AC LOTS	0.170					0.170
OA1,A1-A4	52.28								0.209
A5	2.36	2.36	LANDSCAPE	0.080					0.080
OA1,A1-A5	54.64								0.204
OB1	18.76	18.76	5-AC LOTS	0.137					0.137
B	11.83	11.83	2.5-AC LOTS	0.170					0.170
OB1,B	30.59								0.150
C	5.46	5.46	2.5-AC LOTS	0.170					0.170

100-YEAR C-VALUES									
BASIN	TOTAL AREA (AC)	AREA (%)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (%)	WEIGHTED C VALUE
OA1	15.03	15.03	5-AC LOTS	0.393					0.393
A1	21.69	21.69	2.5-AC LOTS	0.417					0.417
OA1,A1	36.72								0.407
A2	5.12	5.12	2.5-AC LOTS	0.417					0.417
OA1,A1-A2	41.84								0.408
A3	5.70	3.74	BUILDING / PAVEMENT	0.96	1.96	MEADOW / LS	0.35		0.750
OA1,A1-A3	47.54								0.449
A4	4.74	4.74	2.5-AC LOTS	0.417					0.417
OA1,A1-A4	52.28								0.446
A5	2.36	2.36	LANDSCAPE	0.350					0.350
OA1,A1-A5	54.64								0.442
OB1	18.76	18.76	5-AC LOTS	0.393					0.393
B	11.83	11.83	2.5-AC LOTS	0.417					0.417
OB1,B	30.59								0.402
C	5.46	5.46	2.5-AC LOTS	0.417					0.417

ROLLIN RIDGE ESTATES
RATIONAL METHOD

DEVELOPED FLOWS

BASIN	DESIGN AREA POINT (AC)	C		Overland Flow			Channel flow					TOTAL Tc ⁽⁴⁾ (MIN)	INTENSITY ⁽⁶⁾		PEAK FLOW	
		5-YEAR ⁽⁷⁾	100-YEAR ⁽⁷⁾	LENGTH (FT)	SLOPE (FT/FT)	Tco ⁽¹⁾ (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT C	SLOPE (FT/FT)	SCS ⁽²⁾ VELOCITY (FT/S)	Tt ⁽³⁾ (MIN)		5-YR (IN/HR)	100-YR (IN/HR)	Q5 ⁽⁶⁾ (CFS)	Q100 ⁽⁶⁾ (CFS)
WEST CHERRY CREEK BASIN																
OA1	OA1	15.03	0.137													
OA1	OA1	21.69	0.170	300	0.083	15.1	700	15.00	0.0486	3.31	3.5	18.6	3.20	5.37	6.59	31.71
OA1,A1	A1	36.72	0.156			0.0	800	15.00	0.035	2.81	4.8	4.8	5.0	5.17	8.68	19.06
OA2	A2	5.12	0.170	100	0.040	10.7	670	15.00	0.0851	4.38	2.6	13.3	3.70	6.22	4.80	16.37
OA1,A1-A2	A2.1	41.84	0.158									23.4	2.86	4.80	18.89	81.86
A3		5.70	0.618	100	0.080	4.4	770	15.00	0.0481	3.29	3.9	8.3	8.3	4.41	7.40	15.52
Channel A3						0.0	250	15.00	0.012	1.64	2.5	2.5				31.62
OA1,A1-A3	A3	47.54	0.213									25.9	25.9	2.70	4.54	27.36
A4	A4	4.74	0.170	100	0.040	10.7	740	15.00	0.046	3.22	3.8	14.6	14.6	3.57	5.99	2.87
OA1,A1-A4	A4.1	52.28	0.209									25.9	25.9	2.70	4.54	29.53
A5		2.36	0.080													
OA1,A1-A5	1	54.64	0.204			0.0	230	15.00	0.0522	3.43	1.1	1.1	5.0	5.17	8.68	0.98
												27.0	27.0	2.64	4.43	29.41
B		11.83	0.170	300	0.053	16.9	790	15.00	0.0532	3.46	3.8	20.7	20.7	3.04	5.10	6.11
OB1	OB1	18.76	0.137	300	0.057	17.1	770	15.00	0.0468	3.24	4.0	21.1	21.1	3.01	5.05	7.74
OB1B	2.1	30.59	0.150									20.7	20.7	3.04	5.10	13.94
C	3	5.46	0.184	100	0.080	8.4	200	15.00	0.10	4.74	0.7	9.1	9.1	4.27	7.17	4.29

DETAILED FLOWS

BASIN	DESIGN AREA POINT (AC)	C		Overland Flow			Channel flow				TOTAL		INTENSITY ⁽⁶⁾		PEAK FLOW	
		5-YEAR ⁽⁷⁾	100-YEAR ⁽⁷⁾	LENGTH (FT)	SLOPE (FT/FT)	T _{CO} ⁽¹⁾ (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT C	SLOPE (FT/FT)	SCS ⁽²⁾ VELOCITY (FT/S)	T _L ⁽³⁾ (MIN)	T _C ⁽⁴⁾ (MIN)	5-YR (IN/HR)	100-YR (IN/HR)	Q ₅ ⁽⁶⁾ (CFS)	Q ₁₀₀ ⁽⁶⁾ (CFS)
OA1,A1-A5	1d														0.40	63.50
B	2d														0.10	10.40
OB1,B	2.1d														7.84	47.65

1) OVERLAND FLOW T_{CO} = (0.395*(1.1-RUNOFF COEFFICIENT)*(OVERLAND FLOW LENGTH*(0.5)/(SLOPE^(0.333)))

2) SCS VELOCITY = C * ((SLOPE*(FT/FT)^0.5)

C = 2.5 FOR HEAVY MEADOW

C = 5 FOR TILLAGE/FIELD

C = 7 FOR SHORT PASTURE AND LAWNS

C = 10 FOR NEARLY BARE GROUND

C = 15 FOR GRASSED WATERWAY

C = 20 FOR PAVED AREAS AND SHALLOW PAVED SWALES

3) MANNING'S CHANNEL TRAVEL TIME = L/V (WHEN CHANNEL VELOCITY IS KNOWN)

4) T_C = T_{CO} + T_t

*** IF TOTAL TIME OF CONCENTRATION IS LESS THAN 5 MINUTES, THEN 5 MINUTES IS USED

5) INTENSITY BASED ON I-D-F EQUATIONS IN CITY OF COLORADO SPRINGS DRAINAGE CRITERIA MANUAL

$$I_b = -1.5 * \ln(T_c) + 7.583$$

$$I_{100} = -2.52 * \ln(T_c) + 12.735$$

6) Q = C I A

7) WEIGHTED AVERAGE C VALUES FOR COMBINED BASINS

APPENDIX B1

HYDRAULIC CALCULATIONS - CULVERTS

**ROLLIN RIDGE - FILING NO. 1
CULVERT DESIGN SUMMARY**

BASIN	DESIGN POINT	RD CL ELEV	INV IN ELEV	INV OUT ELEV	PIPE LENGTH (FT)	# of CULVERTS	PIPE DIA (FT)	TOTAL Q ₅ (CFS)	PER PIPE Q ₅ (CFS)	Q ₅ MAX ALLOWABLE HEADWATER ¹	CALC Q ₅ HW ELEV	TOTAL Q ₁₀₀ (CFS)	PER PIPE Q ₁₀₀ (CFS)	Q ₁₀₀ MAX ALLOWABLE HEADWATER ²	CALC Q ₁₀₀ HW ELEV
PROPOSED CULVERTS:															
A1	A1	7539.04	7534.15	7533.35	74.0	1	3.0	16.4	16.4	7537.2	7536.0	71.7	71.7	7539.6	7539.1
A2	A2	7543.00	7539.49	7538.74	75.5	1	1.5	3.2	3.2	7541.0	7540.5	13.3	13.3	7543.6	7542.3
A2.1	A2.1	7536.00	7534.00	7524.50	107.9	1	4.0	18.9	18.9	7538.0	7535.6	81.9	81.9	7536.6	7536.3
A4	A4	7538.00	7535.41	7524.40	173.1	1	2.0	2.9	2.9	7537.4	7536.2	11.8	11.8	7538.3	7537.2
EXISTING HODGEN ROAD CULVERTS:															
DP-1	1	7540.50	7522.60	7514.00	222.7	1	4.0	11.5	11.5	7526.6	7524.1	84.7	84.7	7541.1	7527.4
DP-2.1	2.1	7541.10	7531.40	7526.00	121.7	1	3.5	7.2	7.2	7534.9	7532.6	53.2	53.2	7541.7	7535.2

¹ Q₅ MAX. ALLOWABLE HEADWATER, HW/D = 1.0

² Q₁₀₀ MAX. ALLOWABLE HEADWATER = 12" DEPTH AT GUTTER FLOWLINE (PER DCM TABLE 6-1)

HY-8 Culvert Analysis Report – Rollin Ridge Filing No. 1

Crossing Discharge Data – Culvert A1

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 5 cfs

Design Flow: 16.4 cfs

Maximum Flow: 71.7 cfs

Table 1 - Summary of Culvert Flows at Crossing: Crossing A1

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert A1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
7535.09	5.00	5.00	0.00	1
7535.63	11.67	11.67	0.00	1
7535.96	16.40	16.40	0.00	1
7536.46	25.01	25.01	0.00	1
7536.80	31.68	31.68	0.00	1
7537.13	38.35	38.35	0.00	1
7537.50	45.02	45.02	0.00	1
7537.90	51.69	51.69	0.00	1
7538.36	58.36	58.36	0.00	1
7538.87	65.03	65.03	0.00	1
7539.10	71.70	67.65	3.88	11
7539.04	67.00	67.00	0.00	Overtopping

Rating Curve Plot for Crossing: Crossing A1

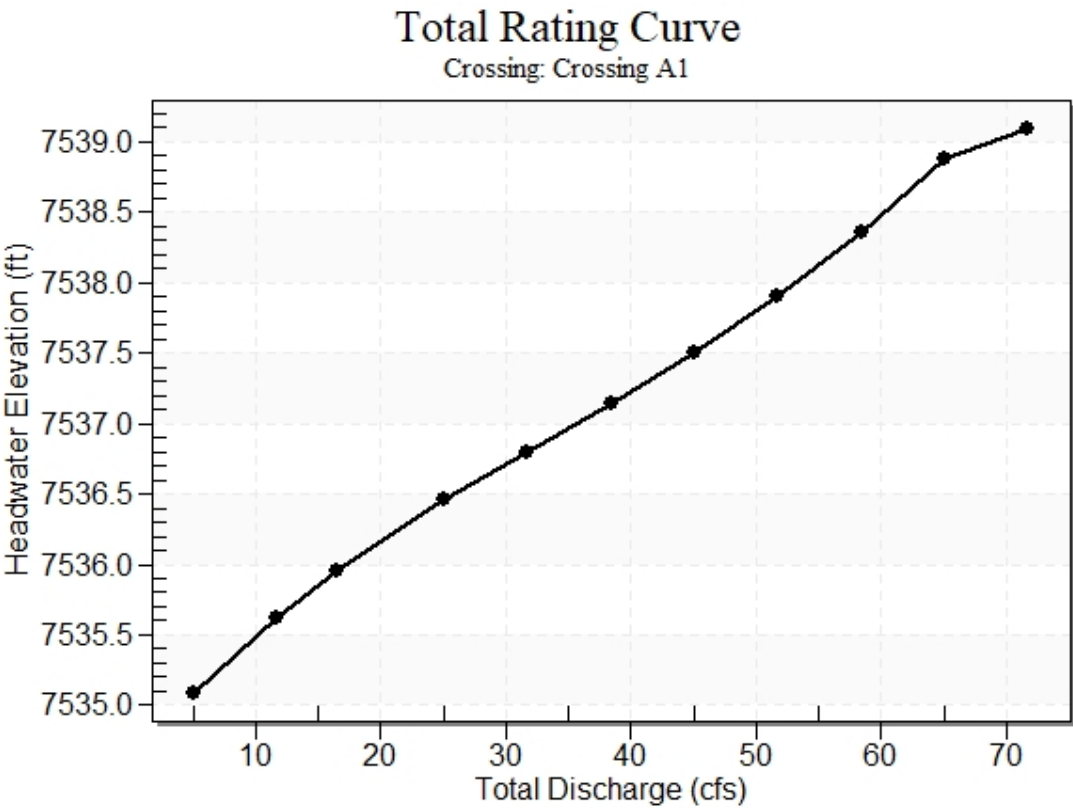


Table 2 - Culvert Summary Table: Culvert A1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5.00	5.00	7535.09	0.942	0.0*	1-S2n	0.544	0.700	0.544	0.329	5.710	2.858
11.67	11.67	7535.63	1.476	0.357	1-S2n	0.831	1.084	0.844	0.521	7.150	3.686
16.40	16.40	7535.96	1.807	0.638	1-S2n	0.992	1.294	1.013	0.622	7.806	4.065
25.01	25.01	7536.46	2.307	1.150	1-S2n	1.244	1.613	1.282	0.772	8.672	4.574
31.68	31.68	7536.80	2.647	1.566	1-S2n	1.421	1.825	1.471	0.868	9.187	4.881
38.35	38.35	7537.13	2.985	2.007	1-S2n	1.591	2.015	1.650	0.954	9.631	5.140
45.02	45.02	7537.50	3.346	2.477	5-S2n	1.758	2.186	1.822	1.032	10.021	5.367
51.69	51.69	7537.90	3.750	3.307	5-S2n	1.927	2.338	1.992	1.103	10.372	5.569
58.36	58.36	7538.36	4.207	3.769	5-S2n	2.105	2.471	2.164	1.169	10.690	5.751
65.03	65.03	7538.87	4.725	4.269	5-S2n	2.302	2.585	2.347	1.231	10.964	5.918
71.70	67.65	7539.10	4.946	4.476	5-S2n	2.391	2.625	2.426	1.289	11.049	6.072

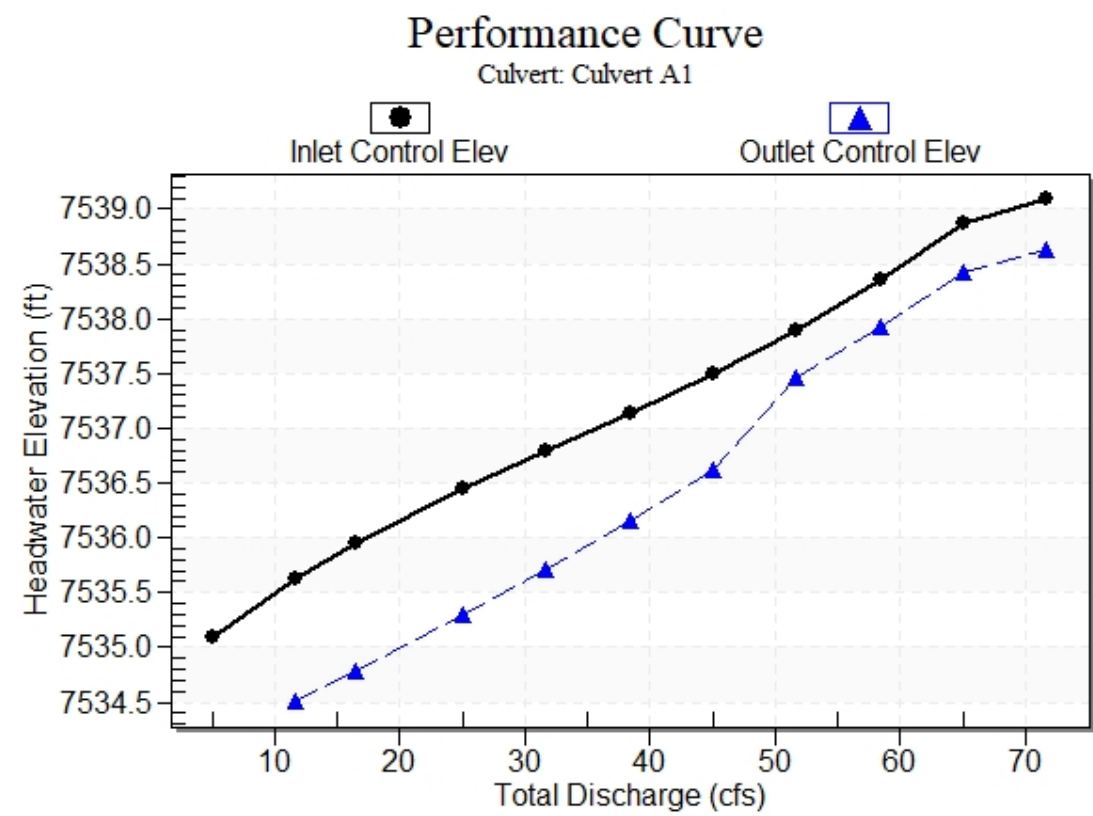
* Full Flow Headwater elevation is below inlet invert.

Straight Culvert

Inlet Elevation (invert): 7534.15 ft, Outlet Elevation (invert): 7533.35 ft

Culvert Length: 74.00 ft, Culvert Slope: 0.0108

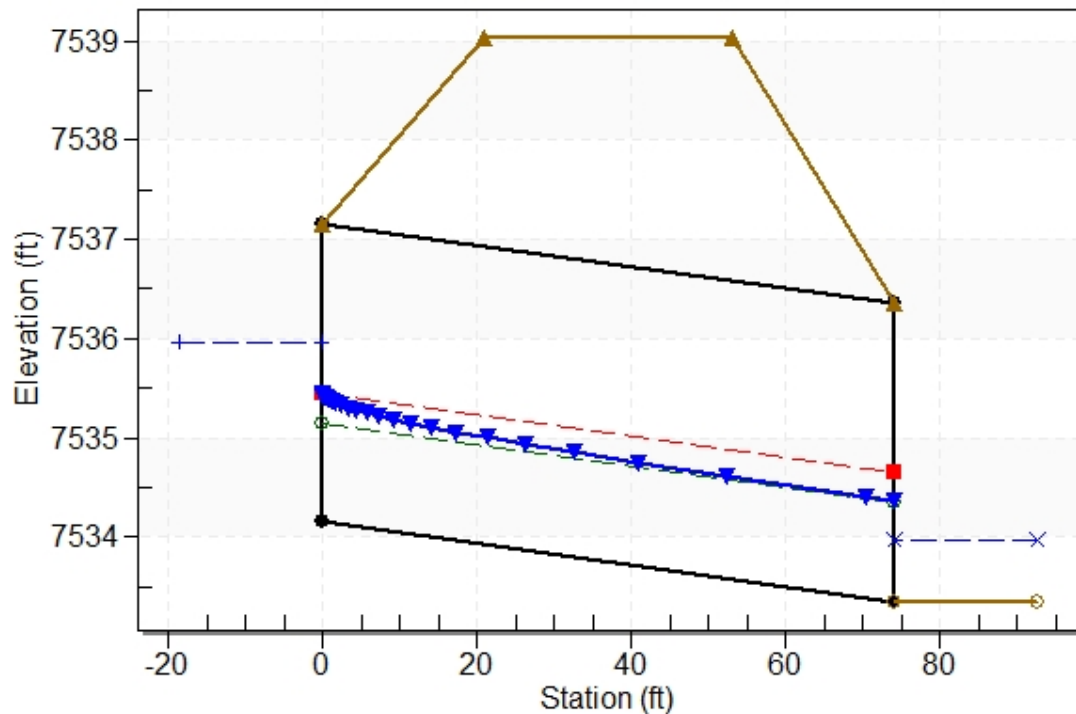
Culvert Performance Curve Plot: Culvert A1



Water Surface Profile Plot for Culvert: Culvert A1

Crossing - Crossing A1, Design Discharge - 16.4 cfs

Culvert - Culvert A1, Culvert Discharge - 16.4 cfs



Site Data - Culvert A1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7534.15 ft

Outlet Station: 74.00 ft

Outlet Elevation: 7533.35 ft

Number of Barrels: 1

Culvert Data Summary - Culvert A1

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: Crossing A1)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
5.00	7533.68	0.33	2.86	0.41	0.98
11.67	7533.87	0.52	3.69	0.65	1.04
16.40	7533.97	0.62	4.06	0.78	1.07
25.01	7534.12	0.77	4.57	0.96	1.10
31.68	7534.22	0.87	4.88	1.08	1.12
38.35	7534.30	0.95	5.14	1.19	1.13
45.02	7534.38	1.03	5.37	1.29	1.14
51.69	7534.45	1.10	5.57	1.38	1.15
58.36	7534.52	1.17	5.75	1.46	1.16
65.03	7534.58	1.23	5.92	1.54	1.17
71.70	7534.64	1.29	6.07	1.61	1.18

Tailwater Channel Data - Crossing A1

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 4.00 ft

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0300

Channel Invert Elevation: 7533.35 ft

Roadway Data for Crossing: Crossing A1

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 7539.04 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

Crossing Discharge Data – Culvert A2

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 2 cfs

Design Flow: 3.2 cfs

Maximum Flow: 13.3 cfs

Table 4 - Summary of Culvert Flows at Crossing: Crossing A2

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert A2 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
7540.22	2.00	2.00	0.00	1
7540.45	3.20	3.20	0.00	1
7540.62	4.26	4.26	0.00	1
7540.78	5.39	5.39	0.00	1
7540.95	6.52	6.52	0.00	1
7541.11	7.65	7.65	0.00	1
7541.30	8.78	8.78	0.00	1
7541.51	9.91	9.91	0.00	1
7541.75	11.04	11.04	0.00	1
7542.02	12.17	12.17	0.00	1
7542.43	13.30	13.30	0.00	1
7543.00	14.81	14.81	0.00	Overtopping

Rating Curve Plot for Crossing: Crossing A2

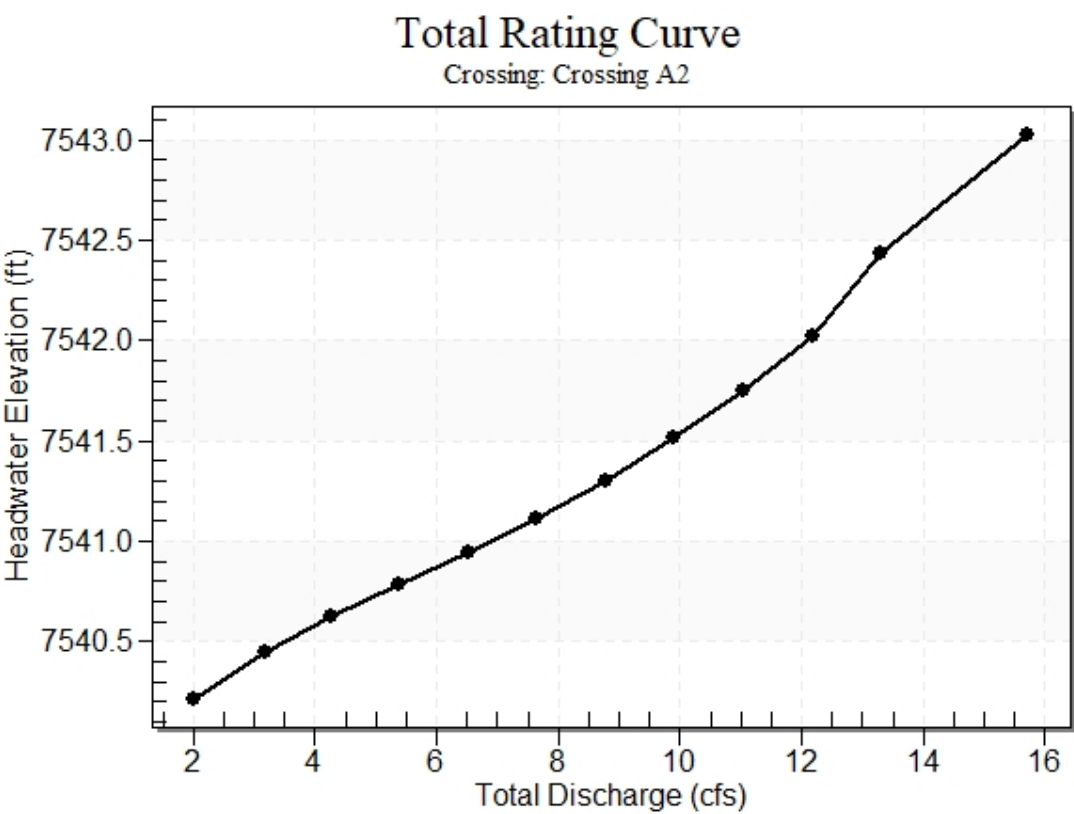


Table 5 - Culvert Summary Table: Culvert A2

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2.00	2.00	7540.22	0.726	0.0*	1-S2n	0.443	0.533	0.443	0.445	4.576	2.522
3.20	3.20	7540.45	0.958	0.062	1-S2n	0.568	0.681	0.568	0.531	5.214	2.836
4.26	4.26	7540.62	1.130	0.273	1-S2n	0.665	0.791	0.665	0.591	5.629	3.046
5.39	5.39	7540.78	1.294	0.516	1-S2n	0.762	0.895	0.762	0.646	5.977	3.231
6.52	6.52	7540.95	1.455	0.780	1-S2n	0.856	0.988	0.859	0.694	6.232	3.389
7.65	7.65	7541.11	1.625	1.069	5-S2n	0.951	1.071	0.951	0.736	6.478	3.527
8.78	8.78	7541.30	1.812	1.558	5-S2n	1.050	1.147	1.050	0.775	6.647	3.650
9.91	9.91	7541.51	2.022	1.861	5-S2n	1.161	1.214	1.161	0.811	6.752	3.762
11.04	11.04	7541.75	2.259	2.158	7-M2c	1.317	1.272	1.272	0.845	6.910	3.865
12.17	12.17	7542.02	2.525	2.527	7-M2c	1.500	1.321	1.321	0.876	7.385	3.961
13.30	13.30	7542.43	2.821	2.943	7-M2c	1.500	1.361	1.361	0.906	7.894	4.050

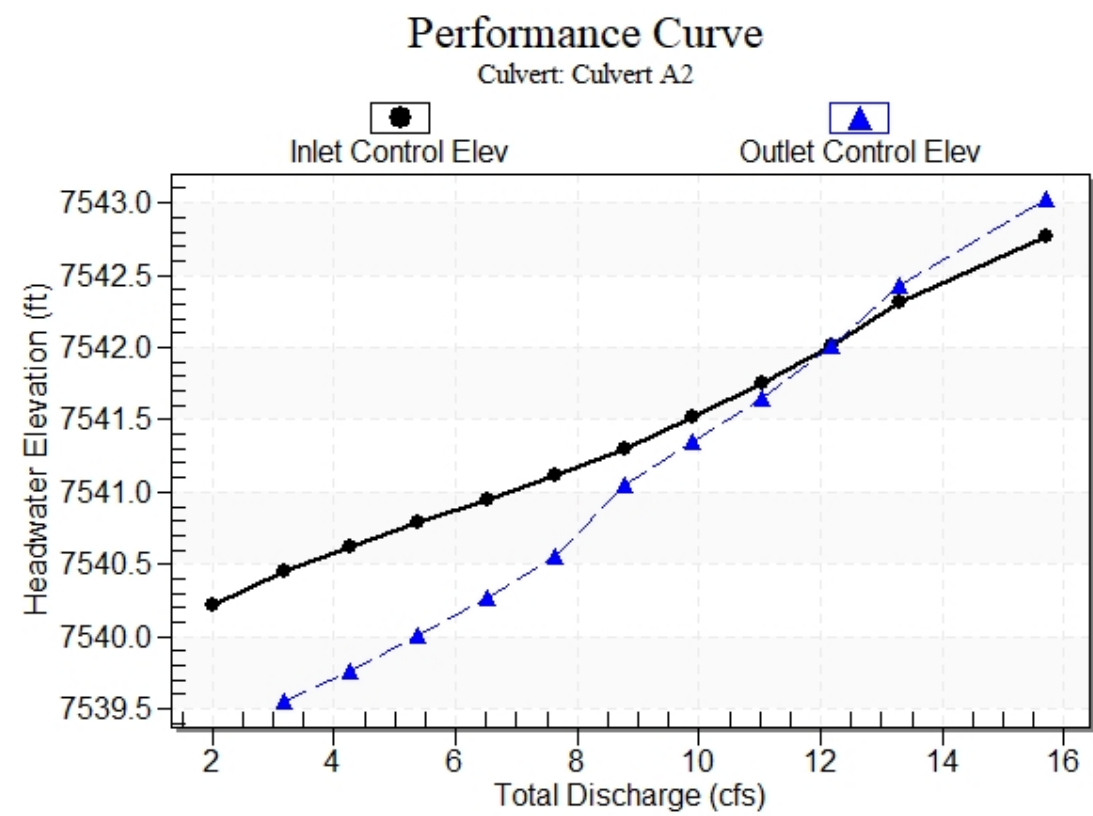
* Full Flow Headwater elevation is below inlet invert.

Straight Culvert

Inlet Elevation (invert): 7539.49 ft, Outlet Elevation (invert): 7538.74 ft

Culvert Length: 75.50 ft, Culvert Slope: 0.0099

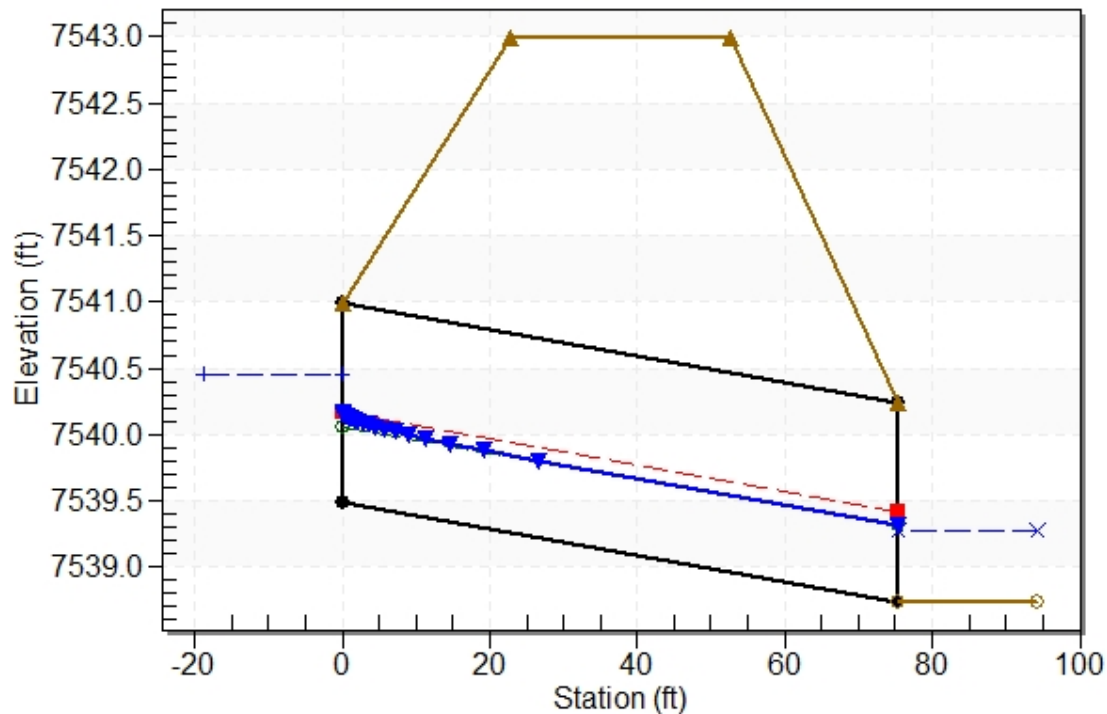
Culvert Performance Curve Plot: Culvert A2



Water Surface Profile Plot for Culvert: Culvert A2

Crossing - Crossing A2, Design Discharge - 3.2 cfs

Culvert - Culvert A2, Culvert Discharge - 3.2 cfs



Site Data - Culvert A2

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7539.49 ft

Outlet Station: 75.50 ft

Outlet Elevation: 7538.74 ft

Number of Barrels: 1

Culvert Data Summary - Culvert A2

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 6 - Downstream Channel Rating Curve (Crossing: Crossing A2)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
2.00	7539.19	0.45	2.52	0.56	0.94
3.20	7539.27	0.53	2.84	0.66	0.97
4.26	7539.33	0.59	3.05	0.74	0.99
5.39	7539.39	0.65	3.23	0.81	1.00
6.52	7539.43	0.69	3.39	0.87	1.01
7.65	7539.48	0.74	3.53	0.92	1.02
8.78	7539.52	0.78	3.65	0.97	1.03
9.91	7539.55	0.81	3.76	1.01	1.04
11.04	7539.59	0.85	3.87	1.05	1.05
12.17	7539.62	0.88	3.96	1.09	1.05
13.30	7539.65	0.91	4.05	1.13	1.06

Tailwater Channel Data - Crossing A2

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0300

Channel Invert Elevation: 7538.74 ft

Roadway Data for Crossing: Crossing A2

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 7543.00 ft

Roadway Surface: Paved

Roadway Top Width: 30.00 ft

Crossing Discharge Data – Culvet A2.1

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 10 cfs

Design Flow: 18.9 cfs

Maximum Flow: 81.9 cfs

Table 7 - Summary of Culvert Flows at Crossing: Crossing A2.1

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert A2.1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
7535.16	10.00	10.00	0.00	1
7535.62	18.90	18.90	0.00	1
7535.86	24.38	24.38	0.00	1
7536.04	31.57	28.83	2.52	11
7536.10	38.76	29.99	8.58	5
7536.14	45.95	30.92	14.83	4
7536.17	53.14	31.77	21.28	4
7536.21	60.33	32.52	27.76	4
7536.24	67.52	33.22	34.12	3
7536.27	74.71	33.91	40.68	3
7536.29	81.90	34.56	47.26	3
7536.00	27.90	27.90	0.00	Overtopping

Rating Curve Plot for Crossing: Crossing A2.1

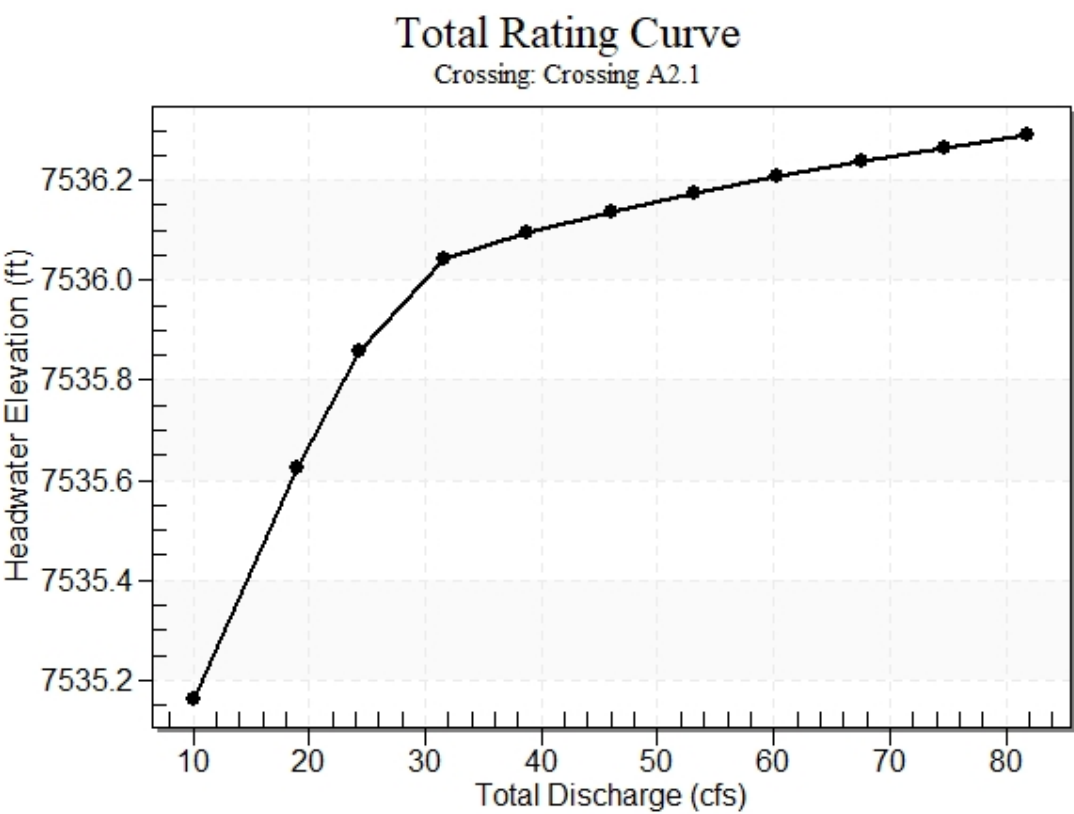


Table 8 - Culvert Summary Table: Culvert A2.1

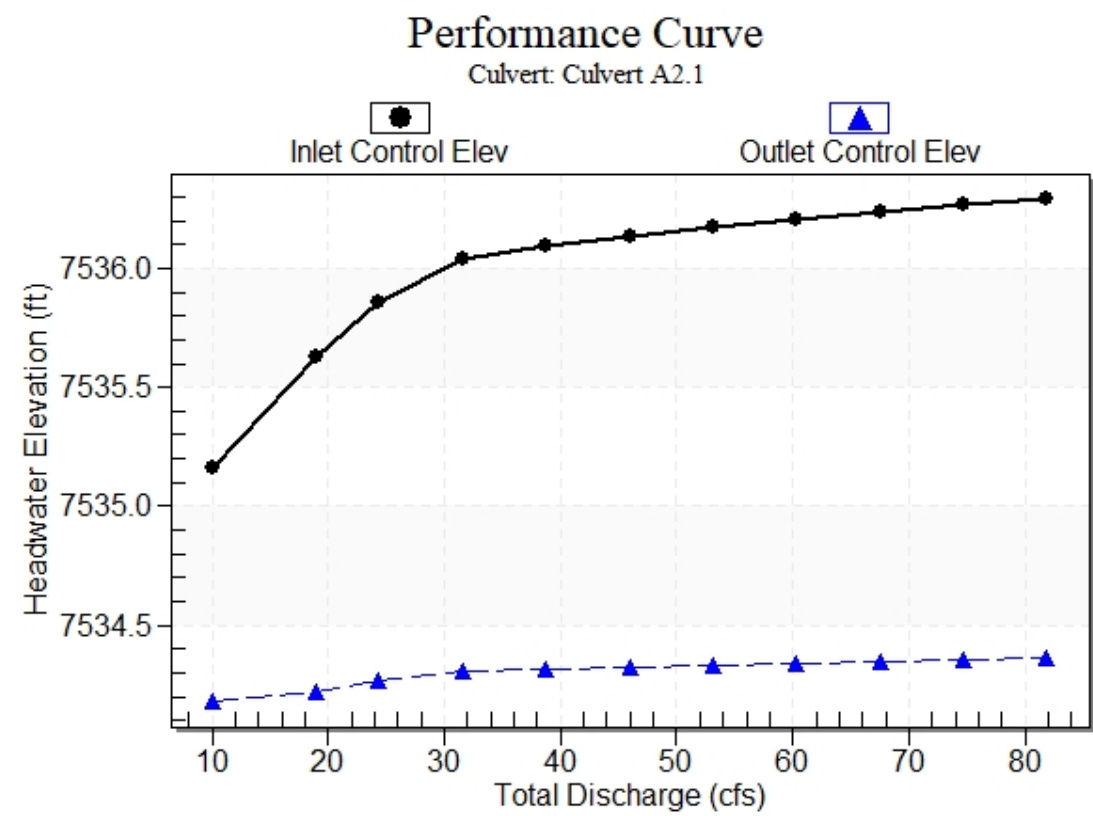
Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
10.00	10.00	7535.16	1.164	0.180	1-JS1f	0.421	0.921	4.000	9.700	0.796	0.000
18.90	18.90	7535.62	1.624	0.224	1-JS1f	0.571	1.278	4.000	9.700	1.504	0.000
24.38	24.38	7535.86	1.860	0.264	1-JS1f	0.647	1.458	4.000	9.700	1.940	0.000
31.57	28.83	7536.04	2.042	0.305	1-JS1f	0.703	1.591	4.000	9.700	2.294	0.000
38.76	29.99	7536.10	2.095	0.316	1-JS1f	0.718	1.624	4.000	9.700	2.387	0.000
45.95	30.92	7536.14	2.136	0.326	1-JS1f	0.728	1.650	4.000	9.700	2.461	0.000
53.14	31.77	7536.17	2.173	0.335	1-JS1f	0.737	1.673	4.000	9.700	2.528	0.000
60.33	32.52	7536.21	2.206	0.343	1-JS1f	0.745	1.694	4.000	9.700	2.588	0.000
67.52	33.22	7536.24	2.236	0.351	1-JS1f	0.753	1.713	4.000	9.700	2.644	0.000
74.71	33.91	7536.27	2.265	0.359	1-JS1f	0.761	1.731	4.000	9.700	2.698	0.000
81.90	34.56	7536.29	2.293	0.367	1-JS1f	0.768	1.749	4.000	9.700	2.750	0.000

Straight Culvert

Inlet Elevation (invert): 7534.00 ft, Outlet Elevation (invert): 7524.50 ft

Culvert Length: 108.32 ft, Culvert Slope: 0.0880

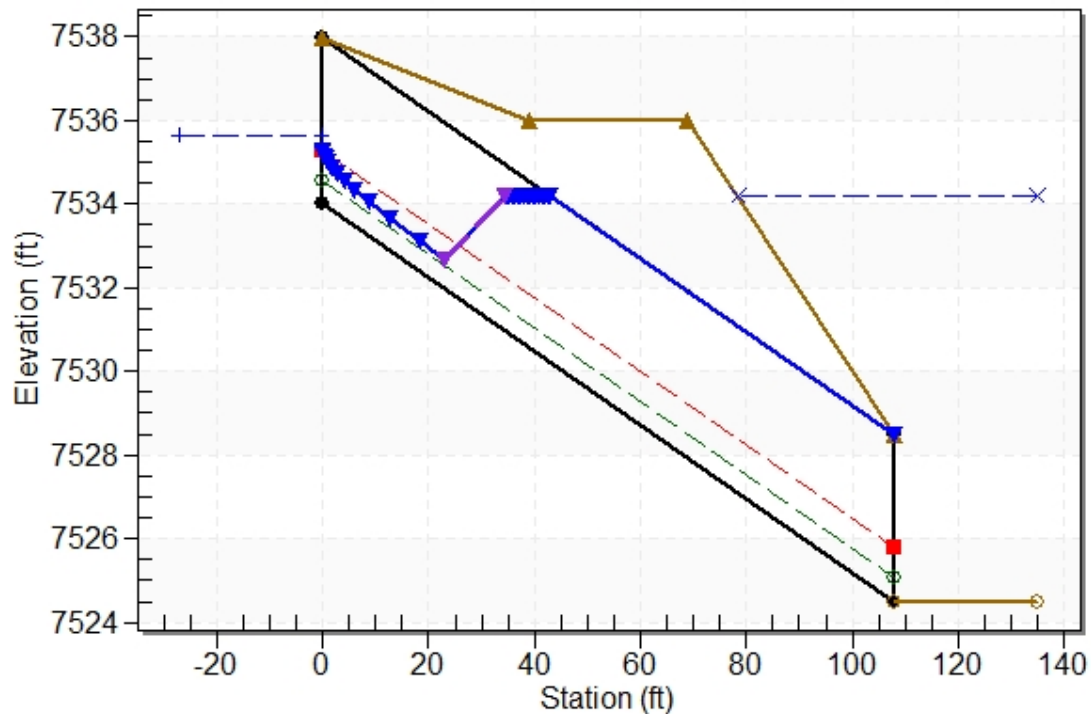
Culvert Performance Curve Plot: Culvert A2.1



Water Surface Profile Plot for Culvert: Culvert A2.1

Crossing - Crossing A2.1, Design Discharge - 18.9 cfs

Culvert - Culvert A2.1, Culvert Discharge - 18.9 cfs



Site Data - Culvert A2.1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7534.00 ft

Outlet Station: 107.90 ft

Outlet Elevation: 7524.50 ft

Number of Barrels: 1

Culvert Data Summary - Culvert A2.1

Barrel Shape: Circular

Barrel Diameter: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 9 - Downstream Channel Rating Curve (Crossing: Crossing A2.1)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
10.00	7534.20	9.70
18.90	7534.20	9.70
24.38	7534.20	9.70
31.57	7534.20	9.70
38.76	7534.20	9.70
45.95	7534.20	9.70
53.14	7534.20	9.70
60.33	7534.20	9.70
67.52	7534.20	9.70
74.71	7534.20	9.70
81.90	7534.20	9.70

Tailwater Channel Data - Crossing A2.1

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 7534.20 ft

Roadway Data for Crossing: Crossing A2.1

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 7536.00 ft

Roadway Surface: Paved

Roadway Top Width: 30.00 ft

Crossing Discharge Data – Culvert A4

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 1 cfs

Design Flow: 2.9 cfs

Maximum Flow: 11.8 cfs

Table 10 - Summary of Culvert Flows at Crossing: Crossing A4

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert A4 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
7535.85	1.00	1.00	0.00	1
7536.06	2.08	2.08	0.00	1
7536.18	2.90	2.90	0.00	1
7536.35	4.24	4.24	0.00	1
7536.48	5.32	5.32	0.00	1
7536.61	6.40	6.40	0.00	1
7536.73	7.48	7.48	0.00	1
7536.84	8.56	8.56	0.00	1
7536.95	9.64	9.64	0.00	1
7537.05	10.72	10.72	0.00	1
7537.15	11.80	11.80	0.00	1
7538.00	19.94	19.94	0.00	Overtopping

Rating Curve Plot for Crossing: Crossing A4

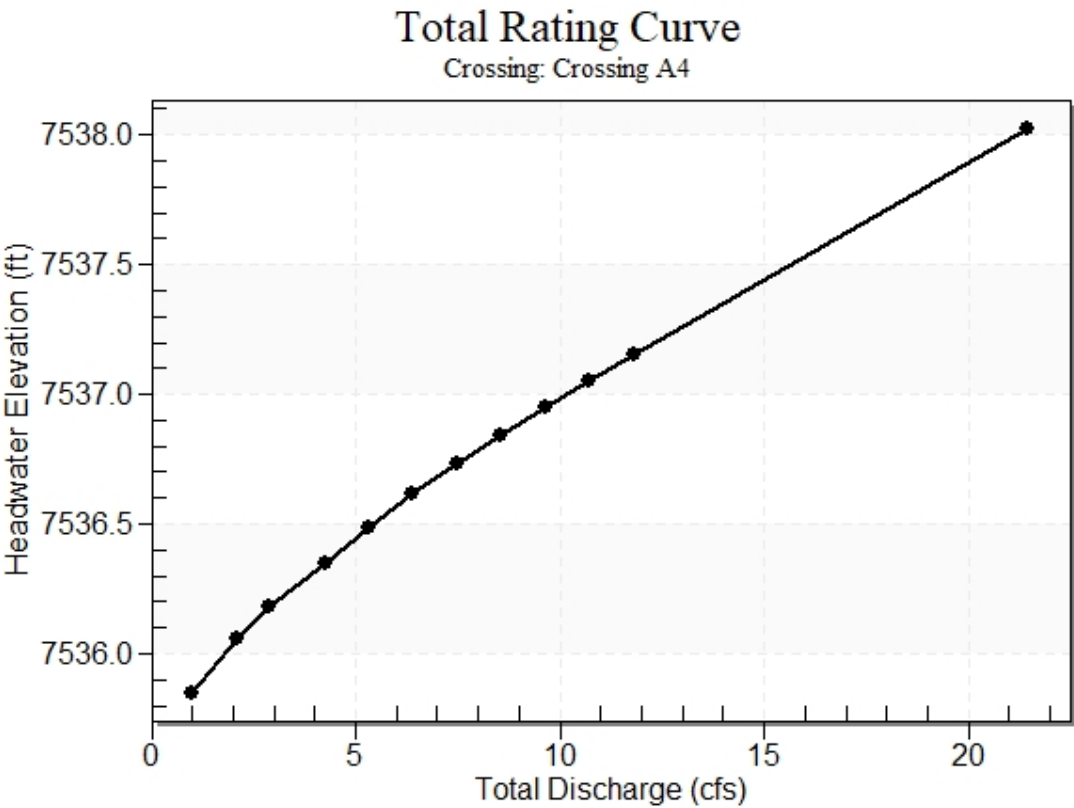


Table 11 - Culvert Summary Table: Culvert A4

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1.00	1.00	7535.85	0.442	0.0*	1-JS1f	0.182	0.344	2.000	9.800	0.318	0.000
2.08	2.08	7536.06	0.646	0.0*	1-JS1f	0.260	0.501	2.000	9.800	0.662	0.000
2.90	2.90	7536.18	0.769	0.0*	1-JS1f	0.306	0.594	2.000	9.800	0.923	0.000
4.24	4.24	7536.35	0.941	0.0*	1-JS1f	0.368	0.723	2.000	9.800	1.350	0.000
5.32	5.32	7536.48	1.074	0.0*	1-JS1f	0.412	0.813	2.000	9.800	1.693	0.000
6.40	6.40	7536.61	1.205	0.0*	1-JS1f	0.451	0.896	2.000	9.800	2.037	0.000
7.48	7.48	7536.73	1.324	0.0*	1-JS1f	0.488	0.972	2.000	9.800	2.381	0.000
8.56	8.56	7536.84	1.434	0.0*	1-JS1f	0.523	1.043	2.000	9.800	2.725	0.000
9.64	9.64	7536.95	1.539	0.0*	1-JS1f	0.555	1.110	2.000	9.800	3.069	0.000
10.72	10.72	7537.05	1.640	0.0*	1-JS1f	0.586	1.173	2.000	9.800	3.412	0.000
11.80	11.80	7537.15	1.740	0.0*	1-JS1f	0.617	1.233	2.000	9.800	3.756	0.000

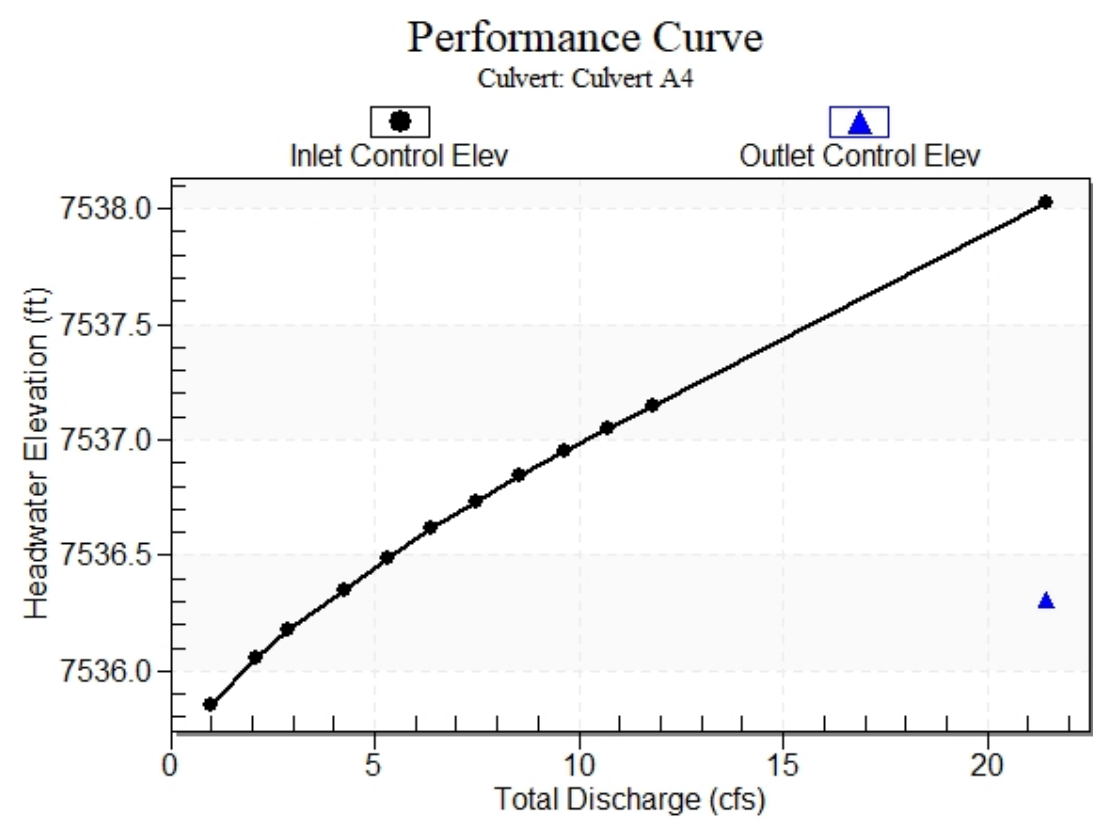
* Full Flow Headwater elevation is below inlet invert.

Straight Culvert

Inlet Elevation (invert): 7535.41 ft, Outlet Elevation (invert): 7524.40 ft

Culvert Length: 173.45 ft, Culvert Slope: 0.0636

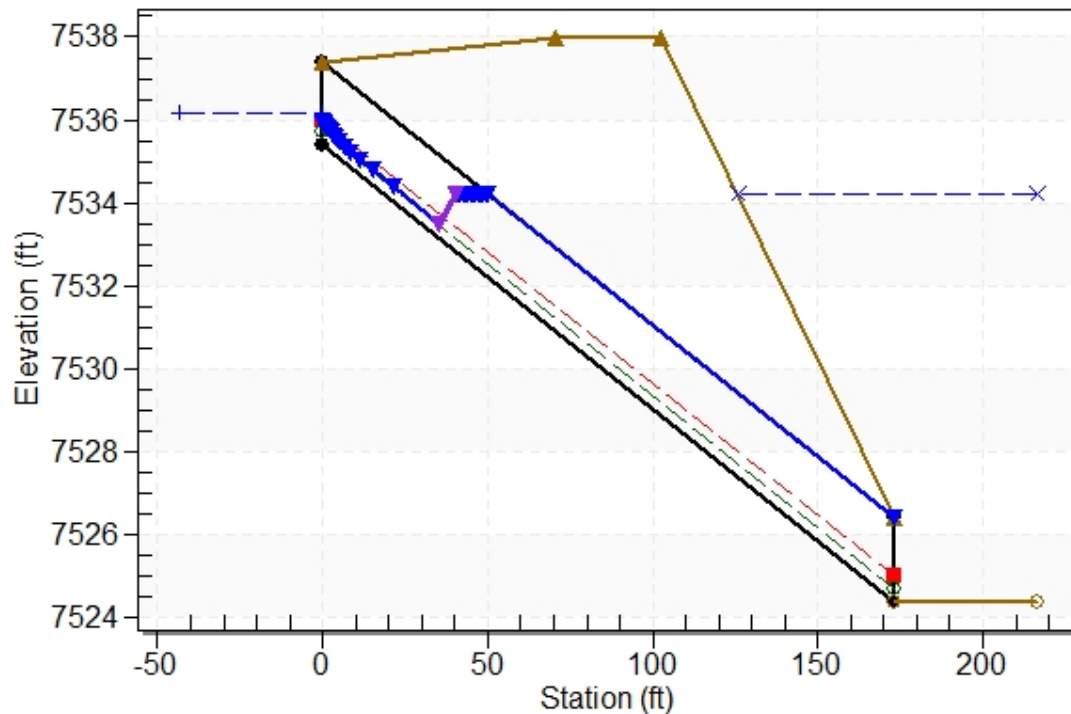
Culvert Performance Curve Plot: Culvert A4



Water Surface Profile Plot for Culvert: Culvert A4

Crossing - Crossing A4, Design Discharge - 2.9 cfs

Culvert - Culvert A4, Culvert Discharge - 2.9 cfs



Site Data - Culvert A4

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7535.41 ft

Outlet Station: 173.10 ft

Outlet Elevation: 7524.40 ft

Number of Barrels: 1

Culvert Data Summary - Culvert A4

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: None

Table 12 - Downstream Channel Rating Curve (Crossing: Crossing A4)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
1.00	7534.20	9.80
2.08	7534.20	9.80
2.90	7534.20	9.80
4.24	7534.20	9.80
5.32	7534.20	9.80
6.40	7534.20	9.80
7.48	7534.20	9.80
8.56	7534.20	9.80
9.64	7534.20	9.80
10.72	7534.20	9.80
11.80	7534.20	9.80

Tailwater Channel Data - Crossing A4

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 7534.20 ft

Roadway Data for Crossing: Crossing A4

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 7538.00 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

HY-8 Culvert Analysis Report

Existing Hodgen Road Culverts

DP-1: Existing 48" CMP Culvert east of Cherry Crossing Drive

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 5 cfs

Design Flow: 11.5 cfs

Maximum Flow: 84.7 cfs

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

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert DP1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
7523.56	5.00	5.00	0.00	1
7524.07	11.50	11.50	0.00	1
7524.63	20.94	20.94	0.00	1
7525.02	28.91	28.91	0.00	1
7525.36	36.88	36.88	0.00	1
7525.67	44.85	44.85	0.00	1
7525.98	52.82	52.82	0.00	1
7526.30	60.79	60.79	0.00	1
7526.64	68.76	68.76	0.00	1
7527.02	76.73	76.73	0.00	1
7527.43	84.70	84.70	0.00	1
7540.50	208.86	208.86	0.00	Overtopping

Rating Curve Plot for Crossing: Crossing-DP-1

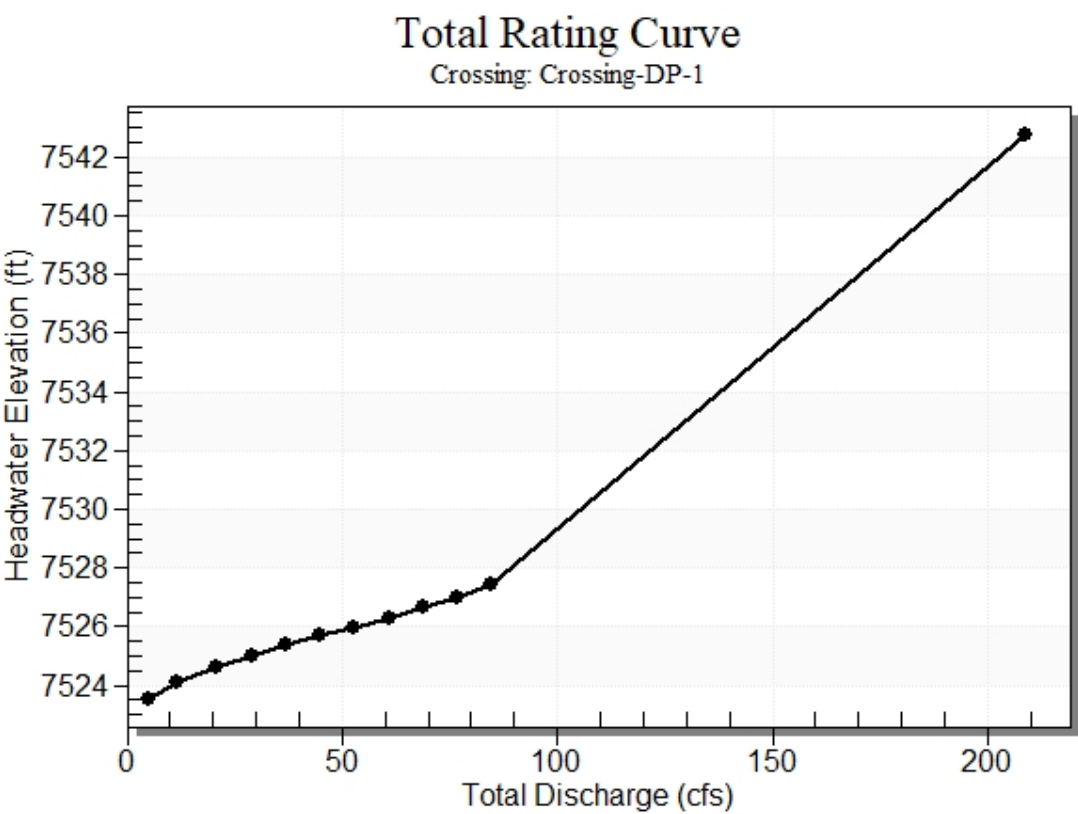


Table 2 - Culvert Summary Table: Culvert DP1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5.00	5.00	7523.56	0.957	0.0*	1-S2n	0.480	0.643	0.493	0.202	5.403	2.292
11.50	11.50	7524.07	1.473	0.0*	1-S2n	0.722	0.986	0.722	0.329	7.172	3.088
20.94	20.94	7524.63	2.028	0.0*	1-S2n	0.972	1.344	0.972	0.465	8.569	3.795
28.91	28.91	7525.02	2.418	0.0*	1-S2n	1.147	1.590	1.147	0.559	9.373	4.224
36.88	36.88	7525.36	2.758	0.0*	1-S2n	1.301	1.809	1.301	0.642	10.033	4.573
44.85	44.85	7525.67	3.072	0.0*	1-S2n	1.444	2.004	1.444	0.716	10.589	4.868
52.82	52.82	7525.98	3.381	0.0*	1-S2n	1.578	2.181	1.578	0.784	11.074	5.125
60.79	60.79	7526.30	3.700	0.0*	1-S2n	1.706	2.347	1.706	0.848	11.491	5.354
68.76	68.76	7526.64	4.042	0.0*	5-S2n	1.830	2.501	1.830	0.907	11.864	5.561
76.73	76.73	7527.02	4.416	0.0*	5-S2n	1.951	2.649	1.951	0.963	12.197	5.750
84.70	84.70	7527.43	4.828	0.0*	5-S2n	2.069	2.786	2.069	1.016	12.497	5.924

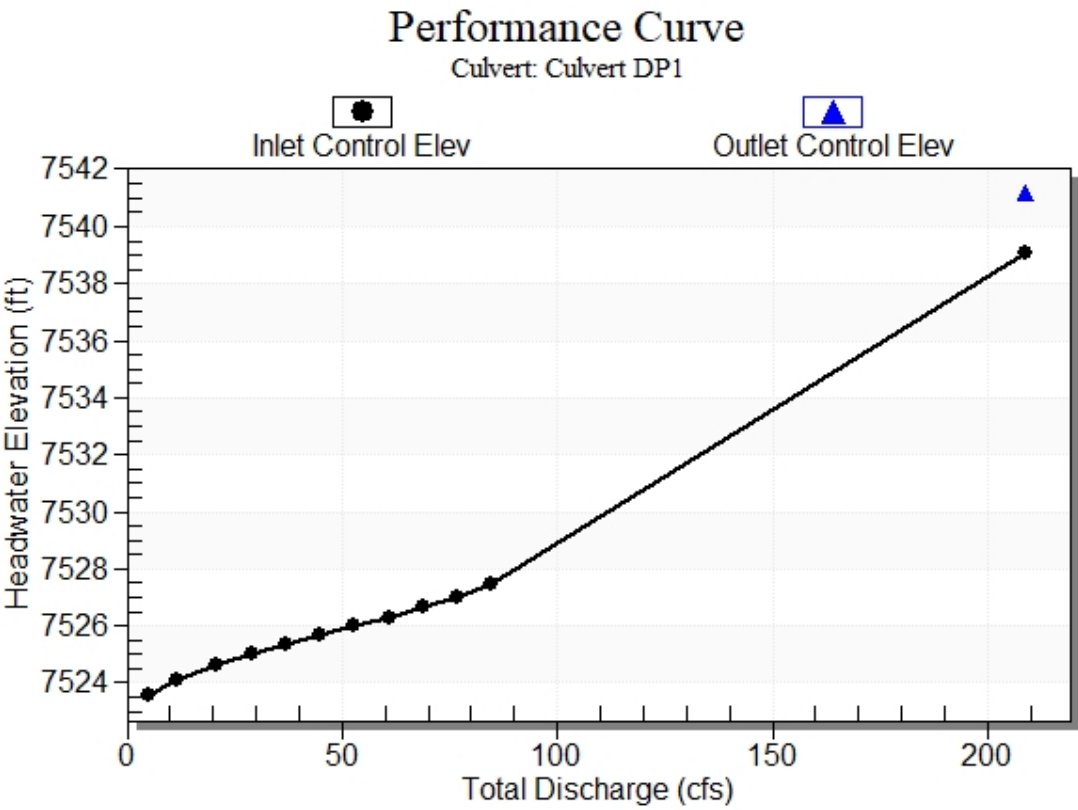
* Full Flow Headwater elevation is below inlet invert.

Straight Culvert

Inlet Elevation (invert): 7522.60 ft, Outlet Elevation (invert): 7514.00 ft

Culvert Length: 222.87 ft, Culvert Slope: 0.0386

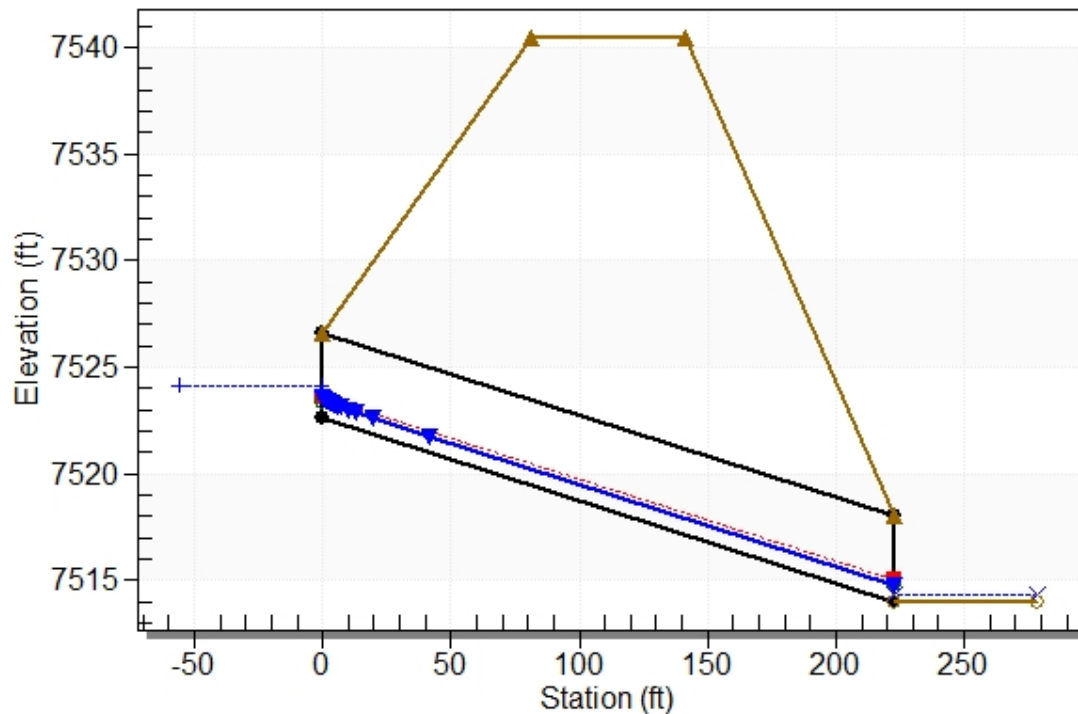
Culvert Performance Curve Plot: Culvert DP1



Water Surface Profile Plot for Culvert: Culvert DP1

Crossing - Crossing-DP-1, Design Discharge - 11.5 cfs

Culvert - Culvert DP1, Culvert Discharge - 11.5 cfs



Site Data - Culvert DP1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7522.60 ft

Outlet Station: 222.70 ft

Outlet Elevation: 7514.00 ft

Number of Barrels: 1

Culvert Data Summary - Culvert DP1

Barrel Shape: Circular

Barrel Diameter: 4.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Mitered to Conform to Slope

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: Crossing-DP-1)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
5.00	7514.20	0.20	2.29	0.25	0.93
11.50	7514.33	0.33	3.09	0.41	1.00
20.94	7514.47	0.47	3.80	0.58	1.05
28.91	7514.56	0.56	4.22	0.70	1.08
36.88	7514.64	0.64	4.57	0.80	1.10
44.85	7514.72	0.72	4.87	0.89	1.12
52.82	7514.78	0.78	5.13	0.98	1.14
60.79	7514.85	0.85	5.35	1.06	1.15
68.76	7514.91	0.91	5.56	1.13	1.16
76.73	7514.96	0.96	5.75	1.20	1.17
84.70	7515.02	1.02	5.92	1.27	1.18

Tailwater Channel Data - Crossing-DP-1

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 10.00 ft

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0300

Channel Invert Elevation: 7514.00 ft

Roadway Data for Crossing: Crossing-DP-1

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 7540.50 ft

Roadway Surface: Paved

Roadway Top Width: 60.00 ft

DP-2: Existing 42" CMP Culvert NW of Rollin Ridge Estates Boundary

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 3 cfs

Design Flow: 7.2 cfs

Maximum Flow: 53.2 cfs

Table 4 - Summary of Culvert Flows at Crossing: Crossing-DP-2.1

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert DP-2.1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
7532.17	3.00	3.00	0.00	1
7532.61	7.20	7.20	0.00	1
7533.06	13.04	13.04	0.00	1
7533.38	18.06	18.06	0.00	1
7533.66	23.08	23.08	0.00	1
7533.91	28.10	28.10	0.00	1
7534.15	33.12	33.12	0.00	1
7534.39	38.14	38.14	0.00	1
7534.63	43.16	43.16	0.00	1
7534.89	48.18	48.18	0.00	1
7535.17	53.20	53.20	0.00	1
7541.10	117.53	117.53	0.00	Overtopping

Rating Curve Plot for Crossing: Crossing-DP-2.1

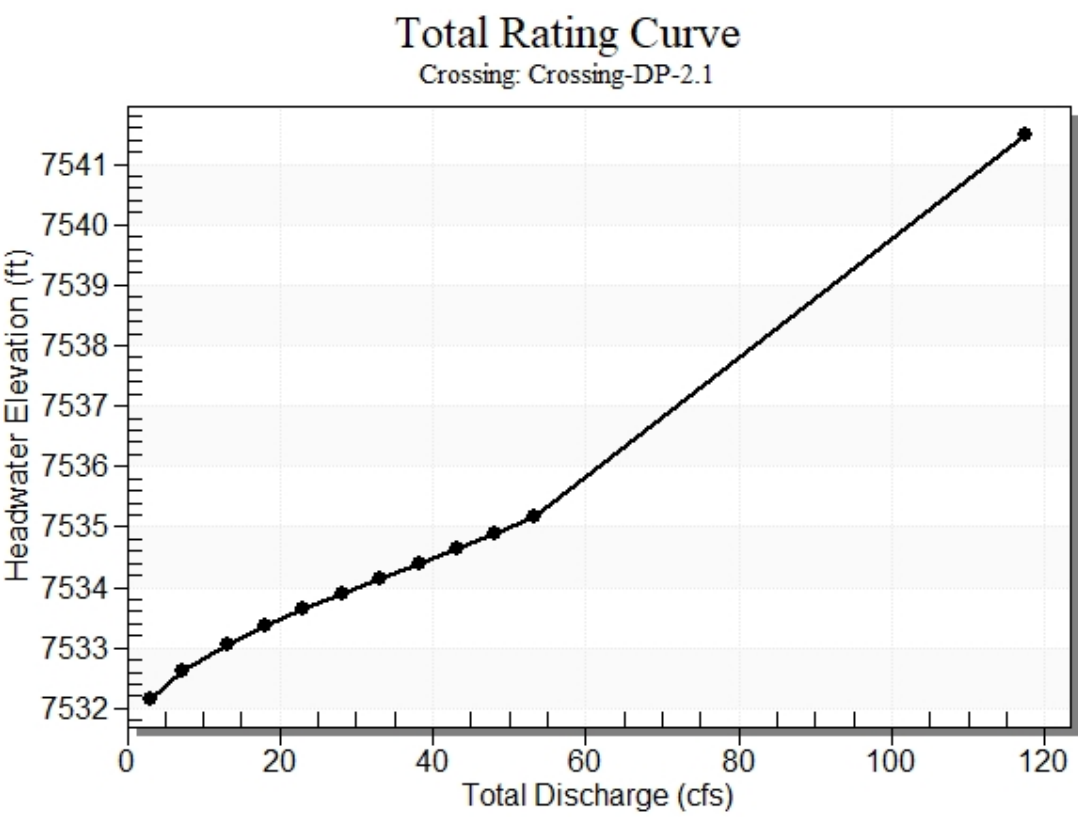


Table 5 - Culvert Summary Table: Culvert DP-2.1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.00	3.00	7532.17	0.768	0.0*	1-S2n	0.377	0.514	0.377	0.099	5.190	1.481
7.20	7.20	7532.61	1.211	0.0*	1-S2n	0.577	0.804	0.577	0.167	6.719	2.080
13.04	13.04	7533.06	1.659	0.0*	1-S2n	0.774	1.092	0.774	0.238	7.940	2.611
18.06	18.06	7533.38	1.979	0.0*	1-S2n	0.913	1.294	0.913	0.289	8.724	2.951
23.08	23.08	7533.66	2.258	0.0*	1-S2n	1.035	1.472	1.035	0.334	9.365	3.234
28.10	28.10	7533.91	2.510	0.0*	1-S2n	1.148	1.635	1.148	0.376	9.878	3.477
33.12	33.12	7534.15	2.750	0.0*	1-S2n	1.253	1.781	1.253	0.414	10.335	3.694
38.14	38.14	7534.39	2.987	0.0*	1-S2n	1.352	1.913	1.352	0.450	10.740	3.890
43.16	43.16	7534.63	3.233	0.0*	1-S2n	1.447	2.042	1.447	0.484	11.103	4.066
48.18	48.18	7534.89	3.493	0.0*	1-S2n	1.539	2.164	1.592	0.516	10.935	4.231
53.20	53.20	7535.17	3.774	0.0*	5-S2n	1.629	2.277	1.629	0.547	11.724	4.384

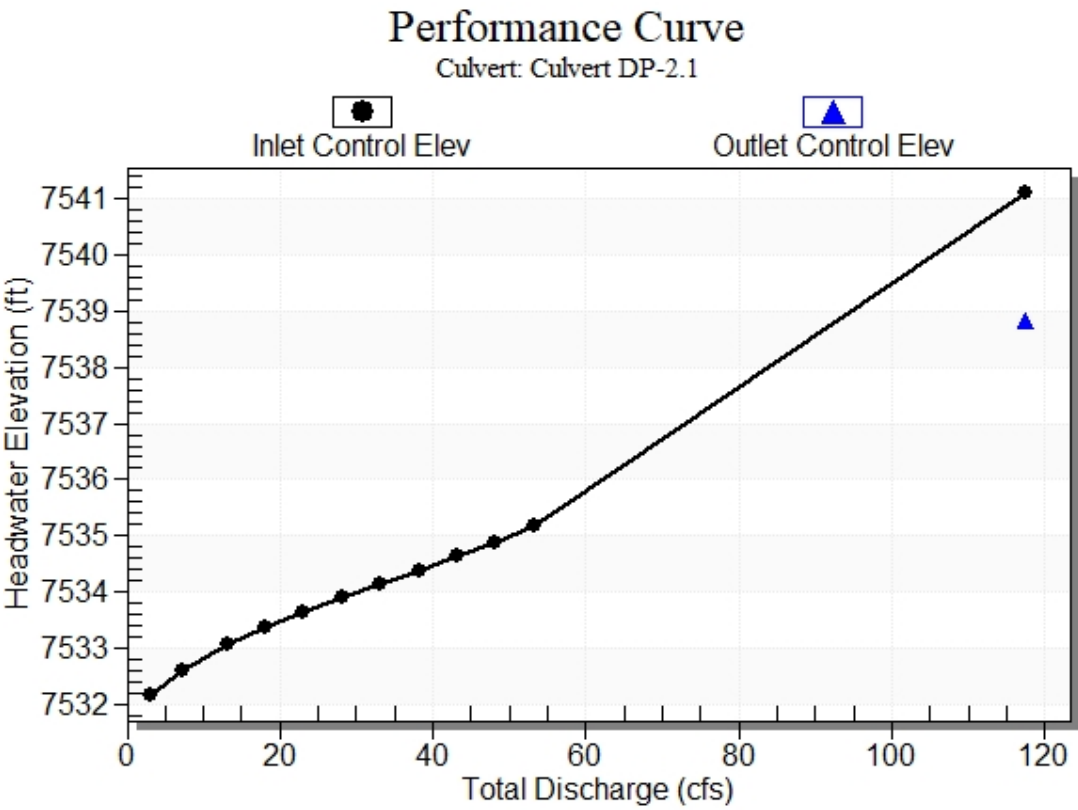
* Full Flow Headwater elevation is below inlet invert.

Straight Culvert

Inlet Elevation (invert): 7531.40 ft, Outlet Elevation (invert): 7526.00 ft

Culvert Length: 121.82 ft, Culvert Slope: 0.0444

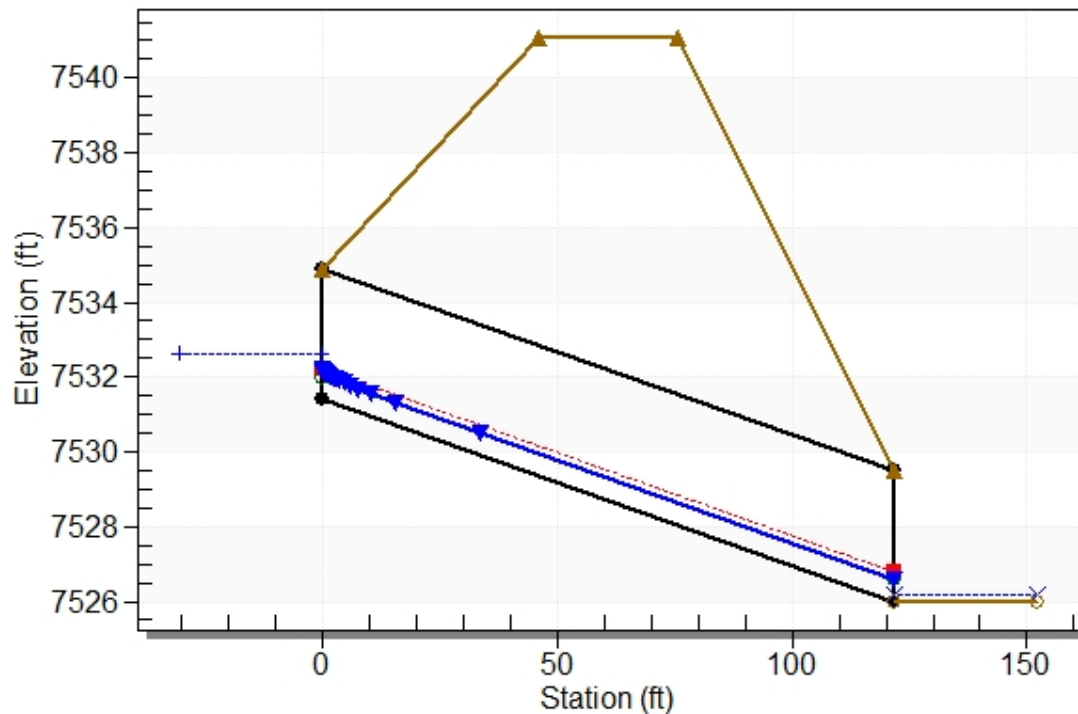
Culvert Performance Curve Plot: Culvert DP-2.1



Water Surface Profile Plot for Culvert: Culvert DP-2.1

Crossing - Crossing-DP-2.1, Design Discharge - 7.2 cfs

Culvert - Culvert DP-2.1, Culvert Discharge - 7.2 cfs



Site Data - Culvert DP-2.1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7531.40 ft

Outlet Station: 121.70 ft

Outlet Elevation: 7526.00 ft

Number of Barrels: 1

Culvert Data Summary - Culvert DP-2.1

Barrel Shape: Circular

Barrel Diameter: 3.50 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Mitered to Conform to Slope

Inlet Depression: None

Table 6 - Downstream Channel Rating Curve (Crossing: Crossing-DP-2.1)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
3.00	7526.10	0.10	1.48	0.12	0.84
7.20	7526.17	0.17	2.08	0.21	0.91
13.04	7526.24	0.24	2.61	0.30	0.96
18.06	7526.29	0.29	2.95	0.36	0.99
23.08	7526.33	0.33	3.23	0.42	1.02
28.10	7526.38	0.38	3.48	0.47	1.03
33.12	7526.41	0.41	3.69	0.52	1.05
38.14	7526.45	0.45	3.89	0.56	1.06
43.16	7526.48	0.48	4.07	0.60	1.07
48.18	7526.52	0.52	4.23	0.64	1.09
53.20	7526.55	0.55	4.38	0.68	1.10

Tailwater Channel Data - Crossing-DP-2.1

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 20.00 ft

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0300

Channel Invert Elevation: 7526.00 ft

Roadway Data for Crossing: Crossing-DP-2.1

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 7541.10 ft

Roadway Surface: Paved

Roadway Top Width: 30.00 ft

APPENDIX B2

HYDRAULIC CALCULATIONS - CHANNELS

The complete line of RollMax™ products offers a variety of options for both short-term and permanent erosion control needs. Reference the RollMax Products Chart below to find the right solution for your next project.



RollMax Product Selection Chart

TEMPORARY							
ERONET						BIONET	
							
	DS75	DS150	S75	S150	SC150	C125	S75BN
Longevity	45 days	60 days	12 mo.	12 mo.	24 mo.	36 mo.	12 mo.
Applications	Low Flow Channels 4:1-3:1 Slopes	Moderate Flow Channels 3:1-2:1 Slopes	Low Flow Channels 4:1-3:1 Slopes	Moderate Flow Channels 3:1-2:1 Slopes	Medium Flow Channels 2:1-1:1 Slopes	High-Flow Channels 1:1 and Greater Slopes	Low Flow Channels 4:1-3:1 Slopes
Design Permissible Shear Stress lbs/ft ² (Pa)	Unvegetated 1.55 (74)	Unvegetated 1.75 (84)	Unvegetated 1.55 (74)	Unvegetated 1.75 (84)	Unvegetated 2.00 (96)	Unvegetated 2.25 (108)	Unvegetated 1.60 (76)
Design Permissible Velocity ft/s (m/s)	Unvegetated 5.00 (1.52)	Unvegetated 6.00 (1.52)	Unvegetated 5.00 (1.2)	Unvegetated 6.00 (1.83)	Unvegetated 8.00 (2.44)	Unvegetated 10.00 (3.05)	Unvegetated 5.00 (1.52)
Top Net	Lightweight accelerated photodegradable polypropylene 1.50 lbs/1000 ft ² (0.73 kg/100 m ²) approx wt	Lightweight accelerated photodegradable polypropylene 1.50 lbs/1000 ft ² (0.73 kg/100 m ²) approx wt	Lightweight photodegradable polypropylene 1.50 lbs/1000 ft ² (0.73 kg/100 m ²) approx wt	Lightweight photodegradable polypropylene 1.50 lbs/1000 ft ² (0.73 kg/100 m ²) approx wt	Heavyweight UV-stabilized polypropylene 2.9 lbs/1000 ft ² (1.47 kg/100 m ²) approx wt	Heavyweight UV-stabilized polypropylene 2.9 lbs/1000 ft ² (1.47 kg/100 m ²) approx wt	Leno woven, 100% biodegradable jute fiber 9.30 lbs/1000 ft ² (4.53 kg/100 m ²) approx wt
Center Net	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fiber Matrix	Straw fiber 0.50 lbs/yd ² (0.27 kg/m ²)	Straw fiber 0.50 lbs/yd ² (0.27 kg/m ²)	Straw fiber 0.50 lbs/yd ² (0.27 kg/m ²)	Straw fiber 0.50 lbs/yd ² (0.27 kg/m ²)	Straw/coconut matrix 70% Straw 0.35 lbs/yd ² (0.19 kg/m ²) 30% Coconut 0.15 lbs/yd ² (0.08 kg/m ²)	Coconut fiber 0.50 lbs/yd ² (0.27 kg/m ²)	Straw fiber 0.50 lbs/yd ² (0.27 kg/m ²)
Bottom Net	N/A	Lightweight accelerated photodegradable polypropylene 1.50 lbs/1000 ft ² (0.73 kg/100 m ²) approx wt	N/A	Lightweight photodegradable polypropylene 1.50 lbs/1000 ft ² (0.73 kg/100 m ²) approx wt	Lightweight photodegradable polypropylene 1.50 lbs/1000 ft ² (0.73 kg/100 m ²) approx wt	Heavyweight UV-stabilized polypropylene 2.9 lbs/1000 ft ² (1.47 kg/100 m ²) approx wt	N/A
Thread	Accelerated degradable	Accelerated degradable	Degradable	Degradable	Degradable	UV-stabilized polypropylene	Biodegradable

ROLLIN RIDGE ESTATES
DITCH CALCULATION SUMMARY

PROPOSED ROADSIDE DITCHES

ROADWAY	FROM STA	TO STA	SIDE	PROPOSED SLOPE (%)	SIDE SLOPE (Z)	CHANNEL DEPTH (FT)	FRICTION FACTOR (n)	ROW WIDTH (ft)	BASIN	Q100 FLOW (CFS)	DITCH FLOW % OF BASIN	DITCH FLOW (CFS)	Q100 DEPTH (FT)	Q100 VELOCITY (FT/S)	DITCH LINING
CHERRY CROSSING DR	1127	1338	E	1.02	4:1/3:1	2.5	0.030	60	A5	7.2	10	0.7	0.4	1.6	GRASS
CHERRY CROSSING DR	1127	1338	W	1.02	4:1/3:1	2.5	0.030	60	A4	11.8	30	3.5	0.7	2.3	GRASS
CHERRY CROSSING DR	1338	1473	E	1.10	4:1/3:1	2.5	0.030	60	A3	31.6	10	3.2	0.6	2.3	GRASS
CHERRY CROSSING DR	1338	1473	W	1.10	4:1/3:1	2.5	0.030	60	A1	78.5	30	23.6	1.3	3.8	GRASS
CHERRY CROSSING DR	1473	1683	E	3.61	4:1/3:1	2.5	0.030	60	A3	31.6	10	3.2	0.5	3.6	GRASS
CHERRY CROSSING DR	1473	1683	W	3.61	4:1/3:1	2.5	0.030	60	A1	78.5	10	7.9	0.7	4.6	GRASS / ECB
CHERRY CROSSING DR	1683	1837	E	8.00	4:1/3:1	2.5	0.030	60	A2	13.3	40	5.3	0.5	5.6	GRASS / ECB
CHERRY CROSSING DR	1683	1837	W	8.00	4:1/3:1	2.5	0.030	60	A1	78.5	10	7.9	0.6	6.2	GRASS / ECB
CHERRY CROSSING DR	1837	1993	E	2.00	4:1/3:1	2.5	0.030	60	A2	13.3	15	2.0	0.5	2.6	GRASS
CHERRY CROSSING DR	1837	1993	W	2.00	4:1/3:1	2.5	0.030	60	A1	78.5	5	3.9	0.6	3.1	GRASS
PRAYER TREE TRAIL	1020	1175	N	4.97	4:1/3:1	2.5	0.030	60	A4	11.8	20	2.4	0.4	3.8	GRASS / ECB
PRAYER TREE TRAIL	1020	1175	S	4.97	4:1/3:1	2.5	0.030	60	A1	78.5	10	7.9	0.7	5.2	GRASS / ECB
PRAYER TREE TRAIL	1175	1445	N	8.00	4:1/3:1	2.5	0.030	60	A4	11.8	20	2.4	0.4	4.6	GRASS / ECB
PRAYER TREE TRAIL	1175	1445	S	8.00	4:1/3:1	2.5	0.030	60	A1	78.5	10	7.9	0.6	6.2	GRASS / ECB
PRAYER TREE TRAIL	1445	1800	W	3.77	4:1/3:1	2.5	0.030	60	A4	11.8	10	1.2	0.3	2.9	GRASS
PRAYER TREE TRAIL	1445	1800	E	3.77	4:1/3:1	2.5	0.030	60	A1	78.5	5	3.9	0.5	3.9	GRASS
PRAYER TREE TRAIL	1800	1939	W	2.00	4:1/3:1	2.5	0.030	60	A4	11.8	10	1.2	0.4	2.3	GRASS
PRAYER TREE TRAIL	1800	1939	E	2.00	4:1/3:1	2.5	0.030	60	A1	78.5	5	3.9	0.6	3.1	GRASS

- 1) Channel flow calculations based on Manning's Equation
- 2) Channel depth includes 1' minimum freeboard
- 3) n = 0.03 for grass-lined non-irrigated channels (minimum)
- 4) n = 0.045 for riprap-lined channels
- 5) Vmax = 5.0 fps per El Paso County criteria (p. 10-13) for fescue (dry land grass) for 100-year flows
- 6) Vmax = 8.0 fps with Erosion Control Blankets (Tensar Eronet SC150 or equal)

Hydraulic Analysis Report

Project Data

Project Title: Rollin Ridge Estates
Designer: JPS
Project Date: Thursday, August 22, 2019
Project Units: U.S. Customary Units
Notes:

Channel Analysis: Ditch-CCD-1127-1338-E

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0102 ft/ft
Manning's n: 0.0300
Flow: 0.7000 cfs

Result Parameters

Depth: 0.3592 ft
Area of Flow: 0.4515 ft²
Wetted Perimeter: 2.6166 ft
Hydraulic Radius: 0.1725 ft
Average Velocity: 1.5505 ft/s
Top Width: 2.5141 ft
Froude Number: 0.6448
Critical Depth: 0.3026 ft
Critical Velocity: 2.1845 ft/s
Critical Slope: 0.0254 ft/ft
Critical Top Width: 2.16 ft
Calculated Max Shear Stress: 0.2286 lb/ft²
Calculated Avg Shear Stress: 0.1098 lb/ft²

Channel Analysis: Ditch-CCD-1127-1338-W

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0102 ft/ft
Manning's n: 0.0300
Flow: 3.5000 cfs

Result Parameters

Depth: 0.6567 ft
Area of Flow: 1.5096 ft²
Wetted Perimeter: 4.7846 ft
Hydraulic Radius: 0.3155 ft
Average Velocity: 2.3185 ft/s
Top Width: 4.5972 ft
Froude Number: 0.7130
Critical Depth: 0.5760 ft
Critical Velocity: 3.0140 ft/s
Critical Slope: 0.0205 ft/ft
Critical Top Width: 4.12 ft
Calculated Max Shear Stress: 0.4180 lb/ft²
Calculated Avg Shear Stress: 0.2008 lb/ft²

Channel Analysis: Ditch-CCD-1338-1473-E

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0110 ft/ft
Manning's n: 0.0300
Flow: 3.2000 cfs

Result Parameters

Depth: 0.6261 ft
Area of Flow: 1.3721 ft²
Wetted Perimeter: 4.5615 ft
Hydraulic Radius: 0.3008 ft
Average Velocity: 2.3322 ft/s
Top Width: 4.3828 ft
Froude Number: 0.7346
Critical Depth: 0.5557 ft
Critical Velocity: 2.9605 ft/s
Critical Slope: 0.0208 ft/ft
Critical Top Width: 3.97 ft
Calculated Max Shear Stress: 0.4298 lb/ft²
Calculated Avg Shear Stress: 0.2065 lb/ft²

Channel Analysis: Ditch-CCD-1338-1473-W

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0110 ft/ft
Manning's n: 0.0300
Flow: 23.6000 cfs

Result Parameters

Depth: 1.3245 ft
Area of Flow: 6.1404 ft²
Wetted Perimeter: 9.6498 ft
Hydraulic Radius: 0.6363 ft
Average Velocity: 3.8434 ft/s
Top Width: 9.2718 ft
Froude Number: 0.8323
Critical Depth: 1.2358 ft
Critical Velocity: 4.4149 ft/s
Critical Slope: 0.0159 ft/ft
Critical Top Width: 8.83 ft
Calculated Max Shear Stress: 0.9092 lb/ft²
Calculated Avg Shear Stress: 0.4368 lb/ft²

Channel Analysis: Ditch-CCD-1473-1683-E

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0361 ft/ft
Manning's n: 0.0300
Flow: 3.2000 cfs

Result Parameters

Depth: 0.5011 ft
Area of Flow: 0.8787 ft²
Wetted Perimeter: 3.6504 ft
Hydraulic Radius: 0.2407 ft
Average Velocity: 3.6418 ft/s
Top Width: 3.5074 ft
Froude Number: 1.2822
Critical Depth: 0.5557 ft
Critical Velocity: 2.9605 ft/s
Critical Slope: 0.0208 ft/ft
Critical Top Width: 3.97 ft
Calculated Max Shear Stress: 1.1287 lb/ft²
Calculated Avg Shear Stress: 0.5422 lb/ft²

Channel Analysis: Ditch-CCD-1473-1683-W

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0361 ft/ft
Manning's n: 0.0300
Flow: 7.9000 cfs

Result Parameters

Depth: 0.7032 ft
Area of Flow: 1.7306 ft²
Wetted Perimeter: 5.1229 ft
Hydraulic Radius: 0.3378 ft
Average Velocity: 4.5649 ft/s
Top Width: 4.9222 ft
Froude Number: 1.3567
Critical Depth: 0.7977 ft
Critical Velocity: 3.5470 ft/s
Critical Slope: 0.0184 ft/ft
Critical Top Width: 5.70 ft
Calculated Max Shear Stress: 1.5840 lb/ft²
Calculated Avg Shear Stress: 0.7610 lb/ft²

Channel Analysis: Ditch-CCD-1683-1837-E

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0800 ft/ft
Manning's n: 0.0300
Flow: 5.3000 cfs

Result Parameters

Depth: 0.5215 ft
Area of Flow: 0.9519 ft²
Wetted Perimeter: 3.7994 ft
Hydraulic Radius: 0.2505 ft
Average Velocity: 5.5679 ft/s
Top Width: 3.6505 ft
Froude Number: 1.9215
Critical Depth: 0.6800 ft
Critical Velocity: 3.2748 ft/s
Critical Slope: 0.0194 ft/ft
Critical Top Width: 4.86 ft
Calculated Max Shear Stress: 2.6034 lb/ft²
Calculated Avg Shear Stress: 1.2507 lb/ft²

Channel Analysis: Ditch-CCD-1683-1837-W

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0800 ft/ft
Manning's n: 0.0300
Flow: 7.9000 cfs

Result Parameters

Depth: 0.6057 ft
Area of Flow: 1.2841 ft²
Wetted Perimeter: 4.4128 ft
Hydraulic Radius: 0.2910 ft
Average Velocity: 6.1522 ft/s
Top Width: 4.2400 ft
Froude Number: 1.9701
Critical Depth: 0.7977 ft
Critical Velocity: 3.5470 ft/s
Critical Slope: 0.0184 ft/ft
Critical Top Width: 5.70 ft
Calculated Max Shear Stress: 3.0237 lb/ft²
Calculated Avg Shear Stress: 1.4526 lb/ft²

Channel Analysis: Ditch-CCD-1837-1993-E

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0200 ft/ft
Manning's n: 0.0300
Flow: 2.0000 cfs

Result Parameters

Depth: 0.4693 ft
Area of Flow: 0.7708 ft²
Wetted Perimeter: 3.4188 ft
Hydraulic Radius: 0.2254 ft
Average Velocity: 2.5948 ft/s
Top Width: 3.2849 ft
Froude Number: 0.9440
Critical Depth: 0.4605 ft
Critical Velocity: 2.6949 ft/s
Critical Slope: 0.0221 ft/ft
Critical Top Width: 3.29 ft
Calculated Max Shear Stress: 0.5857 lb/ft²
Calculated Avg Shear Stress: 0.2814 lb/ft²

Channel Analysis: Ditch-CCD-1837-1993-W

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0200 ft/ft
Manning's n: 0.0300
Flow: 3.9000 cfs

Result Parameters

Depth: 0.6028 ft
Area of Flow: 1.2719 ft²
Wetted Perimeter: 4.3918 ft
Hydraulic Radius: 0.2896 ft
Average Velocity: 3.0663 ft/s
Top Width: 4.2198 ft
Froude Number: 0.9843
Critical Depth: 0.6015 ft
Critical Velocity: 3.0800 ft/s
Critical Slope: 0.0202 ft/ft
Critical Top Width: 4.30 ft
Calculated Max Shear Stress: 0.7523 lb/ft²
Calculated Avg Shear Stress: 0.3614 lb/ft²

Channel Analysis: Ditch-PTT-1020-1175-N

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0497 ft/ft
Manning's n: 0.0300
Flow: 2.4000 cfs

Result Parameters

Depth: 0.4236 ft
Area of Flow: 0.6281 ft²
Wetted Perimeter: 3.0864 ft
Hydraulic Radius: 0.2035 ft
Average Velocity: 3.8208 ft/s
Top Width: 2.9655 ft
Froude Number: 1.4630
Critical Depth: 0.4953 ft
Critical Velocity: 2.7950 ft/s
Critical Slope: 0.0216 ft/ft
Critical Top Width: 3.54 ft
Calculated Max Shear Stress: 1.3138 lb/ft²
Calculated Avg Shear Stress: 0.6312 lb/ft²

Channel Analysis: Ditch-PTT-1020-1175-S

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0497 ft/ft
Manning's n: 0.0300
Flow: 7.9000 cfs

Result Parameters

Depth: 0.6623 ft
Area of Flow: 1.5351 ft²
Wetted Perimeter: 4.8248 ft
Hydraulic Radius: 0.3182 ft
Average Velocity: 5.1464 ft/s
Top Width: 4.6358 ft
Froude Number: 1.5761
Critical Depth: 0.7977 ft
Critical Velocity: 3.5470 ft/s
Critical Slope: 0.0184 ft/ft
Critical Top Width: 5.70 ft
Calculated Max Shear Stress: 2.0538 lb/ft²
Calculated Avg Shear Stress: 0.9867 lb/ft²

Channel Analysis: Ditch-PTT-1175-1445-N

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0800 ft/ft

Manning's n: 0.0300

Flow: 2.4000 cfs

Result Parameters

Depth: 0.3875 ft

Area of Flow: 0.5255 ft²

Wetted Perimeter: 2.8228 ft

Hydraulic Radius: 0.1861 ft

Average Velocity: 4.5675 ft/s

Top Width: 2.7123 ft

Froude Number: 1.8287

Critical Depth: 0.4953 ft

Critical Velocity: 2.7950 ft/s

Critical Slope: 0.0216 ft/ft

Critical Top Width: 3.54 ft

Calculated Max Shear Stress: 1.9342 lb/ft²

Calculated Avg Shear Stress: 0.9292 lb/ft²

Channel Analysis: Ditch-PTT-1175-1445-S

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0800 ft/ft
Manning's n: 0.0300
Flow: 7.9000 cfs

Result Parameters

Depth: 0.6057 ft
Area of Flow: 1.2841 ft²
Wetted Perimeter: 4.4128 ft
Hydraulic Radius: 0.2910 ft
Average Velocity: 6.1522 ft/s
Top Width: 4.2400 ft
Froude Number: 1.9701
Critical Depth: 0.7977 ft
Critical Velocity: 3.5470 ft/s
Critical Slope: 0.0184 ft/ft
Critical Top Width: 5.70 ft
Calculated Max Shear Stress: 3.0237 lb/ft²
Calculated Avg Shear Stress: 1.4526 lb/ft²

Channel Analysis: Ditch-PTT-1445-1800-W

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0377 ft/ft
Manning's n: 0.0300
Flow: 1.2000 cfs

Result Parameters

Depth: 0.3440 ft
Area of Flow: 0.4143 ft²
Wetted Perimeter: 2.5065 ft
Hydraulic Radius: 0.1653 ft
Average Velocity: 2.8966 ft/s
Top Width: 2.4083 ft
Froude Number: 1.2307
Critical Depth: 0.3754 ft
Critical Velocity: 2.4332 ft/s
Critical Slope: 0.0237 ft/ft
Critical Top Width: 2.68 ft
Calculated Max Shear Stress: 0.8094 lb/ft²
Calculated Avg Shear Stress: 0.3888 lb/ft²

Channel Analysis: Ditch-PTT-1445-1800-E

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0377 ft/ft
Manning's n: 0.0300
Flow: 3.9000 cfs

Result Parameters

Depth: 0.5353 ft
Area of Flow: 1.0028 ft²
Wetted Perimeter: 3.8996 ft
Hydraulic Radius: 0.2571 ft
Average Velocity: 3.8892 ft/s
Top Width: 3.7469 ft
Froude Number: 1.3248
Critical Depth: 0.6015 ft
Critical Velocity: 3.0800 ft/s
Critical Slope: 0.0202 ft/ft
Critical Top Width: 4.30 ft
Calculated Max Shear Stress: 1.2592 lb/ft²
Calculated Avg Shear Stress: 0.6049 lb/ft²

Channel Analysis: Ditch-PTT-1800-1939-W

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0200 ft/ft
Manning's n: 0.0300
Flow: 1.2000 cfs

Result Parameters

Depth: 0.3875 ft
Area of Flow: 0.5255 ft²
Wetted Perimeter: 2.8228 ft
Hydraulic Radius: 0.1861 ft
Average Velocity: 2.2837 ft/s
Top Width: 2.7123 ft
Froude Number: 0.9144
Critical Depth: 0.3754 ft
Critical Velocity: 2.4332 ft/s
Critical Slope: 0.0237 ft/ft
Critical Top Width: 2.68 ft
Calculated Max Shear Stress: 0.4836 lb/ft²
Calculated Avg Shear Stress: 0.2323 lb/ft²

Channel Analysis: Ditch-PTT-1800-1939-E

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0200 ft/ft
Manning's n: 0.0300
Flow: 3.9000 cfs

Result Parameters

Depth: 0.6028 ft
Area of Flow: 1.2719 ft²
Wetted Perimeter: 4.3918 ft
Hydraulic Radius: 0.2896 ft
Average Velocity: 3.0663 ft/s
Top Width: 4.2198 ft
Froude Number: 0.9843
Critical Depth: 0.6015 ft
Critical Velocity: 3.0800 ft/s
Critical Slope: 0.0202 ft/ft
Critical Top Width: 4.30 ft
Calculated Max Shear Stress: 0.7523 lb/ft²
Calculated Avg Shear Stress: 0.3614 lb/ft²

APPENDIX C

DETENTION POND CALCULATIONS

ROLLIN RIDGE SUBDIVISION
IMPERVIOUS AREA CALCULATIONS

IMPERVIOUS AREAS - DEVELOPED CONDITIONS - ULTIMATE DEVELOPMENT (INCLUDING COMMERCIAL AREA)									
BASIN	TOTAL AREA (AC)	AREA (AC)	SUB-AREA 1 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (AC)	WEIGHTED % IMP
OA1	15.03	15.03	5-AC LOTS	7.0					7.00
A1	21.69	21.69	2.5-AC LOTS	11.0					11.00
A2	5.12	5.12	2.5-AC LOTS	11.0					11.00
A3	5.70	3.74	BUILDING / PAVEMENT	100.0	1.96	MEADOW / LS	0.0		65.61
A4	4.74	4.74	2.5-AC LOTS	11.0					11.00
A5	2.36	2.36	LANDSCAPE	0.0					0.00
OA1,A1-A5	54.64								15.122
B	11.83	11.83	2.5-AC LOTS	11.0					11.00
C	5.46	5.46	2.5-AC LOTS	11.0					11.00

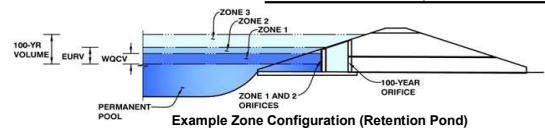
IMPERVIOUS AREAS - DEVELOPED CONDITIONS - INTERIM DEVELOPMENT (FILING NO. 1 RESIDENTIAL ONLY)									
BASIN	TOTAL AREA (AC)	AREA (AC)	SUB-AREA 1 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (AC)	WEIGHTED % IMP
OA1	15.03	15.03	5-AC LOTS	7.0					7.00
A1	21.69	21.69	2.5-AC LOTS	11.0					11.00
A2	5.12	5.12	2.5-AC LOTS	11.0					11.00
A3	5.70	0.17	BUILDING / PAVEMENT	100.0	5.53	MEADOW / LS	0.0		2.98
A4	4.74	4.74	2.5-AC LOTS	11.0					11.00
A5	2.36	2.36	LANDSCAPE	0.0					0.00
OA1,A1-A5	54.64								8.588
B	11.83	11.83	2.5-AC LOTS	11.0					11.00
C	5.46	5.46	2.5-AC LOTS	11.0					11.00

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: ROLLIN RIDGE ESTATES

Basin ID: A - INTERIM CONDITIONS (FILING NO. 1 RESIDENTIAL ONLY)



Required Volume Calculation

Selected BMP Type =	EDB	
Watershed Area =	54.60	acres
Watershed Length =	2.250	ft
Watershed Slope =	0.045	ft/ft
Watershed Imperviousness =	8.59%	percent
Percentage Hydrologic Soil Group A =	30.0%	percent
Percentage Hydrologic Soil Group B =	70.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Desired WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	
Water Quality Capture Volume (WQCV) =	0.268	acre-feet
Excess Urban Runoff Volume (EURV) =	0.404	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.270	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	0.413	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	0.917	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	2.425	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	3.490	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	5.015	acre-feet
500-yr Runoff Volume (P1 = 3.07 in.) =	7.948	acre-feet
Approximate 2-yr Detention Volume =	0.250	acre-feet
Approximate 5-yr Detention Volume =	0.386	acre-feet
Approximate 10-yr Detention Volume =	0.785	acre-feet
Approximate 25-yr Detention Volume =	1.115	acre-feet
Approximate 50-yr Detention Volume =	1.213	acre-feet
Approximate 100-yr Detention Volume =	1.665	acre-feet

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.268	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.136	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.261	acre-feet
Total Detention Basin Volume =	1.665	acre-feet

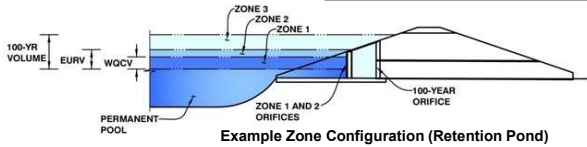
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Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: **ROLLIN RIDGE ESTATES**

Basin ID: **A - INTERIM CONDITIONS (FILING NO. 1 RESIDENTIAL ONLY)**



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	3.27	0.268	Orifice Plate
Zone 2 (EURV)	4.18	0.136	Orifice Plate
Zone 3 (100-year)	9.13	1.261	Weir&Pipe (Restrict)
		1.665	Total

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	N/A	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft ²
Underdrain Orifice Centroid =	N/A	feet

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	4.18	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	22.20	inches
Orifice Plate: Orifice Area per Row =	1.38	sq. inches (diameter = 1-5/16 inches)

Calculated Parameters for Plate

WQ Orifice Area per Row =	9.583E-03	ft ²
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft ²

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.39	2.79					
Orifice Area (sq. inches)	1.38	1.38	1.38					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft ²
Vertical Orifice Centroid =	N/A	N/A	feet

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	9.80	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	8.00	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	8.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H _c =	9.80	N/A	feet
Over Flow Weir Slope Length =	8.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	13.67	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	44.80	N/A	ft ²
Overflow Grate Open Area w/ Debris =	22.40	N/A	ft ²

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	1.00	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	30.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	19.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	3.28	N/A	ft ²
Outlet Orifice Centroid =	0.89	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.84	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	11.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	30.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

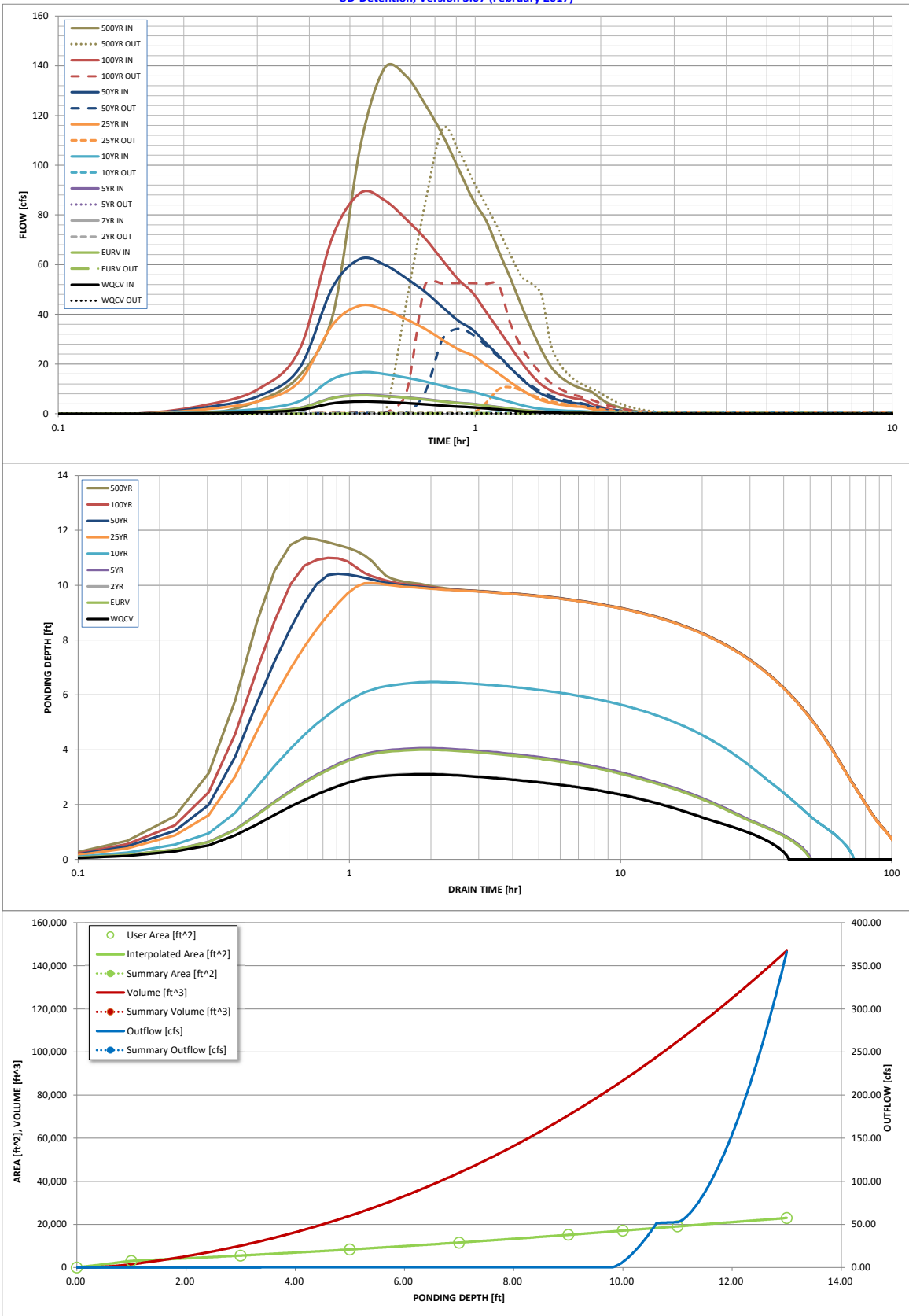
Spillway Design Flow Depth=	0.98	feet
Stage at Top of Freeboard =	12.98	feet
Basin Area at Top of Freeboard =	0.53	acres

Routed Hydrograph Results

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =									
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.07
Calculated Runoff Volume (acre-ft) =	0.268	0.404	0.270	0.413	0.917	2.425	3.490	5.015	7.948
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.267	0.403	0.270	0.413	0.917	2.425	3.492	5.013	7.943
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.16	0.52	0.78	1.11	1.72
Predevelopment Peak Q (cfs) =	0.0	0.0	0.5	1.0	8.8	28.5	42.4	60.7	94.0
Peak Inflow Q (cfs) =	4.9	7.4	5.0	7.6	16.7	43.5	62.4	88.9	139.2
Peak Outflow Q (cfs) =	0.2	0.2	0.2	0.2	0.3	10.7	34.2	52.6	114.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	0.0	0.4	0.8	0.9	1.2
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.2	0.8	1.2	1.2
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	44	38	45	62	87	82	77	69
Time to Drain 99% of Inflow Volume (hours) =	40	47	40	48	68	99	96	92	86
Maximum Ponding Depth (ft) =	3.11	4.00	3.13	4.06	6.47	10.08	10.42	10.99	11.73
Area at Maximum Ponding Depth (acres) =	0.13	0.16	0.13	0.16	0.25	0.40	0.41	0.44	0.47
Maximum Volume Stored (acre-ft) =	0.245	0.376	0.248	0.384	0.873	2.023	2.161	2.403	2.735

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)



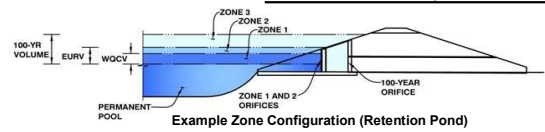
S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: ROLLIN RIDGE ESTATES

Basin ID: A - ULTIMATE CONDITIONS (INCLUDING COMMERCIAL AREA)



Required Volume Calculation

Selected BMP Type =	EDB	
Watershed Area =	54.60	acres
Watershed Length =	2,250	ft
Watershed Slope =	0.045	ft/ft
Watershed Imperviousness =	15.10%	percent
Percentage Hydrologic Soil Group A =	30.0%	percent
Percentage Hydrologic Soil Group B =	70.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Desired WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	
Water Quality Capture Volume (WQCV) =	0.427	acre-feet
Excess Urban Runoff Volume (EURV) =	0.765	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.536	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	0.786	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	1.389	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	2.896	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	3.994	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	5.511	acre-feet
500-yr Runoff Volume (P1 = 3.07 in.) =	8.432	acre-feet
Approximate 2-yr Detention Volume =	0.498	acre-feet
Approximate 5-yr Detention Volume =	0.735	acre-feet
Approximate 10-yr Detention Volume =	1.219	acre-feet
Approximate 25-yr Detention Volume =	1.589	acre-feet
Approximate 50-yr Detention Volume =	1.732	acre-feet
Approximate 100-yr Detention Volume =	2.242	acre-feet

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.427	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.338	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.477	acre-feet
Total Detention Basin Volume =	2.242	acre-feet

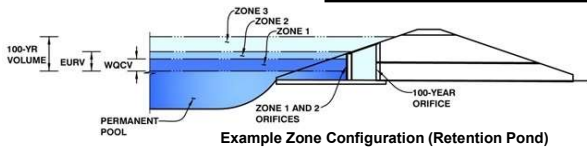
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Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: **ROLLIN RIDGE ESTATES**

Basin ID: **A - ULTIMATE CONDITIONS (INCLUDING COMMERCIAL AREA)**



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	4.32	0.427	Orifice Plate
Zone 2 (EURV)	6.02	0.338	Orifice Plate
Zone 3 (100-year)	10.62	1.477	Weir&Pipe (Restrict)
		2.242	Total

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	N/A	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft ²
Underdrain Orifice Centroid =	N/A	feet

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	6.02	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	22.20	inches
Orifice Plate: Orifice Area per Row =	2.00	sq. inches (diameter = 1-9/16 inches)

Calculated Parameters for Plate

WQ Orifice Area per Row =	1.389E-02	ft ²
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft ²

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	2.01	4.01					
Orifice Area (sq. inches)	2.00	2.00	2.00					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft ²
Vertical Orifice Centroid =	N/A	N/A	feet

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, H _o =	9.80	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	8.00	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	8.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H _u =	9.80	N/A	feet
Over Flow Weir Slope Length =	8.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	13.67	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	44.80	N/A	ft ²
Overflow Grate Open Area w/ Debris =	22.40	N/A	ft ²

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	1.00	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	30.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	19.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	3.28	N/A	ft ²
Outlet Orifice Centroid =	0.89	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.84	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	11.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	30.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

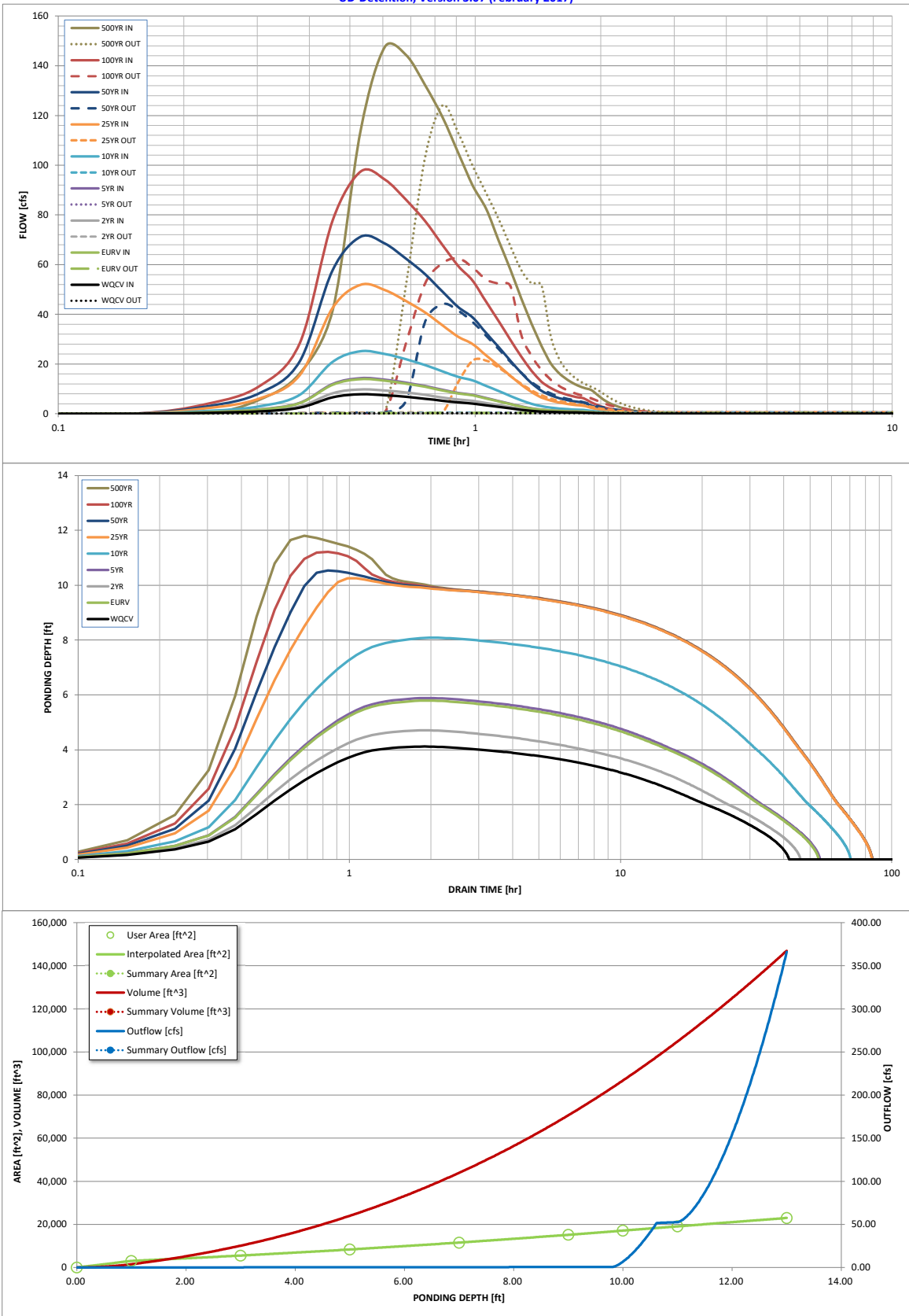
Spillway Design Flow Depth=	0.98	feet
Stage at Top of Freeboard =	12.98	feet
Basin Area at Top of Freeboard =	0.53	acres

Routed Hydrograph Results

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =									
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.07
Calculated Runoff Volume (acre-ft) =	0.427	0.765	0.536	0.786	1.389	2.896	3.994	5.511	8.432
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.427	0.764	0.535	0.785	1.389	2.897	3.995	5.504	8.431
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.16	0.52	0.78	1.11	1.72
Predevelopment Peak Q (cfs) =	0.0	0.0	0.5	1.0	8.8	28.5	42.4	60.7	94.0
Peak Inflow Q (cfs) =	7.8	13.9	9.8	14.3	25.1	51.9	71.2	97.4	147.6
Peak Outflow Q (cfs) =	0.3	0.4	0.3	0.4	0.5	21.4	44.1	62.5	124.0
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.4	0.1	0.7	1.0	1.0	1.3
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.5	1.0	1.2	1.2
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	48	41	48	61	68	64	59	53
Time to Drain 99% of Inflow Volume (hours) =	40	51	44	52	66	77	75	73	69
Maximum Ponding Depth (ft) =	4.12	5.79	4.71	5.89	8.09	10.25	10.54	11.22	11.80
Area at Maximum Ponding Depth (acres) =	0.16	0.22	0.18	0.22	0.31	0.40	0.42	0.45	0.47
Maximum Volume Stored (acre-ft) =	0.395	0.714	0.495	0.734	1.319	2.087	2.206	2.501	2.773

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)



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

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.06, November 2016)

Sheet 1 of 4

Designer: JPS
Company: JPS
Date: February 21, 2020
Project: ROLLIN RIDGE FILING NO. 1
Location: POND A

1. Basin Storage Volume

- A) Effective Imperviousness of Tributary Area, I_a
- B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)
- C) Contributing Watershed Area
- D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm
- E) Design Concept
(Select EURV when also designing for flood control)
- F) Design Volume (WQCV) Based on 40-hour Drain Time
($V_{DESIGN} = (1.0 * 0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * \text{Area}$)
- G) For Watersheds Outside of the Denver Region,
Water Quality Capture Volume (WQCV) Design Volume
($V_{WQCV \text{ OTHER}} = (d_6 * (V_{DESIGN} / 0.43))$)
- H) User Input of Water Quality Capture Volume (WQCV) Design Volume
(Only if a different WQCV Design Volume is desired)
- I) Predominant Watershed NRCS Soil Group
- J) Excess Urban Runoff Volume (EURV) Design Volume
 For HSG A: $EURV_A = 1.68 * i^{1.28}$
 For HSG B: $EURV_B = 1.36 * i^{1.08}$
 For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$

$I_a = 15.1$ %

$i = 0.151$

Area = 54.600 ac

$d_6 =$ in

Choose One

☐ Water Quality Capture Volume (WQCV)

☒ Excess Urban Runoff Volume (EURV)

$V_{DESIGN} = 0.427$ ac-ft

$V_{DESIGN \text{ OTHER}} =$ ac-ft

$V_{DESIGN \text{ USER}} =$ ac-ft

Choose One

☐ A

☒ B

☐ C / D

EURV = 0.803 ac-ft

2. Basin Shape: Length to Width Ratio

(A basin length to width ratio of at least 2:1 will improve TSS reduction.)

L : W = 2.0 : 1

3. Basin Side Slopes

- A) Basin Maximum Side Slopes
(Horizontal distance per unit vertical, 4:1 or flatter preferred)

Z = 3.00 ft / ft

DIFFICULT TO MAINTAIN, INCREASE WHERE POSSIBLE

4. Inlet

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

Concrete Forebay

Design Procedure Form: Extended Detention Basin (EDB)

Sheet 2 of 4

Designer: JPS
Company: JPS
Date: February 21, 2020
Project: ROLLIN RIDGE FILING NO. 1
Location: POND A

5. Forebay

A) Minimum Forebay Volume
($V_{FMIN} = 3\%$ of the WQCV)

$V_{FMIN} = 0.013$ ac-ft

B) Actual Forebay Volume

$V_F = 0.013$ ac-ft

C) Forebay Depth
($D_F = 18$ inch maximum)

$D_F = 18.0$ in

D) Forebay Discharge

i) Undetained 100-year Peak Discharge

$Q_{100} = 107.00$ cfs

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

$Q_F = 2.14$ cfs

E) Forebay Discharge Design

Choose One
☐ Berm With Pipe
☒ Wall with Rect. Notch
☐ Wall with V-Notch Weir

(flow too small for berm w/ pipe)

F) Discharge Pipe Size (minimum 8-inches)

Calculated $D_p =$ in

G) Rectangular Notch Width

Calculated $W_N = 7.8$ in

6. Trickle Channel

A) Type of Trickle Channel

Choose One
☒ Concrete
☐ Soft Bottom

F) Slope of Trickle Channel

$S = 0.0050$ ft / ft

7. Micropool and Outlet Structure

A) Depth of Micropool (2.5-feet minimum)

$D_M = 2.5$ ft

B) Surface Area of Micropool (10 ft² minimum)

$A_M = 10$ sq ft

C) Outlet Type

Choose One
☒ Orifice Plate
☐ Other (Describe):

D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing
(Use UD-Detention)

$D_{orifice} = 1.56$ inches

E) Total Outlet Area

$A_{ot} = 6.00$ square inches

Design Procedure Form: Extended Detention Basin (EDB)

Sheet 3 of 4

Designer: JPS
Company: JPS
Date: February 21, 2020
Project: ROLLIN RIDGE FILING NO. 1
Location: POND A

8. Initial Surcharge Volume

- A) Depth of Initial Surcharge Volume
(Minimum recommended depth is 4 inches)
- B) Minimum Initial Surcharge Volume
(Minimum volume of 0.3% of the WQCV)
- C) Initial Surcharge Provided Above Micropool

$D_{IS} = 4$ in

$V_{IS} = 55.8$ cu ft

$V_s = 3.3$ cu ft

9. Trash Rack

- A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5 * (e^{-0.095D})$
- B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open area to the total screen area for the material specified.)

Other (Y/N): N

- C) Ratio of Total Open Area to Total Area (only for type 'Other')

- D) Total Water Quality Screen Area (based on screen type)

- E) Depth of Design Volume (EURV or WQCV)
(Based on design concept chosen under 1E)

- F) Height of Water Quality Screen (H_{TR})

- G) Width of Water Quality Screen Opening ($W_{opening}$)
(Minimum of 12 inches is recommended)

$A_t = 199$ square inches

Aluminum Amico-Klemp SR Series with Cross Rods 2" O.C.

User Ratio =

$A_{total} = 281$ sq. in.

$H = 6$ feet

$H_{TR} = 100$ inches

$W_{opening} = 12.0$ inches

Design Procedure Form: Extended Detention Basin (EDB)

Sheet 4 of 4

Designer: JPS
Company: JPS
Date: February 21, 2020
Project: ROLLIN RIDGE FILING NO. 1
Location: POND A

10. Overflow Embankment

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

Buried Riprap Spillway

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

3.00

DIFFICULT TO MAINTAIN, INCREASE WHERE POSSIBLE

11. Vegetation

Choose One

☐ Irrigated

☒ Not Irrigated

12. Access

A) Describe Sediment Removal Procedures

Periodic inspection and maintenance as required

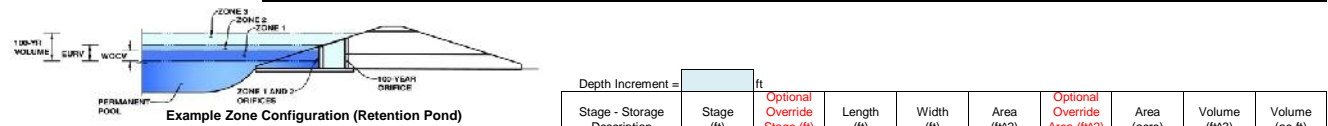
Notes:

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: ROLLIN RIDGE ESTATES

Basin ID: B



Required Volume Calculation

Selected BMP Type =	EDB		
Watershed Area =	11.83	acres	
Watershed Length =	1.090	ft	
Watershed Slope =	0.053	ft/ft	
Watershed Imperviousness =	11.00%	percent	
Percentage Hydrologic Soil Group A =	50.0%	percent	
Percentage Hydrologic Soil Group B =	50.0%	percent	
Percentage Hydrologic Soil Groups C/D =	0.0%	percent	
Desired WQCV Drain Time =	40.0	hours	
Location for 1-hr Rainfall Depths =	User Input		
Water Quality Capture Volume (WQCV) =	0.072	acre-foot	Optional User Override
Excess Urban Runoff Volume (EURV) =	0.111	acre-foot	1-hr Precipitation
2-yr Runoff Volume (P1 = 1.19 in.) =	0.075	acre-foot	1.19 inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.110	acre-foot	1.50 inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.202	acre-foot	1.75 inches
25-yr Runoff Volume (P1 = 2 in.) =	0.450	acre-foot	2.00 inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.655	acre-foot	2.25 inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.962	acre-foot	2.52 inches
500-yr Runoff Volume (P1 = 3.14 in.) =	1.616	acre-foot	3.14 inches
Approximate 2-yr Detention Volume =	0.069	acre-foot	
Approximate 5-yr Detention Volume =	0.102	acre-foot	
Approximate 10-yr Detention Volume =	0.176	acre-foot	
Approximate 25-yr Detention Volume =	0.241	acre-foot	
Approximate 50-yr Detention Volume =	0.272	acre-foot	
Approximate 100-yr Detention Volume =	0.377	acre-foot	

Stage-Storage Calculation

Zone 1 Volume (WC _V) =	0.072	acre-feet
Zone 2 Volume (EUR _V - Zone 1) =	0.039	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.266	acre-feet
Total Detention Basin Volume =	0.377	acre-feet
Initial Surcharge Volume (IS _V) =	user	ft ³
Initial Surcharge Depth (IS _D) =	user	ft
Total Available Detention Depth (H _{total}) =	user	ft
Depth of Trickle Channel (H _{TC}) =	user	ft
Slope of Trickle Channel (S _{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S _{main}) =	user	H:V
Basin Length-to-Width Ratio (R _{L/W}) =	user	

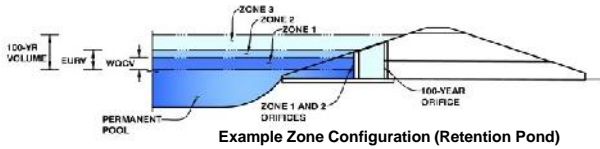
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Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: ROLLIN RIDGE ESTATES

Basin ID: B



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.98	0.072	Orifice Plate
Zone 2 (EURV)	1.33	0.039	Orifice Plate
Zone 3 (100-year)	3.25	0.266	Weir&Pipe (Restrict)
		0.377	Total

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

Underdrain Orifice Invert Depth = ft (distance below the filtration media surface)
Underdrain Orifice Diameter = inches

Calculated Parameters for Underdrain

Underdrain Orifice Area = ft²
Underdrain Orifice Centroid = feet

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

Invert of Lowest Orifice = ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate = ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing = inches
Orifice Plate: Orifice Area per Row = sq. inches (diameter = 15/16 inch)

Calculated Parameters for Plate

WQ Orifice Area per Row = ft²
Elliptical Half-Width = feet
Elliptical Slot Centroid = feet
Elliptical Slot Area = ft²

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.44	0.89					
Orifice Area (sq. inches)	0.69	0.69	0.69					

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

User Input: Vertical Orifice (Circular or Rectangular)

Invert of Vertical Orifice = ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice = ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter = inches

Calculated Parameters for Vertical Orifice

Vertical Orifice Area = ft²
Vertical Orifice Centroid = feet

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

Overflow Weir Front Edge Height, H_o = ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length = feet
Overflow Weir Slope = H:V (enter zero for flat grate)
Horiz. Length of Weir Sides = feet
Overflow Grate Open Area % = %, grate open area/total area
Debris Clogging % = %

Calculated Parameters for Overflow Weir

Height of Grate Upper Edge, H_g = feet
Over Flow Weir Slope Length = feet
Grate Open Area / 100-yr Orifice Area = should be ≥ 4
Overflow Grate Open Area w/o Debris = ft²
Overflow Grate Open Area w/ Debris = ft²

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

Depth to Invert of Outlet Pipe = ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter = inches
Restrictor Plate Height Above Pipe Invert = inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

Outlet Orifice Area = ft²
Outlet Orifice Centroid = feet
Half-Central Angle of Restrictor Plate on Pipe = radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage = ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length = feet
Spillway End Slopes = H:V
Freeboard above Max Water Surface = feet

Calculated Parameters for Spillway

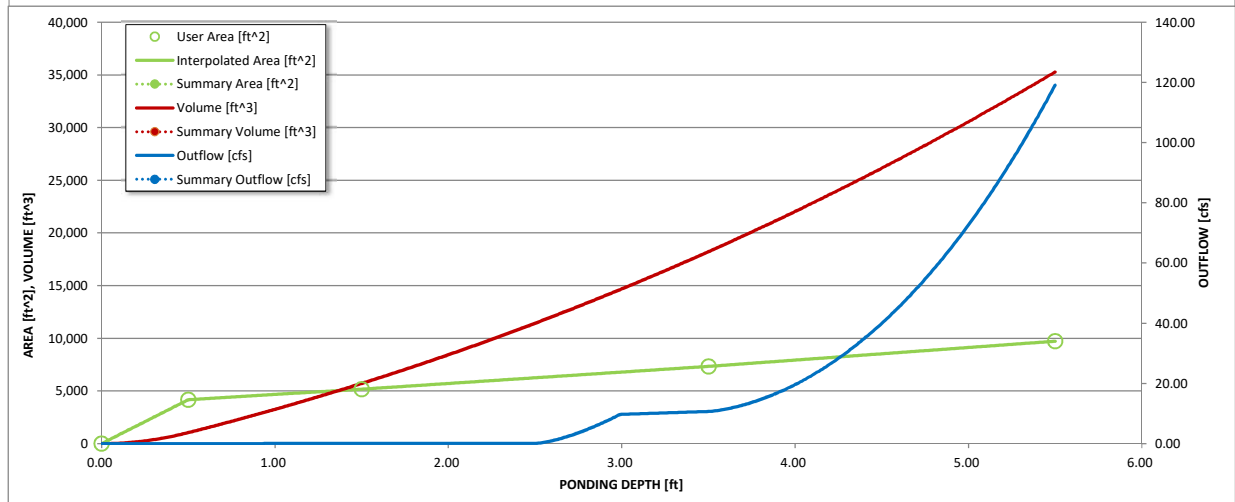
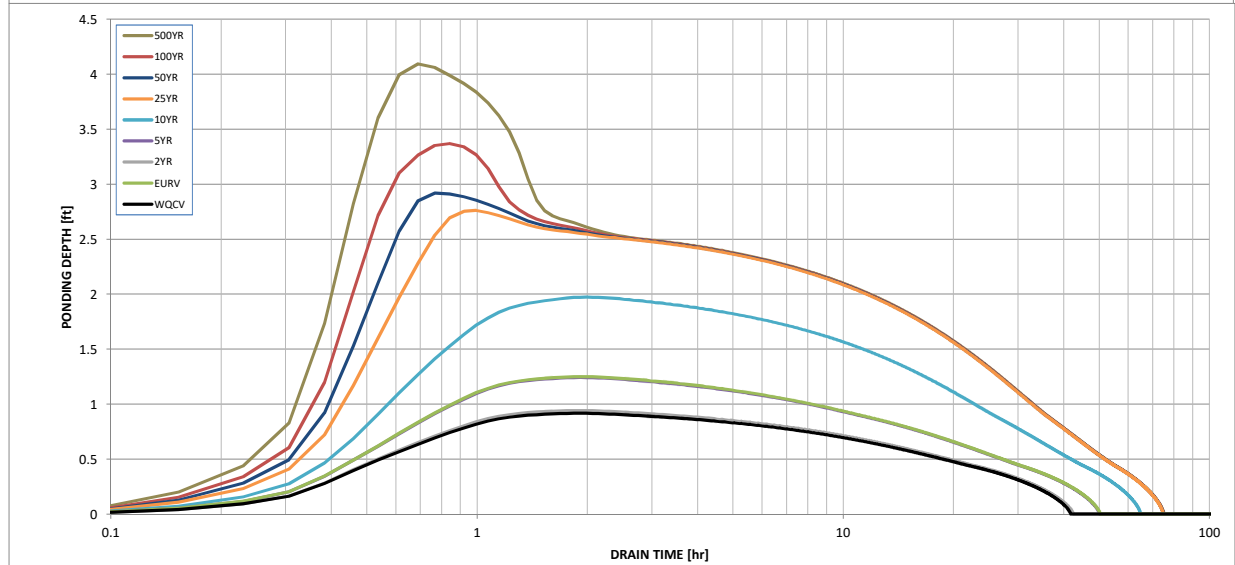
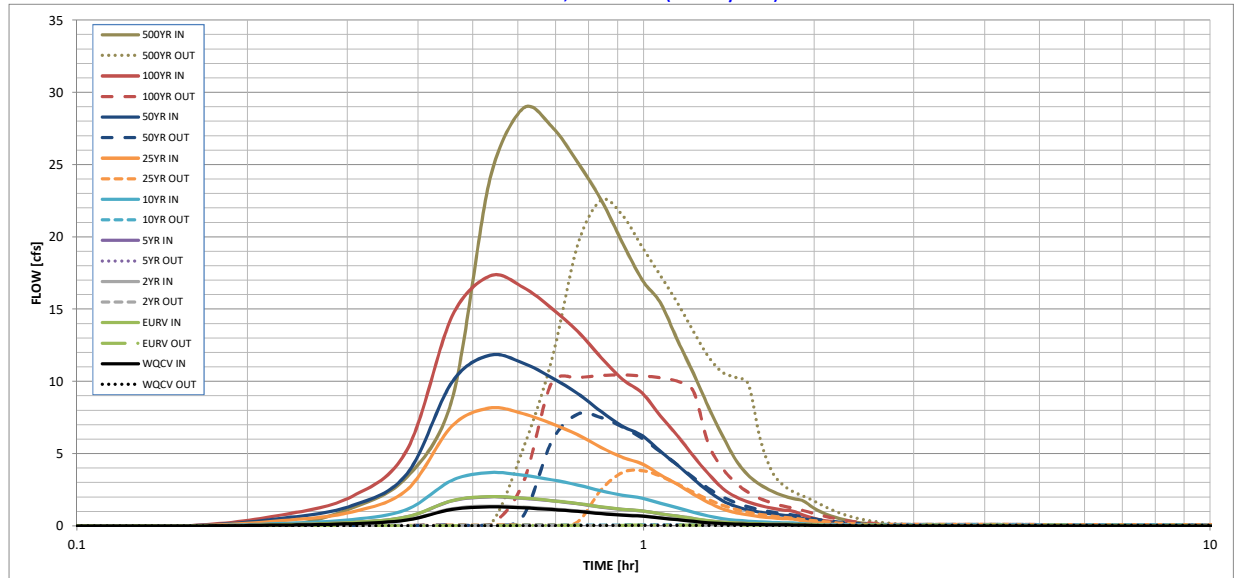
Spillway Design Flow Depth = feet
Stage at Top of Freeboard = feet
Basin Area at Top of Freeboard = acres

Routed Hydrograph Results

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.14
One-Hour Rainfall Depth (in) =	0.072	0.111	0.075	0.110	0.202	0.450	0.655	0.962	1.616
Calculated Runoff Volume (acre-ft) =									
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.071	0.110	0.074	0.109	0.201	0.449	0.653	0.961	1.614
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.01	0.12	0.37	0.60	0.92	1.55
Predevelopment Peak Q (cfs) =	0.0	0.0	0.1	0.2	1.4	4.4	7.1	10.9	18.4
Peak Inflow Q (cfs) =	1.3	2.0	1.4	2.0	3.7	8.2	11.8	17.3	28.9
Peak Outflow Q (cfs) =	0.0	0.1	0.0	0.1	0.1	3.8	7.7	10.4	22.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.4	0.1	0.9	1.1	1.0	1.2
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.5	1.1	1.5	1.7
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	45	39	45	57	59	55	50	41
Time to Drain 99% of Inflow Volume (hours) =	40	48	41	48	61	68	66	63	58
Maximum Ponding Depth (ft) =	0.92	1.25	0.94	1.24	1.97	2.76	2.92	3.37	4.09
Area at Maximum Ponding Depth (acres) =	0.11	0.11	0.11	0.11	0.13	0.15	0.15	0.17	0.18
Maximum Volume Stored (acre-ft) =	0.065	0.102	0.068	0.101	0.190	0.300	0.323	0.397	0.522

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)



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

Detention Basin Outlet Structure Design

Outflow Hydrograph Workbook Filename: _____

UD-Detention, Version 3.07 (February 2017)

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

	SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
4.59 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrograph Constant	0:04:35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:09:11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.088	0:13:46	0.06	0.09	0.06	0.09	0.17	0.36	0.52	0.76	1.25
	0:18:22	0.16	0.25	0.17	0.25	0.45	0.98	1.41	2.05	3.40
	0:22:57	0.42	0.64	0.43	0.63	1.15	2.51	3.62	5.28	8.74
	0:27:32	1.15	1.75	1.19	1.74	3.16	6.91	9.95	14.50	24.00
	0:32:08	1.33	2.03	1.38	2.02	3.70	8.16	11.82	17.31	28.88
	0:36:43	1.26	1.93	1.31	1.91	3.51	7.78	11.28	16.53	27.64
	0:41:19	1.14	1.75	1.18	1.74	3.20	7.08	10.27	15.05	25.16
	0:45:54	1.00	1.55	1.04	1.54	2.84	6.31	9.17	13.47	22.57
	0:50:29	0.85	1.32	0.89	1.31	2.43	5.44	7.92	11.66	19.59
	0:55:05	0.75	1.16	0.78	1.15	2.12	4.74	6.90	10.15	17.02
	0:59:40	0.68	1.05	0.70	1.04	1.92	4.29	6.25	9.20	15.44
	1:04:16	0.54	0.85	0.57	0.84	1.57	3.53	5.16	7.62	12.85
	1:08:51	0.43	0.68	0.45	0.67	1.26	2.87	4.21	6.24	10.58
	1:13:26	0.32	0.51	0.33	0.50	0.95	2.20	3.25	4.84	8.27
	1:18:02	0.23	0.36	0.24	0.36	0.70	1.63	2.42	3.63	6.27
	1:22:37	0.17	0.27	0.18	0.27	0.51	1.18	1.75	2.62	4.59
	1:27:13	0.14	0.21	0.14	0.21	0.40	0.92	1.36	2.02	3.50
	1:31:48	0.11	0.18	0.12	0.17	0.33	0.76	1.12	1.66	2.86
	1:36:23	0.10	0.15	0.10	0.15	0.28	0.64	0.95	1.41	2.41
	1:40:59	0.08	0.13	0.09	0.13	0.25	0.57	0.83	1.23	2.11
	1:45:34	0.08	0.12	0.08	0.12	0.22	0.51	0.75	1.11	1.90
	1:50:10	0.07	0.11	0.08	0.11	0.21	0.47	0.69	1.02	1.74
	1:54:45	0.05	0.08	0.06	0.08	0.15	0.35	0.51	0.75	1.28
	1:59:20	0.04	0.06	0.04	0.06	0.11	0.25	0.37	0.55	0.94
	2:03:56	0.03	0.04	0.03	0.04	0.08	0.19	0.27	0.40	0.69
	2:08:31	0.02	0.03	0.02	0.03	0.06	0.14	0.20	0.30	0.51
	2:13:07	0.01	0.02	0.01	0.02	0.04	0.10	0.14	0.21	0.37
	2:17:42	0.01	0.02	0.01	0.02	0.03	0.07	0.10	0.15	0.26
	2:22:17	0.01	0.01	0.01	0.01	0.02	0.05	0.07	0.11	0.19
	2:26:53	0.00	0.01	0.00	0.01	0.01	0.03	0.05	0.07	0.13
	2:31:28	0.00	0.00	0.00	0.00	0.01	0.02	0.03	0.04	0.08
	2:36:04	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.04
	2:40:39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02
	2:45:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:49:50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:54:25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:59:01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:03:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:08:11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:12:47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:17:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:21:58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:26:33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:31:08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:44:55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:49:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:54:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:58:41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:03:16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:07:52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:12:27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:17:02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:21:38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:26:13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:39:59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:44:35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:49:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:53:46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:58:21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:02:56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:07:32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:12:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:16:43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:21:18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.06, November 2016)

Sheet 1 of 4

Designer: JPS
Company: JPS
Date: March 2, 2020
Project: ROLLIN RIDGE FILING NO. 1
Location: POND B

1. Basin Storage Volume

- A) Effective Imperviousness of Tributary Area, I_a
- B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$)
- C) Contributing Watershed Area
- D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm
- E) Design Concept
(Select EURV when also designing for flood control)
- F) Design Volume (WQCV) Based on 40-hour Drain Time
 $(V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i)) / 12 * \text{Area})$
- G) For Watersheds Outside of the Denver Region,
 Water Quality Capture Volume (WQCV) Design Volume
 $(V_{WQCV\ OTHER} = (d_6 * (V_{DESIGN} / 0.43)))$
- H) User Input of Water Quality Capture Volume (WQCV) Design Volume
 (Only if a different WQCV Design Volume is desired)
- I) Predominant Watershed NRCS Soil Group
- J) Excess Urban Runoff Volume (EURV) Design Volume
 For HSG A: $EURV_A = 1.68 * i^{1.28}$
 For HSG B: $EURV_B = 1.36 * i^{1.08}$
 For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$

$I_a = 11.0$ %

$i = 0.110$

Area = 11.830 ac

$d_6 =$ in

Choose One

☐ Water Quality Capture Volume (WQCV)

☒ Excess Urban Runoff Volume (EURV)

$V_{DESIGN} = 0.072$ ac-ft

$V_{DESIGN\ OTHER} =$ ac-ft

$V_{DESIGN\ USER} =$ ac-ft

Choose One

☐ A

☒ B

☐ C / D

EURV = 0.124 ac-ft

2. Basin Shape: Length to Width Ratio

(A basin length to width ratio of at least 2:1 will improve TSS reduction.)

L : W = 3.0 : 1

3. Basin Side Slopes

- A) Basin Maximum Side Slopes
(Horizontal distance per unit vertical, 4:1 or flatter preferred)

Z = 4.00 ft / ft

4. Inlet

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

Concrete Forebay

Design Procedure Form: Extended Detention Basin (EDB)

Sheet 2 of 4

Designer: JPS
Company: JPS
Date: March 2, 2020
Project: ROLLIN RIDGE FILING NO. 1
Location: POND B

5. Forebay

A) Minimum Forebay Volume
($V_{FMIN} = 1\%$ of the WQCV)

$V_{FMIN} = 0.001$ ac-ft

B) Actual Forebay Volume

$V_F = 0.001$ ac-ft

C) Forebay Depth
($D_F = 12$ inch maximum)

$D_F = 12.0$ in

D) Forebay Discharge

i) Undetained 100-year Peak Discharge

$Q_{100} = 25.20$ cfs

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

$Q_F = 0.50$ cfs

E) Forebay Discharge Design

Choose One
☐ Berm With Pipe
☒ Wall with Rect. Notch
☐ Wall with V-Notch Weir

(flow too small for berm w/ pipe)

F) Discharge Pipe Size (minimum 8-inches)

Calculated $D_p =$ in

G) Rectangular Notch Width

Calculated $W_N = 4.2$ in

6. Trickle Channel

A) Type of Trickle Channel

Choose One
☒ Concrete
☐ Soft Bottom

F) Slope of Trickle Channel

$S = 0.0050$ ft / ft

7. Micropool and Outlet Structure

A) Depth of Micropool (2.5-feet minimum)

$D_M = 2.5$ ft

B) Surface Area of Micropool (10 ft² minimum)

$A_M = 10$ sq ft

C) Outlet Type

Choose One
☒ Orifice Plate
☐ Other (Describe):

D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing
(Use UD-Detention)

$D_{orifice} = 0.94$ inches

E) Total Outlet Area

$A_{ot} = 2.67$ square inches

Design Procedure Form: Extended Detention Basin (EDB)

Sheet 3 of 4

Designer: JPS
Company: JPS
Date: March 2, 2020
Project: ROLLIN RIDGE FILING NO. 1
Location: POND B

8. Initial Surcharge Volume

A) Depth of Initial Surcharge Volume
(Minimum recommended depth is 4 inches)

$D_{IS} =$ 6 in

B) Minimum Initial Surcharge Volume
(Minimum volume of 0.3% of the WQCV)

$V_{IS} =$ cu ft

C) Initial Surcharge Provided Above Micropool

$V_s =$ 5.0 cu ft

9. Trash Rack

A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5 * (e^{-0.095D})$

$A_t =$ 94 square inches

B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open area to the total screen area for the material specified.)

S.S. Well Screen with 60% Open Area

Other (Y/N): N

C) Ratio of Total Open Area to Total Area (only for type 'Other')

User Ratio =

D) Total Water Quality Screen Area (based on screen type)

$A_{total} =$ 157 sq. in.

E) Depth of Design Volume (EURV or WQCV)
(Based on design concept chosen under 1E)

$H =$ 1.33 feet

F) Height of Water Quality Screen (H_{TR})

$H_{TR} =$ 43.96 inches

G) Width of Water Quality Screen Opening ($W_{opening}$)
(Minimum of 12 inches is recommended)

$W_{opening} =$ 12.0 inches

Design Procedure Form: Extended Detention Basin (EDB)

Sheet 4 of 4

Designer: JPS
Company: JPS
Date: March 2, 2020
Project: ROLLIN RIDGE FILING NO. 1
Location: POND B

10. Overflow Embankment

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

Buried Riprap Spillway

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

4.00

11. Vegetation

Choose One

☐ Irrigated

☒ Not Irrigated

12. Access

A) Describe Sediment Removal Procedures

Periodic inspection and maintenance as required

Notes:

APPENDIX D

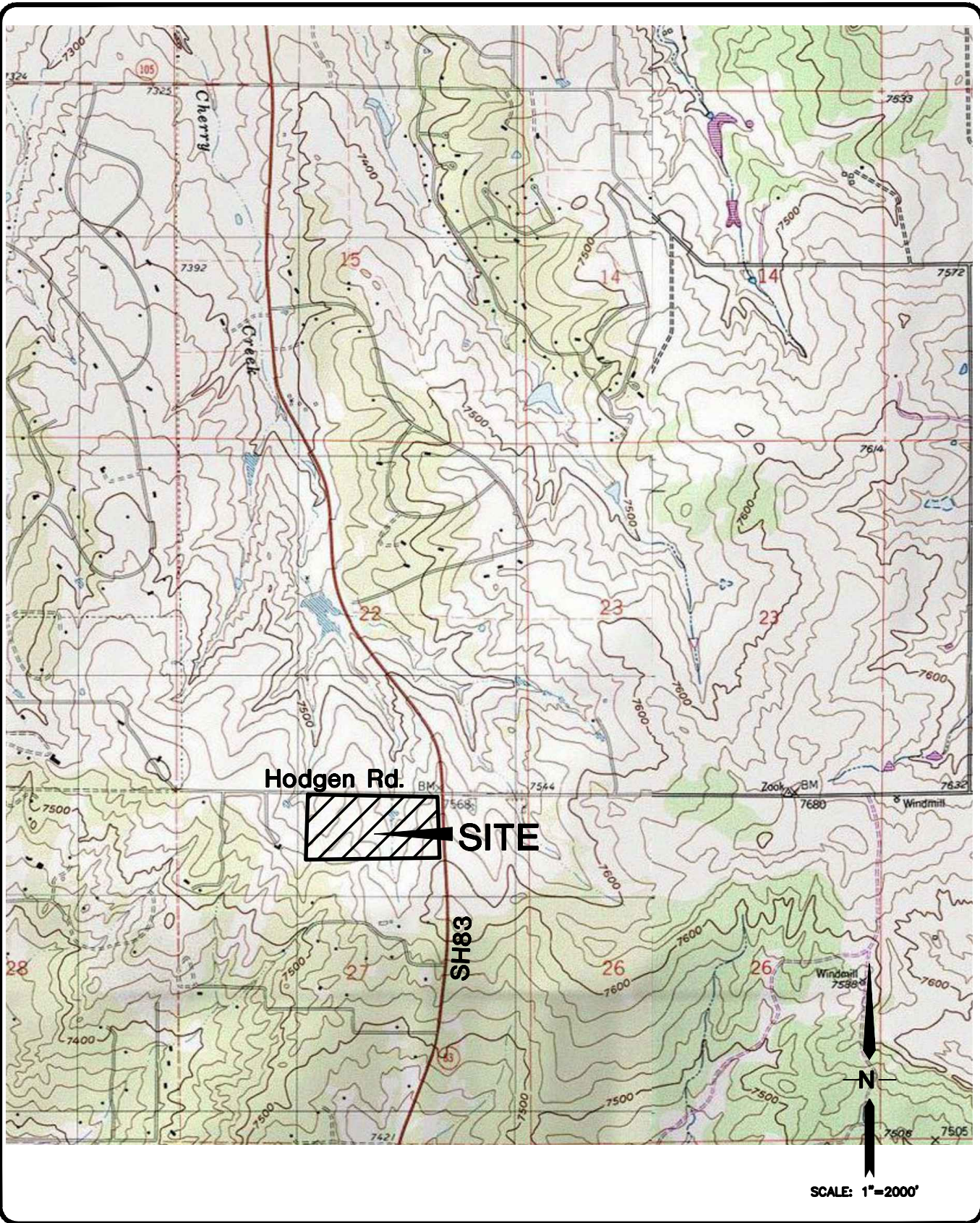
DRAINAGE COST ESTIMATE

**ROLLIN RIDGE FILING NO. 1
DRAINAGE IMPROVEMENTS COST ESTIMATE**

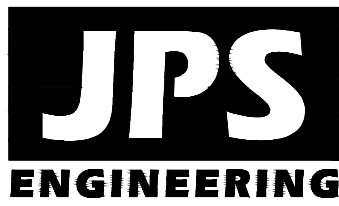
Item No.	Description	Quantity	Unit	Unit Cost (\$\$)	Total Cost (\$\$)
PUBLIC DRAINAGE IMPROVEMENTS (NON-REIMBURSABLE)					
506	Riprap Culvert Aprons (d ₅₀ = 12")	25	CY	\$98	\$2,450
603	18" RCP Culvert	76	LF	\$65	\$4,940
603	24" RCP Culvert	173	LF	\$78	\$13,494
603	36" RCP Culvert	74	LF	\$120	\$8,880
603	18" FES	2	EA	\$390	\$780
603	24" FES	2	EA	\$468	\$936
603	36" FES	2	EA	\$720	\$1,440
604	Type D Inlet	1	EA	\$5,731	\$5,731
	SUBTOTAL				\$38,651
	Contingency @ 15%				\$5,798
	TOTAL				\$44,449
PRIVATE DRAINAGE IMPROVEMENTS					
506	Riprap Aprons (d ₅₀ = 12")	10	CY	\$98	\$980
603	18" RCP / HDPE Pond Discharge Pipe	56	LF	\$65	\$3,640
603	30" RCP / HDPE Pond Discharge Pipe	74	LF	\$97	\$7,178
603	48" RCP Culvert	108	LF	\$195	\$21,060
603	18" FES	1	EA	\$390	\$390
603	48" FES	2	EA	\$2,340	\$4,680
604	Detention Pond Forebay	2	EA	\$3,000	\$6,000
604	Detention Pond Spillway	2	LS	\$5,000	\$10,000
604	Detention Pond Outlet Structure	2	LS	\$6,000	\$12,000
	SUBTOTAL				\$65,928
	Contingency @ 15%				\$9,889
	TOTAL				\$75,817
	TOTAL DRAINAGE IMPROVEMENTS				\$120,266

APPENDIX E

FIGURES



VICINITY MAP



**ROLLIN RIDGE
ESTATES**

FIGURE A1
JPS PROJ NO. 081702

National Flood Hazard Layer FIRMette



Legend

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

SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) Zone A, V, A99
		With BFE or Depth Zone AE, AO, AH, VE, AR
		Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
		Future Conditions 1% Annual Chance Flood Hazard Zone X
		Area with Reduced Flood Risk due to Levee. See Notes. Zone X
		Area with Flood Risk due to Levee Zone D
OTHER AREAS		NO SCREEN Area of Minimal Flood Hazard Zone X
		Effective LOMRs
		Area of Undetermined Flood Hazard Zone D
GENERAL STRUCTURES		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall
OTHER FEATURES		20.2 Cross Sections with 1% Annual Chance Water Surface Elevation
		17.5
		Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
		Coastal Transect Baseline
MAP PANELS		Digital Data Available
		No Digital Data Available
		Unmapped



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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on **3/15/2019 at 1:15:25 PM** and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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



39°4'19.42"N

104°46'9.82"W

T11S, R66W, S022

EL PASO COUNTY
080059

AREA OF MINIMAL FLOOD HAZARD
Zone X

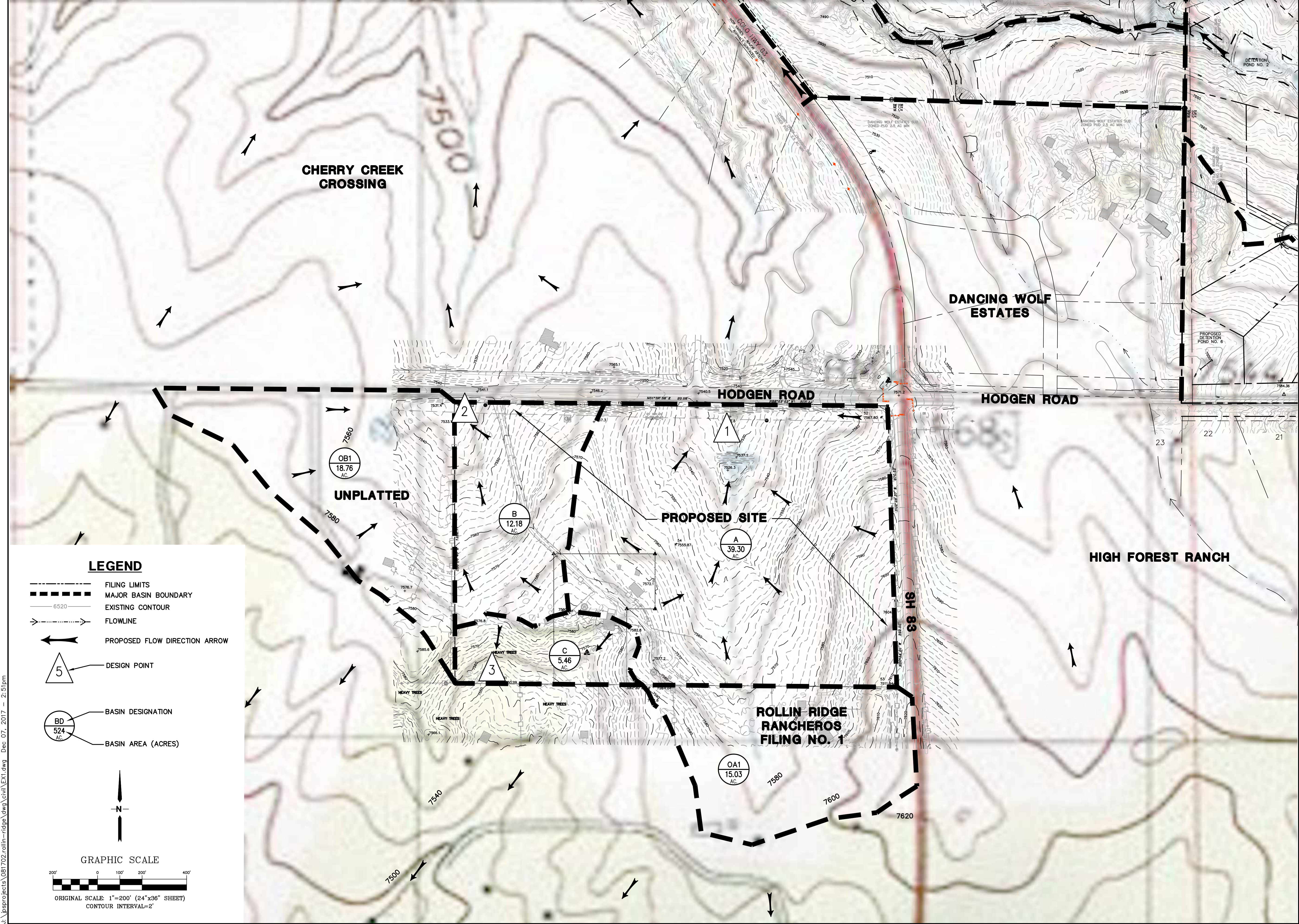
08041 C0285 G
eff. 12/7/2018

USGS The National Map: Orthoimagery. Data refreshed October, 2017.

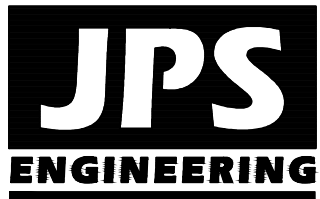
0 250 500 1,000 1,500 2,000 Feet 1:6,000

39°3'51.49"N

104°45'32.36"W



ROLLIN RIDGE ESTATES



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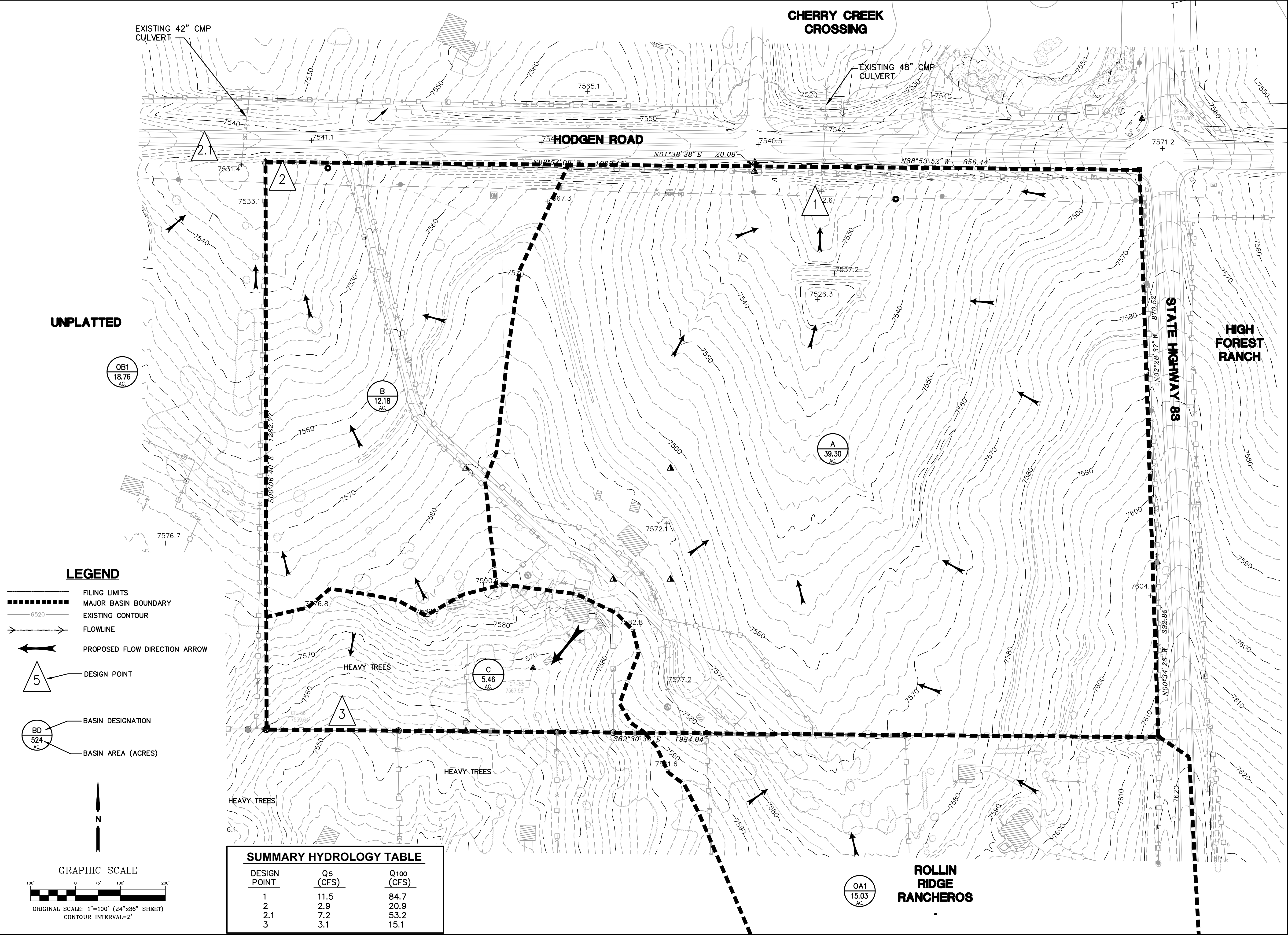
No.	REVISION	BY	DATE

MAJOR BASIN / HISTORIC DRAINAGE PLAN

HORZ. SCALE: 1"=200'	DRAWN: BJJ
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: RAMPART	CHECKED: JPS
CREATED: 9/12/17	LAST MODIFIED: 2/7/17
PROJECT NO: 081702	MODIFIED BY: BJJ

SHEET: EX1

Z:\081702\rollin-ridge.dwg.ctb Feb 22, 2020 11:47am

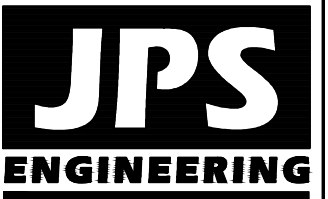


ROLLIN RIDGE ESTATES

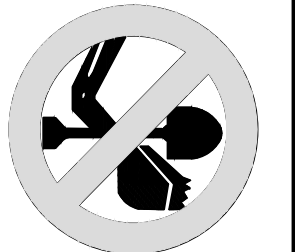
HISTORIC DRAINAGE PLAN

HORZ. SCALE: 1"=100'
VERT. SCALE: N/A
SURVEYED: RAMPART
CREATED: 9/12/17
PROJECT NO: 081702
SHEET: EX2

DRAWN: BJJ
DESIGNED: JPS
CHECKED: JPS
LAST MODIFIED: 2/22/20
MODIFIED BY: BJJ



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NOTE: SEE APPENDIX B1 OF FDR FOR ANALYSIS OF EXISTING HODGEN ROAD CULVERTS

PROPOSED DETENTION POND B
BOT EL=7533.0
SPILLWAY EL=7535.5
TOP EL=7538.0
REQ'D FSD VOL=0.38 AC. FT.
DSN. VOL=0.42 AC. FT.

SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q ₅ (CFS)	Q ₁₀₀ (CFS)
A1	16.4	71.7
A2	3.2	13.3
A2.1	18.9	81.9
A3	27.4	96.8
A4	2.9	11.8
1	29.4	107.0
(1d DETAINED)	0.4	62.5
2	6.1	25.2
(2d DETAINED)	0.1	10.4
3	4.3	16.8

GENERAL DRAINAGE NOTES:

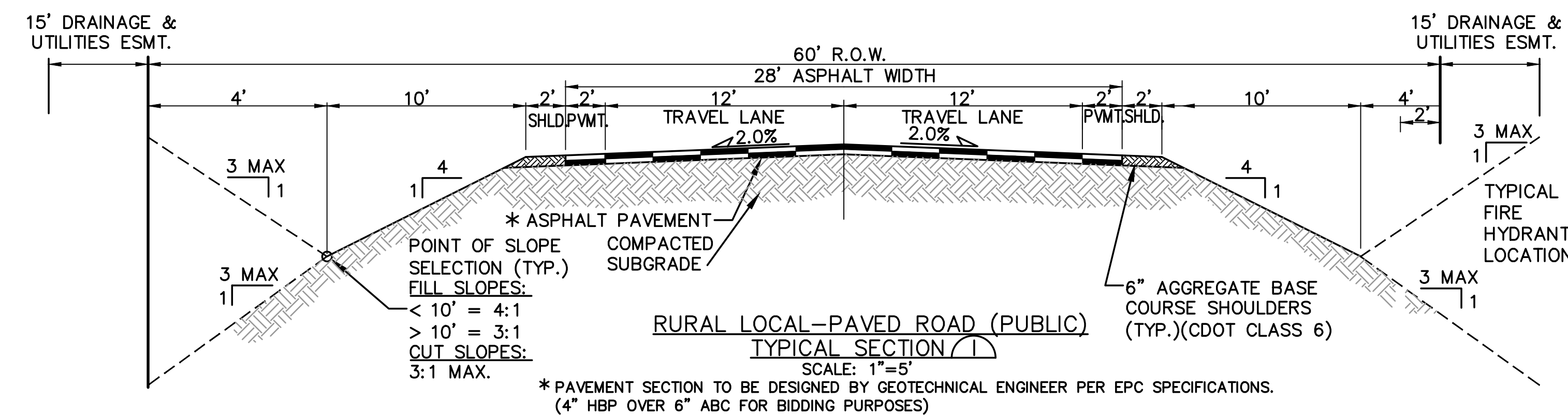
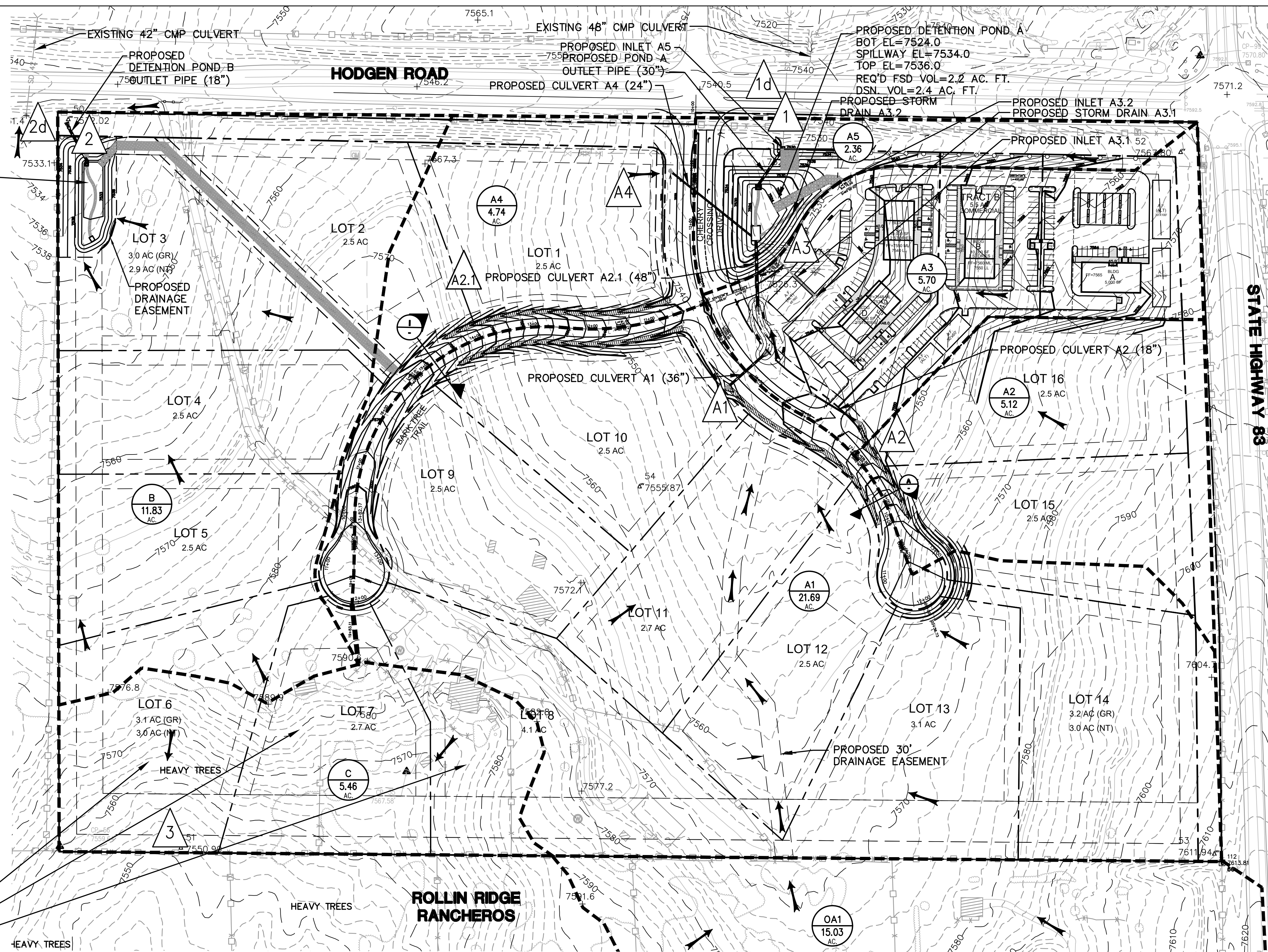
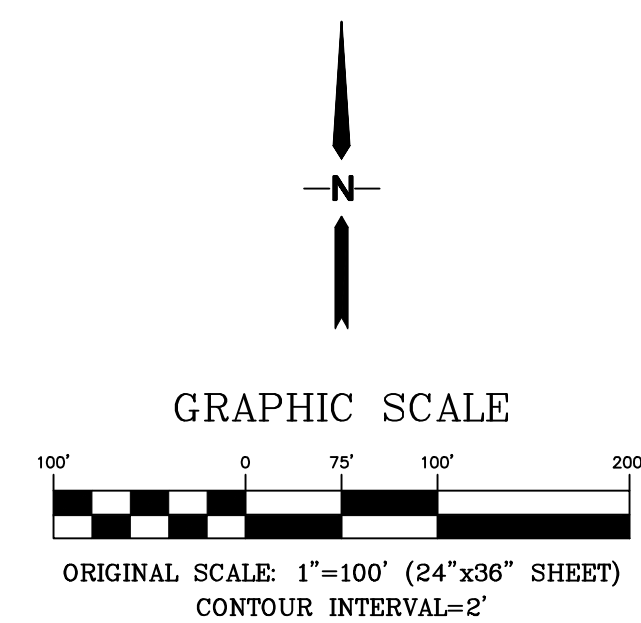
- INDIVIDUAL BUILDERS SHALL PROVIDE POSITIVE DRAINAGE AWAY FROM STRUCTURES AND ACCOUNT FOR POTENTIAL CROSS-LOT DRAINAGE IMPACTS WITHIN EACH LOT.
- BUILDERS AND PROPERTY OWNERS SHALL IMPLEMENT & MAINTAIN EROSION CONTROL BEST MANAGEMENT PRACTICES FOR PROTECTION OF DOWNSTREAM PROPERTIES AND FACILITIES.

LEGEND

- FILING LIMITS
- MAJOR BASIN BOUNDARY
- EXISTING CONTOUR
- FLOWLINE
- PROPOSED FLOW DIRECTION ARROW
- DESIGN POINT
- BASIN DESIGNATION
- BASIN AREA (ACRES)
- GR GROSS LOT AREA
- NT NET LOT AREA

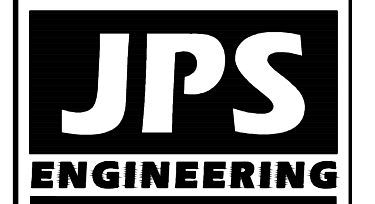
NOTES:

- HOMES IN BASIN C SHALL DIRECT DOWNSPOUTS SO AS TO NOT ADVERSELY IMPACT DOWNSTREAM PROPERTIES
- LOTS WITHIN BASIN C MAY NOT EXCEED A TOTAL LOT IMPERVIOUS AREA OF 10 PERCENT



IMPERVIOUS AREA CALCULATIONS

BASIN A3 AREA	= 5.70 AC.
IMPERVIOUS AREAS:	
SURFACE TYPE	AREA
PARKING PAVEMENT	105,412 SF
BUILDING	45,560 SF
SIDEWALK	11,834 SF
TOTAL	162,806 SF
	= 3.74 AC
	= 66% IMPERVIOUS



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DEVELOPED DRAINAGE PLAN

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D1.1