



## **FINAL DRAINAGE REPORT**

**for**

**BLACK FOREST OFFICE  
The North Half of the NE Quarter of the SE Quarter of Section 7  
Township 12 South, Range 65 West of the 6<sup>th</sup> P.M.  
County of El Paso, State of Colorado  
12740 Black Forest Road  
Colorado Springs, Colorado 80908**

2N Civil Job No. 19015  
September 11, 2020

**PREPARED FOR:**  
Black Forest, LLC  
8655 Table Butte Road  
Colorado Springs, Colorado 80908-1224  
Contacts: Rad Jackson, Project Manager

Engineer:  
2N Civil, LLC  
6 Inverness Court East, Suite 125  
Englewood, Colorado 80112  
Contact: Ryan Eichele, PE, Project Manager  
Todd West, PE Project Engineer



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**Engineer's Statement**

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

SIGNATURE: \_\_\_\_\_  
Todd Eric West, PE  
Colorado Registration No. 37643  
For and on behalf of 2N Civil, LLC

**Developer's Statement**

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

\_\_\_\_\_  
Business Name

By: \_\_\_\_\_

Title: \_\_\_\_\_

Address: \_\_\_\_\_

**El Paso County Statement:**

Filed in accordance with Section 51.1 of the El Paso Land Development Code, as amended.

\_\_\_\_\_  
Director of Public Works

\_\_\_\_\_  
Date

Conditions:

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Table of Contents

1) GENERAL LOCATION AND DESCRIPTION .....	4
2) DRAINAGE BASINS AND SUB-BASINS .....	4
3) DRAINAGE DESIGN CRITERIA .....	5
4) DRAINAGE FACILITY DESIGN.....	6
5) DRAWING CONTENTS.....	7
6) CONCLUSION .....	7

APPENDIX A:

Vicinity Map

Soils Map

FEMA Map

APPENDIX B:

Hydrologic Calculations

APPENDIX C:

EDB Calculations

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1) GENERAL LOCATION AND DESCRIPTION

(a) Location

The Black Hills Office property, addressed as 12740 Black Hills Road, is the north half of the Northeast Quarter of the Southeast Quarter of Section 7, Township 12 South, Range 65 West of the 6<sup>th</sup> Principle Meridian, County of El Paso, State of Colorado. Black Forest Road bounds the site on the east. Rural Residential development (Zoning RR-5) surrounds the site on the north, south, and west. An existing asphalt and gravel road provides access to the vacant parcel. There are no major drainageways on the site.

(b) Description of property and Proposed Improvements

The subject property contains approximately 4.83 acres. Sparse ground cover consists of native weeds with a few trees at the northeast corner of the site. A shallow ridgeline divides the site, directing the east portion of the site to the north, and the west portion of the site to the west. The National Resources Conservation Service Web Soil Survey classifies the in situ soils as Hydrologic Group B, which exhibit a moderate infiltration rate when thoroughly wet.

There are no major drainage ways or irrigation facilities on the site.

The development will consist of a single story 4,400 sf office building with a full, walk-out basement of equal size with a 3,250-sf studio/shop building on the 4.77 acres. The office building will house the Owner's corporate functions for Metal Roof Innovations, Ltd. company (strategic planning, accounting, sales/marketing management).

An existing barn (currently under construction) was permitted under the A-5 zoning. Construction began in the spring of 2020. The barn will be re-purposed in use as a studio/shop to supplement the corporate functions. No manufacturing, warehousing, shipping, wholesale or retail sales will take place at this facility.

2) DRAINAGE BASINS AND SUB-BASINS

(a) Major Basin Description

The site is tributary to the upper reach of Kettle Creek drainage basin (FOMO3000), that flows from north to south approximately 1,500 feet west of the site. This basin is an unstudied basin included in the El Paso County drainage basin fee program.

Based on the FEMA Map No. 08041C0315G with an effective date of 12/07/18 (included in the Appendix) the site is located within Zone X, areas of minimal flood hazard. No portion of the site is located within the 100 year floodplain. The upper reach of the Kettle Creek basin is sparsely developed and includes single family homes on large acreages.

(b) Sub-Basin Description

The site historically drains north and west. The development of the site will occur on the upper portion of the lot, with the majority of the new impervious areas directed to a proposed detention facility that will intercept flow prior to discharge to the west.

3) DRAINAGE DESIGN CRITERIA

(a) Development Criteria Reference

The City of Colorado Springs Drainage Criteria Manual Volumes 1 and 2 (DCMV1 & DCMV2) was utilized per El Paso County's stormwater quality design criteria as well as the applicable standards from the County's Engineering Criteria Manual (ECM).

(b) Hydrologic Criteria

The Rational Method was selected to calculate existing and proposed runoff rates from the site for the 5 year (minor storm) and 100 year (major storm) recurrence intervals. The design rainfall will be from DCMV1 Table 6-2 Rainfall Depths for Colorado Springs.

**Table 6-2. Rainfall Depths for Colorado Springs**

Return Period	1-Hour Depth	6-Hour Depth	24-Hour Depth
2	1.19	1.70	2.10
5	1.50	2.10	2.70
10	1.75	2.40	3.20
25	2.00	2.90	3.60
50	2.25	3.20	4.20
100	2.52	3.50	4.60

Where  $Z = 6,840 \text{ ft}/100$

The most current version of UDFCD's Peak Runoff Prediction by the Rational

Method, Version 2.00 released May 2017 was used to determine flows. The Runoff Coefficients from DCMV1, Table 6-6 were input to determine peak runoff values.

The development will implement Full Spectrum Detention (FSD) utilizing an Extended Detention Basin (EDB) to capture and treat runoff prior to discharge downstream. Full Spectrum Detention (FSD) is a design concept that provides control of the full range of runoff rates that pass through detention facilities.

#### 4) DRAINAGE FACILITY DESIGN

##### (a) General Concept

The area being developed has been divided into three subbasins. Basin PR-1 includes the paved parking area and portions of the buildings (office and warehouse) and perimeter landscaping. Basin PR-1 will flow within the asphalt parking lot to a new 5' Type R inlet, where it will be conveyed to the pond via an 18" RCP pipe. Due to the small size of the development, per the UD-BMP\_v3.07 spreadsheet by MHFD, a forebay is not necessary for this size site.

Basin PR-2, located along the south property line, will collect flow from a portion of the office roof, which will be conveyed to the detention basin via an earthen swale. Basin PR-3, located along the northern limit of the development, will flow north following the historic drainage path and is not tributary to the proposed pond.

The imperviousness value of 46.39%, which represents the composite value for the area tributary to the pond, was used to determine the required EDB. The UD-Detention spreadsheet can be found in the Appendix.

The drainage concept for the development does not alter historic drainage patterns. The detention pond will act to limit the stormwater release rate to pre-development conditions.

##### (b) Specific Details

The development will implement Full Spectrum Detention (FSD) utilizing an Extended Detention Basin (EDB) to capture and treat runoff prior to discharge downstream. The proposed detention pond is designed using the UDFCD spreadsheet, UD-Detention v.4.03. This design considers the water quality capture volume (WQCV), excess urban runoff volume (EURV), and 100-year detention volume.

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5) DRAWING CONTENTS

(a) General Location Map

A Vicinity Map is included in the Appendix.

(b) Drainage Plan

Refer to the Proposed Drainage Plan in the Appendix for basin delineation, drainage routes and flows, and proposed stormwater facilities.

6) CONCLUSION

In our professional opinion, the proposed development will pose an insignificant change in the historic drainage patterns of the existing site. The development of the office and warehouse will include construction of an Extended Detention Basin, which will provide detention of the WQCV, EURV, and 100 year flow. This facility will slow the rate of discharge from the site and promote infiltration. These runoff reduction measures ensure that the capacity of the downstream drainageways will not be negatively affected by the construction of these improvements.

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## REFERENCES

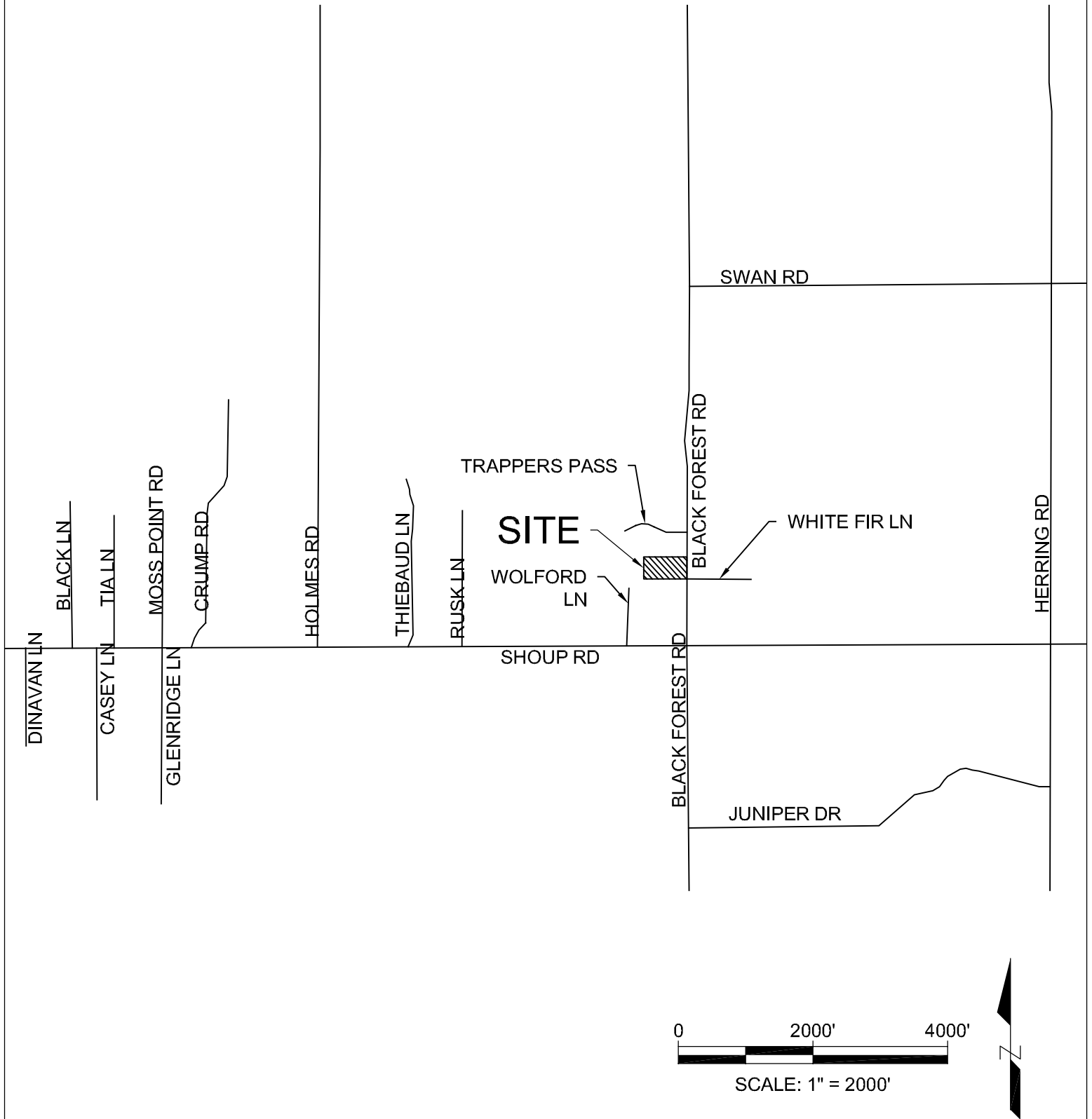
1. El Paso County *Engineering Criteria Manual* (ECM), Revised 12/13/2016.
2. *Colorado Springs Drainage Criteria Manual Volumes 1 and 2* (DCMV1 & DCMV2), May 2014.
3. *Urban Storm Drainage Criteria Manual, Volumes 1, 2, & 3, Urban Drainage and Flood Control District*, Volumes 1 & 2 - Originally Published September 1969, Updated March 2017; Volume 3 - Originally Published September 1992, Updated November 2010.



## **APPENDIX A**

Vicinity Map  
Soils Map  
FEMA Map

# VICINITY MAP



Project Number: 19015

J:\Projects\19\19015.dwg Site Plan\Vicinity Map.dwg

**2N Civil, LLC**

6 Inverness Ct. E., Suite 125  
Englewood, CO 80112

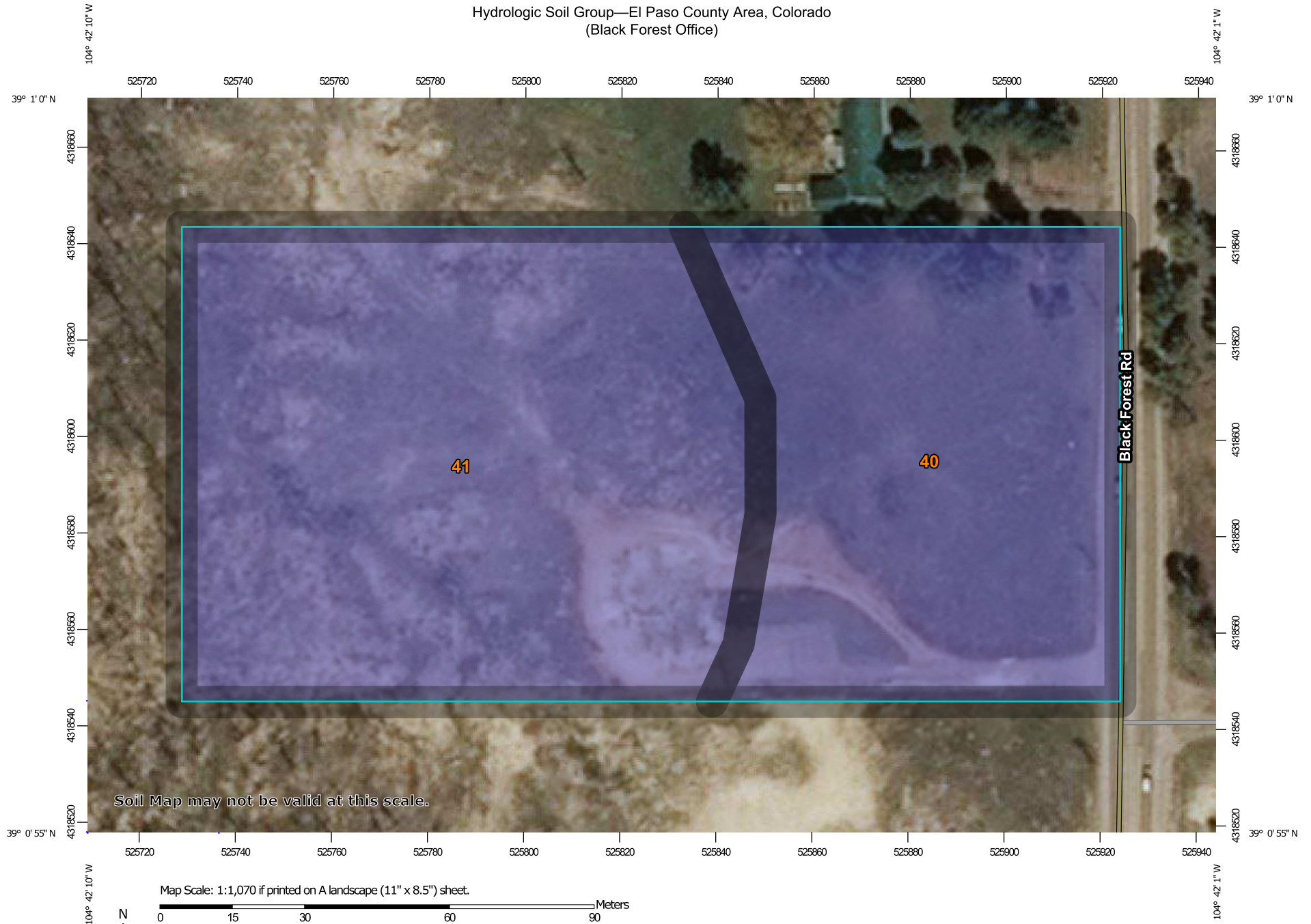
Phone 303-925-0544 Fax 303-925-0547  
www.2NCivil.com

## VICINITY MAP BLACK FOREST LLC

Drawn By: TEW  
Checked By: EPT  
Revisions: 7-2-20

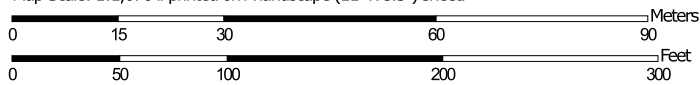


# Hydrologic Soil Group—El Paso County Area, Colorado (Black Forest Office)



Soil Map may not be valid at this scale.

Map Scale: 1:1,070 if printed on A landscape (11" x 8.5") sheet.



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



**Natural Resources  
Conservation Service**


Web Soil Survey  
National Cooperative Soil Survey

7/15/2020  
Page 1 of 4

Hydrologic Soil Group—El Paso County Area, Colorado  
(Black Forest Office)



## MAP LEGEND

### Area of Interest (AOI)









 Area of Interest (AOI)

### Soils

#### Soil Rating Polygons





 A  
 A/D  
 B  
 B/D  
 C  
 C/D  
 D  
 Not rated or not available

#### Soil Rating Lines


 A  
 A/D  
 B  
 B/D  
 C  
 C/D  
 D  
 Not rated or not available

#### Soil Rating Points




 A  
 A/D  
 B  
 B/D

 C  
 C/D  
 D  
 Not rated or not available

### Water Features

 Streams and Canals

### Transportation

 Rails  
 Interstate Highways  
 US Routes  
 Major Roads  
 Local Roads

### Background

 Aerial Photography

## MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado  
 Survey Area Data: Version 18, Jun 5, 2020

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

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

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

## Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
40	Kettle gravelly loamy sand, 3 to 8 percent slopes	B	1.9	40.6%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	B	2.8	59.4%
<b>Totals for Area of Interest</b>			<b>4.8</b>	<b>100.0%</b>

## 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



# National Flood Hazard Layer FIRMette



104°42'25"W 39°1'11"N



## 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
GENERAL STRUCTURES		Area of Undetermined Flood Hazard Zone D
		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		Profile Baseline
		Hydrographic Feature
		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 7/16/2020 at 3:38 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.

USGS The National Map: Orthoimagery, Data refreshed April 2020

104°41'47"W 39°0'43"N

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

1:6,000

## **APPENDIX B**

### Hydrologic Calculations



**Black Forest Office**

Composite Impervious Calculations - Proposed Conditions

Date: September 11, 2020

**Proposed Conditions**

Information from UCFCF Volume 1 Table 6-6

Type B NRCS Hydrologic Soils Group

Land Use	% Impervious	C5	C100
Streets (Paved)	100%	0.90	0.96
Streets (Gravel)	80%	0.59	0.74
Drive and Walks	100%	0.90	0.96
Roofs	90%	0.73	0.83
Lawns	0%	0.08	0.50

*I. Land Use Breakdown*

Basin	Area (square feet)					Σ Area
	Paved	Gravel	Drive/Walk	Roofs	Lawns	
PR-1	14,245	0	2,969	1,640	4,374	23,228
PR-2	0	0	2,737	4,401	24,366	31,504
PR-3	0	0	375	1,609	0	1,984
						56,716

Basin	Area (acres)					Σ Area
	Paved	Gravel	Drive/Walk	Roofs	Lawns	
PR-1	0.33	0.00	0.07	0.04	0.10	0.533
PR-2	0.00	0.00	0.06	0.10	0.56	0.723
PR-3	0.00	0.00	0.01	0.04	0.00	0.046
Total						1.302

*II. Composite Basin Imperviousness and Runoff Coefficients*

Basin	Σ (% I * Area)	Σ Area (ac)	$I_{\text{Weighted C5}} = \frac{\Sigma (C5 * \text{Area})}{\Sigma \text{Area}}$	$I_{\text{Weighted C100}} = \frac{\Sigma (C100 * \text{Area})}{\Sigma \text{Area}}$	$I_{\text{Weighted Basin}} = \frac{\Sigma (\% I * \text{Area})}{\Sigma \text{Area}}$
			Σ Area	Σ Area	Σ Area
PR-1	0.43	0.533	0.73	0.86	<b>80.5%</b>
PR-2	0.15	0.723	0.24	0.59	<b>21.3%</b>
PR-3	0.04	0.046	0.76	0.85	<b>91.9%</b>

*Composite Imperviousness Value for Watershed Tributary to Pond (used in MHFD-Detention Spreadsheet for EDB Pond)*

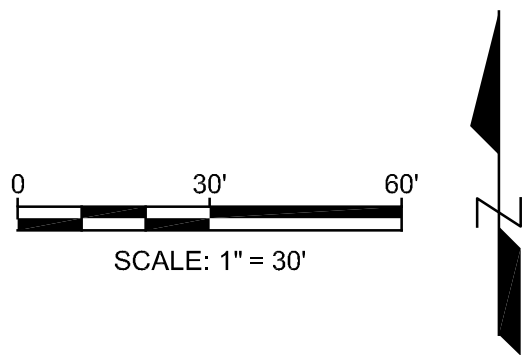
Basins PR-1 & PR-2	Σ Area (ac)	<b>1.26</b>	% $I_{\text{Watershed}} =$	<b>46.39%</b>
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Calculation of Peak Runoff using Rational Method	
Area (A)	1000000 m <sup>2</sup>
Runoff Coefficient (C)	0.8
Intensity (I)	10 mm/hr
Time of Concentration (T <sub>c</sub> )	10 min
Peak Runoff (Q <sub>p</sub> )	800000 m <sup>3</sup> /hr

$$Q(cfs) = CIA$$
[illegible]

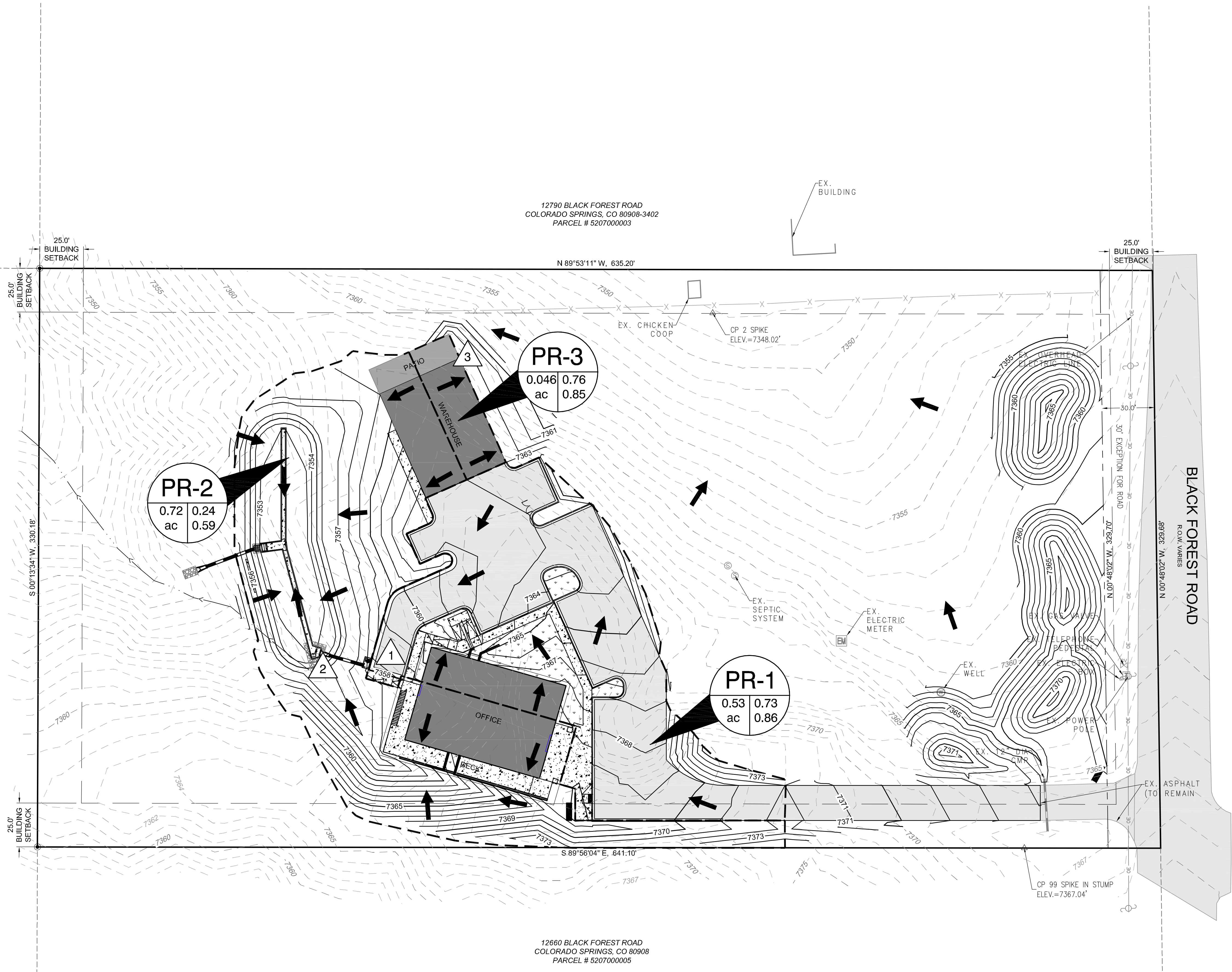


BLACK FOREST OFFICE  
N1/2 NE1/4 SE1/4 SE1/4 OF SECTION 07, TOWNSHIP 12 SOUTH, RANGE 65 WEST OF  
THE 6TH P.M., EL PASO COUNTY, COLORADO



2N CIVIL

303.925.0544  
www.2ncivil.com



LEGEND

EXISTING

- ZONE LOT LINE
- RIGHT OF WAY
- RANGE LINE
- LOT LINE
- EX-SS SANITARY SEWER MAIN
- SS SANITARY SEWER MANHOLE
- EX-ST STORM SEWER MAIN
- ST STORM SEWER INLET
- ST STORM SEWER MANHOLE
- 12" WATER LINE
- 8" WATER LINE
- 4" WATER LINE
- FIRE HYDRANT
- VALVE
- WATER SERVICE & METER
- OVERHEAD UTILITY LINE
- ELECTRIC MANHOLE
- LIGHT POLE
- POWER POLE
- ELECTRIC BOX
- RAIL POLE
- TRAFFIC BOX
- BURIED COMM. LINE
- GAS LINE
- BURIED ELECTRIC LINE
- 5225 MAJOR CONTOUR
- 5227 MINOR CONTOUR

PROPOSED

- BUILDING LINE
- CONCRETE
- LANDSCAPING
- STORM SEWER MAIN
- STORM SEWER CLEANOUT
- STORM SEWER MANHOLE

BASIN NAME

PR-1

0.0 ac

0.00 runoff coefficient

0.00 value

BASIN AREA

1

BASIN DESIGN POINT

RUNOFF FLOW ARROW

PROPOSED BASIN LIMITS

Summary Runoff Table					
DESIGN POINT	CONTRIBUTING BASIN(S)	CONTRIBUTING AREA (AC)	Q <sub>0</sub> (cfs)	Q <sub>100</sub> (cfs)	NOTES
1	PR-1	0.53	1.91	3.77	Releases to EDB Pond
2	PR-2	0.72	0.88	3.65	Releases to EDB Pond
3	PR-3	0.05	0.18	0.34	Releases undetained following historic flow path

**CAUTION: NOTICE TO CONTRACTOR**  
THE CONTRACTOR IS SPECIFICALLY CAUTIONED THAT THE LOCATION AND/OR ELEVATION OF EXISTING UTILITIES AS SHOWN ON THESE PLANS IS BASED ON RECORDS OF THE VARIOUS UTILITY COMPANIES AND, WHERE POSSIBLE, MEASUREMENTS TAKEN IN THE FIELD. THE INFORMATION IS NOT TO BE RELIED ON AS BEING EXACT OR COMPLETE. THE CONTRACTOR MUST CALL THE LOCAL UTILITY LOCATION CENTER AT LEAST 48 HOURS BEFORE ANY EXCAVATION TO REQUEST EXACT FIELD LOCATIONS OF THE UTILITIES. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO RELOCATE ALL EXISTING UTILITIES WHICH CONFLICT WITH THE PROPOSED IMPROVEMENTS SHOWN ON THE PLANS.



**BENCHMARK**  
SURVEY CONTROL POINTS AS SHOWN HEREON. ALL ELEVATIONS ARE BASED UPON NAVD88 VERTICAL DATUM.

PREPARED FOR:  
BLACK FOREST, LLC  
12740 BLACK FOREST RD  
COLORADO SPRINGS, CO 80908

PROPOSED BASIN MAP  
BLACK FOREST OFFICE  
COLORADO SPRINGS, COLORADO

BY: DATE:

REVISIONS:  
1.  
2.  
3.  
4.

PROJECT NUMBER: 19015  
ISSUED DATE: 08-07-20  
DESIGNED BY: TEW  
REVIEWED BY: RCE

PROPOSED  
BASIN MAP

PR-BASIN



**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 ( $t_t$ ) 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 ( $t_t$ ) 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.

For Colorado Springs and much of the Fountain Creek watershed, the 1-hour depths are fairly uniform and are summarized in Table 6-2. Depending on the location of the project, rainfall depths may be calculated using the described method and the NOAA Atlas maps shown in Figures 6-6 through 6-17.

**Table 6-2. Rainfall Depths for Colorado Springs**

Return Period	1-Hour Depth	6-Hour Depth	24-Hour Depth
2	1.19	1.70	2.10
5	1.50	2.10	2.70
10	1.75	2.40	3.20
25	2.00	2.90	3.60
50	2.25	3.20	4.20
100	2.52	3.50	4.60

Where  $Z = 6,840 \text{ ft}/100$

These depths can be applied to the design storms or converted to intensities (inches/hour) for the Rational Method as described below. However, as the basin area increases, it is unlikely that the reported point rainfalls will occur uniformly over the entire basin. To account for this characteristic of rain storms an adjustment factor, the Depth Area Reduction Factor (DARF) is applied. This adjustment to rainfall depth and its effect on design storms is also described below. The UDFCD UD-Rain spreadsheet, available on UDFCD's website, also provides tools to calculate point rainfall depths and Intensity-Duration-Frequency curves<sup>2</sup> and should produce similar depth calculation results.

## 2.2 Design Storms

Design storms are used as input into rainfall/runoff models and provide a representation of the typical temporal distribution of rainfall events when the creation or routing of runoff hydrographs is required. It has long been observed that rainstorms in the Front Range of Colorado tend to occur as either short-duration, high-intensity, localized, convective thunderstorms (cloud bursts) or longer-duration, lower-intensity, broader, frontal (general) storms. The significance of these two types of events is primarily determined by the size of the drainage basin being studied. Thunderstorms can create high rates of runoff within a relatively small area, quickly, but their influence may not be significant very far downstream. Frontal storms may not create high rates of runoff within smaller drainage basins due to their lower intensity, but tend to produce larger flood flows that can be hazardous over a broader area and extend further downstream.

- **Thunderstorms:** Based on the extensive evaluation of rain storms completed in the Carlton study (Carlton 2011), it was determined that typical thunderstorms have a duration of about 2 hours. The study evaluated over 300,000 storm cells using gage-adjusted NEXRAD data, collected over a 14-year period (1994 to 2008). Storms lasting longer than 3 hours were rarely found. Therefore, the results of the Carlton study have been used to define the shorter duration design storms.

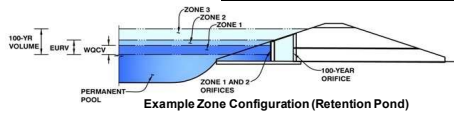
To determine the temporal distribution of thunderstorms, 22 gage-adjusted NEXRAD storm cells were studied in detail. Through a process described in a technical memorandum prepared by the City of Colorado Springs (City of Colorado Springs 2012), the results of this analysis were interpreted and normalized to the 1-hour rainfall depth to create the distribution shown in Table 6-3 with a 5 minute time interval for drainage basins up to 1 square mile in size. This distribution represents the rainfall

## **APPENDIX C**

### EDB Calculations

MHFD-Detention, Version 4.03 (May 2020)

**Basin ID:** EDB Basin



### Example Zone Configuration (Retention Pond)

Selected BMP Type =	EDB	
Watershed Area =	1.26	acres
Watershed Length =	390	ft
Watershed Length to Centroid =	160	ft
Watershed Slope =	0.040	ft/ft
Watershed Imperviousness =	46.39%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths = User Input		

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

Water Quality Capture Volume (WQCV) =	0.021	acre-feet
Excess Urban Runoff Volume (EURV) =	0.062	acre-feet
2-yr Runoff Volume ( $P1 = 1.19$ in.) =	0.056	acre-feet
5-yr Runoff Volume ( $P1 = 1.5$ in.) =	0.082	acre-feet
10-yr Runoff Volume ( $P1 = 1.75$ in.) =	0.104	acre-feet
25-yr Runoff Volume ( $P1 = 2$ in.) =	0.135	acre-feet
50-yr Runoff Volume ( $P1 = 2.25$ in.) =	0.160	acre-feet
100-yr Runoff Volume ( $P1 = 2.52$ in.) =	0.191	acre-feet
500-yr Runoff Volume ( $P1 = 3.14$ in.) =	0.255	acre-feet
Approximate 2-yr Detention Volume =	0.047	acre-feet
Approximate 5-yr Detention Volume =	0.064	acre-feet
Approximate 10-yr Detention Volume =	0.086	acre-feet
Approximate 25-yr Detention Volume =	0.095	acre-feet
Approximate 50-yr Detention Volume =	0.099	acre-feet
Approximate 100-yr Detention Volume =	0.112	acre-feet

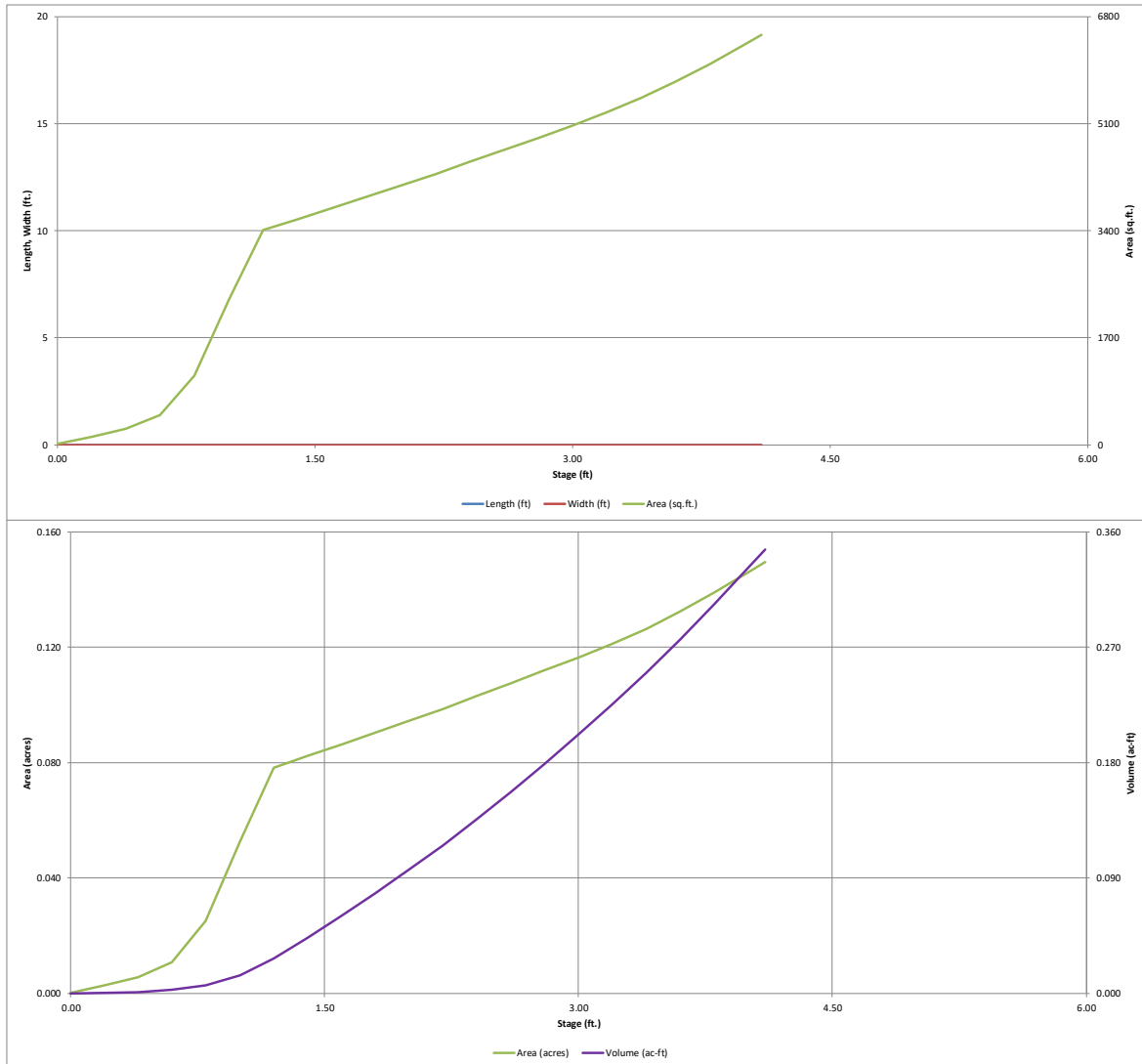
Zone 1 Volume (WQCV) =	0.021	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.041	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.050	acre-feet
Total Detention Basin Volume =	0.112	acre-feet
Initial Surge Volume (ISV) =	user	ft <sup>3</sup>
Initial Surge Depth (ISD) =	user	ft
Total Available Detention Depth ( $H_{total}$ ) =	user	ft
Depth of Trickle Channel ( $H_{TC}$ ) =	user	ft
Slope of Trickle Channel ( $S_{TC}$ ) =	user	ft/ft
Slopes of Main Basin Bases ( $S_{main}$ ) =	user	H:V
Basin Length-to-Width Ratio ( $R_{L/W}$ ) =	user	

Initial Surcharge Area ( $A_{SV}$ )	=	user	ft <sup>2</sup>
Surcharge Volume Length ( $L_{SV}$ )	=	user	ft
Surcharge Volume Width ( $W_{SV}$ )	=	user	ft
Depth of Basin Floor ( $H_{FLOOR}$ )	=	user	ft
Length of Basin Floor ( $L_{FLOOR}$ )	=	user	ft
Width of Basin Floor ( $W_{FLOOR}$ )	=	user	ft
Area of Basin Floor ( $A_{FLOOR}$ )	=	user	ft <sup>2</sup>
Volume of Basin Floor ( $V_{FLOOR}$ )	=	user	ft <sup>3</sup>
Depth of Main Basin ( $H_{MAIN}$ )	=	user	ft
Length of Main Basin ( $L_{MAIN}$ )	=	user	ft
Width of Main Basin ( $W_{MAIN}$ )	=	user	ft
Area of Main Basin ( $A_{MAIN}$ )	=	user	ft <sup>2</sup>
Volume of Main Basin ( $V_{MAIN}$ )	=	user	ft <sup>3</sup>
Calculated Total Basin Volume ( $V_{TOTAL}$ )	=	user	acre-feet

[illegible]

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.03 (May 2020)



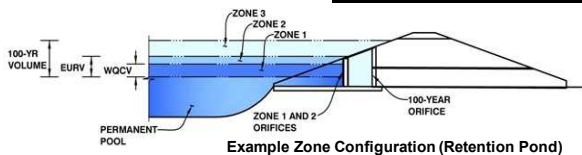


# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.03 (May 2020)

Project: Black Forest Office

Basin ID: EDB Basin



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.11	0.021	Orifice Plate
Zone 2 (EURV)	1.63	0.041	Orifice Plate
Zone 3 (100-year)	2.16	0.050	Weir&Pipe (Restrict)
Total (all zones)		0.112	

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<sup>2</sup>  
Underdrain Orifice Centroid = N/A feet

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

Calculated Parameters for Plate

Invert of Lowest Orifice = 0.00 ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Orifice Plate = 1.63 ft (relative to basin bottom at Stage = 0 ft)  
Orifice Plate: Orifice Vertical Spacing = 7.75 inches  
Orifice Plate: Orifice Area per Row = N/A inches

WQ Orifice Area per Row = N/A ft<sup>2</sup>  
Elliptical Half-Width = N/A feet  
Elliptical Slot Centroid = N/A feet  
Elliptical Slot Area = N/A ft<sup>2</sup>

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	0.60	1.20					
Orifice Area (sq. inches)	0.14	0.14	0.50					

	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)

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected		Not Selected	Not Selected
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A ft <sup>2</sup>
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A feet
Vertical Orifice Diameter =	N/A	N/A	inches		

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

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected		Zone 3 Weir	Not Selected
Overflow Weir Front Edge Height, H <sub>o</sub> =	1.63	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Gate Upper Edge, H <sub>g</sub> =	2.63 feet
Overflow Weir Front Edge Length =	4.00	N/A	feet	Overflow Weir Slope Length =	4.12 feet
Overflow Weir Gate Slope =	4.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	47.77
Horiz. Length of Weir Sides =	4.00	N/A	feet	Overflow Grate Open Area w/o Debris =	11.54 ft <sup>2</sup>
Overflow Grate Open Area % =	70%	N/A	% , grate open area/total area	Overflow Grate Open Area w/ Debris =	5.77 ft <sup>2</sup>
Debris Clogging % =	50%	N/A	%		

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

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected		Zone 3 Restrictor	Not Selected
Depth to Invert of Outlet Pipe =	0.25	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	0.24 ft <sup>2</sup>
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.17 feet
Restrictor Plate Height Above Pipe Invert =	3.50		inches	Half-Central Angle of Restrictor Plate on Pipe =	0.91 radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Calculated Parameters for Spillway

Spillway Invert Stage =	2.17	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth =
Spillway Crest Length =	5.00	feet	Stage at Top of Freeboard =
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =

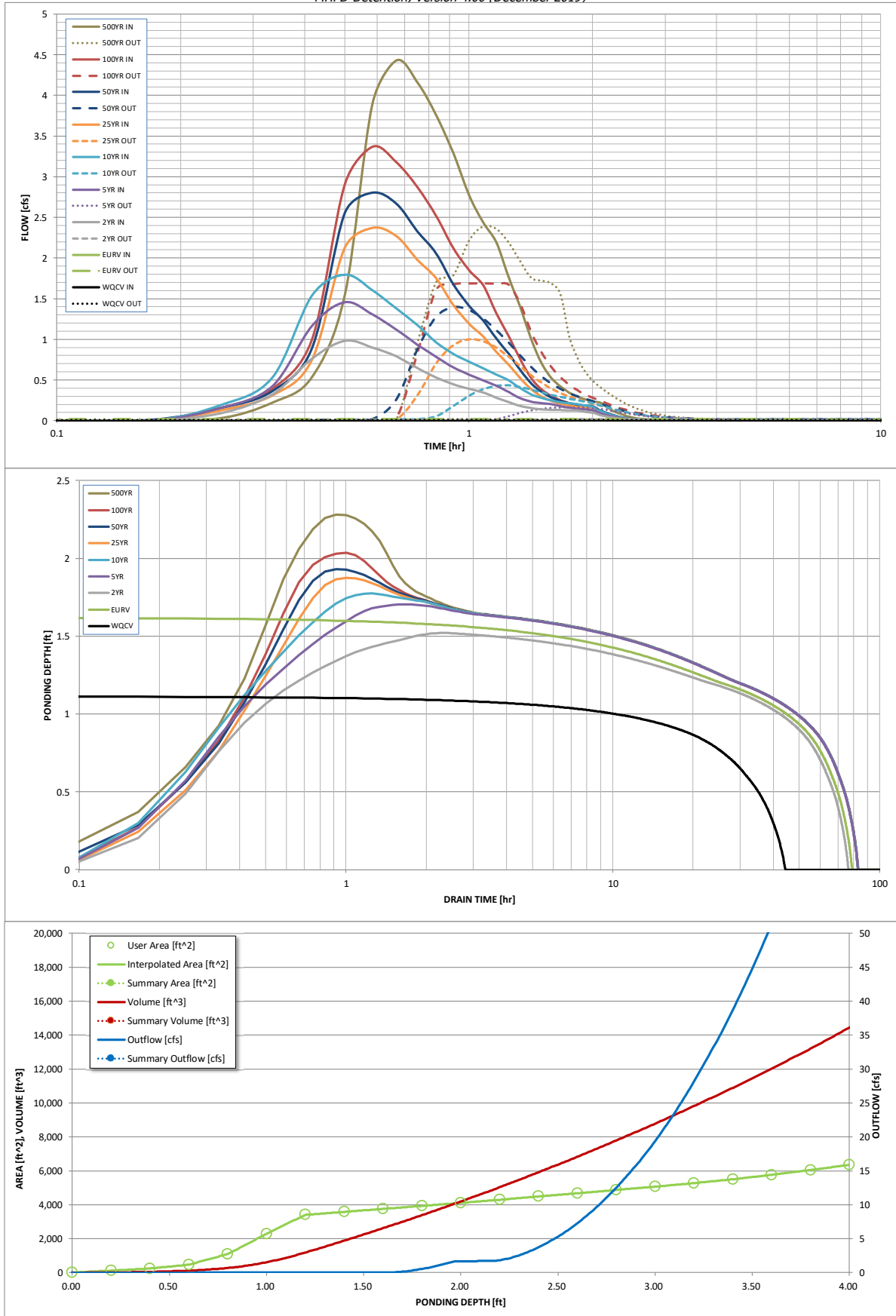
Routed Hydrograph Results

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

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
One-Hour Rainfall Depth (in)									
CUHP Runoff Volume (acre-ft)	0.021	0.062	0.056	0.082	0.104	0.135	0.160	0.191	0.255
Inflow Hydrograph Volume (acre-ft)	N/A	N/A	0.056	0.082	0.104	0.135	0.160	0.191	0.255
CUHP Predevelopment Peak Q (cfs)	N/A	N/A	0.2	0.4	0.7	1.2	1.5	1.8	2.5
OPTIONAL Override Predevelopment Peak Q (cfs)	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre)	N/A	N/A	0.13	0.35	0.52	0.92	1.15	1.44	2.01
Peak Inflow Q (cfs)	N/A	N/A	1.0	1.5	1.8	2.4	2.8	3.4	4.4
Peak Outflow Q (cfs)	0.0	0.0	0.0	0.2	0.4	1.0	1.4	1.7	2.4
Ratio Peak Outflow to Predevelopment Q	N/A	N/A	N/A	0.4	0.7	0.9	1.0	0.9	0.9
Structure Controlling Flow	Plate	Overflow Weir 1	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Gate 1 (fps)	N/A	N/A	N/A	0.0	0.0	0.1	0.1	0.1	0.2
Max Velocity through Gate 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)	40	70	68	72	70	67	66	64	60
Time to Drain 99% of Inflow Volume (hours)	42	75	72	78	77	76	75	74	71
Maximum Ponding Depth (ft)	1.12	1.63	1.52	1.70	1.78	1.88	1.93	2.04	2.28
Area at Maximum Ponding Depth (acres)	0.07	0.09	0.08	0.09	0.09	0.09	0.09	0.10	0.10
Maximum Volume Stored (acre-ft)	0.021	0.063	0.053	0.069	0.075	0.084	0.090	0.099	0.124

# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)



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

# DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

## Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00_min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.03
	0:15:00	0.00	0.00	0.10	0.16	0.19	0.13	0.16	0.16	0.22
	0:20:00	0.00	0.00	0.33	0.43	0.53	0.32	0.37	0.39	0.54
	0:25:00	0.00	0.00	0.76	1.17	1.54	0.75	0.89	1.00	1.55
	0:30:00	0.00	0.00	0.98	1.46	1.80	2.13	2.56	2.91	3.89
	0:35:00	0.00	0.00	0.90	1.31	1.61	2.37	2.80	3.37	4.43
	0:40:00	0.00	0.00	0.79	1.12	1.38	2.27	2.67	3.18	4.17
	0:45:00	0.00	0.00	0.65	0.94	1.18	1.98	2.33	2.87	3.76
	0:50:00	0.00	0.00	0.53	0.79	0.97	1.75	2.06	2.52	3.29
	0:55:00	0.00	0.00	0.45	0.66	0.82	1.42	1.68	2.12	2.78
	1:00:00	0.00	0.00	0.39	0.57	0.73	1.20	1.42	1.85	2.44
	1:05:00	0.00	0.00	0.35	0.50	0.65	1.04	1.23	1.67	2.20
	1:10:00	0.00	0.00	0.28	0.43	0.57	0.85	1.01	1.32	1.76
	1:15:00	0.00	0.00	0.23	0.35	0.50	0.69	0.82	1.04	1.39
	1:20:00	0.00	0.00	0.18	0.28	0.40	0.52	0.62	0.75	1.01
	1:25:00	0.00	0.00	0.16	0.24	0.33	0.39	0.46	0.53	0.71
	1:30:00	0.00	0.00	0.14	0.22	0.28	0.30	0.36	0.39	0.53
	1:35:00	0.00	0.00	0.14	0.20	0.25	0.25	0.29	0.31	0.42
	1:40:00	0.00	0.00	0.13	0.18	0.23	0.21	0.25	0.25	0.35
	1:45:00	0.00	0.00	0.13	0.16	0.22	0.19	0.22	0.22	0.30
	1:50:00	0.00	0.00	0.13	0.15	0.20	0.17	0.20	0.19	0.26
	1:55:00	0.00	0.00	0.11	0.14	0.19	0.16	0.19	0.17	0.24
	2:00:00	0.00	0.00	0.10	0.13	0.17	0.15	0.18	0.16	0.22
	2:05:00	0.00	0.00	0.07	0.09	0.12	0.11	0.13	0.12	0.16
	2:10:00	0.00	0.00	0.05	0.07	0.09	0.08	0.09	0.09	0.12
	2:15:00	0.00	0.00	0.04	0.05	0.06	0.06	0.07	0.06	0.09
	2:20:00	0.00	0.00	0.03	0.03	0.04	0.04	0.05	0.04	0.06
	2:25:00	0.00	0.00	0.02	0.02	0.03	0.03	0.03	0.03	0.04
	2:30:00	0.00	0.00	0.01	0.02	0.02	0.02	0.02	0.02	0.03
	2:35:00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02
	2:40:00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

## DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.03 (May 2020)*

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

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

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

[illegible]

# BLACK FOREST OFFICE

N1/2 NE1/4 SE1/4 SE1/4 OF SECTION 07, TOWNSHIP 12 SOUTH, RANGE 65 WEST OF  
THE 6TH P.M., EL PASO COUNTY, COLORADO



PREPARED FOR:  
BLACK FOREST, LLC  
12740 BLACK FOREST RD  
COLORADO SPRINGS, CO 80908

OUTLET STRUCTURE DETAILS  
BLACK FOREST OFFICE  
COLORADO SPRINGS, COLORADO

BY: DATE:

REVISIONS:  
1.  
2.  
3.  
4.

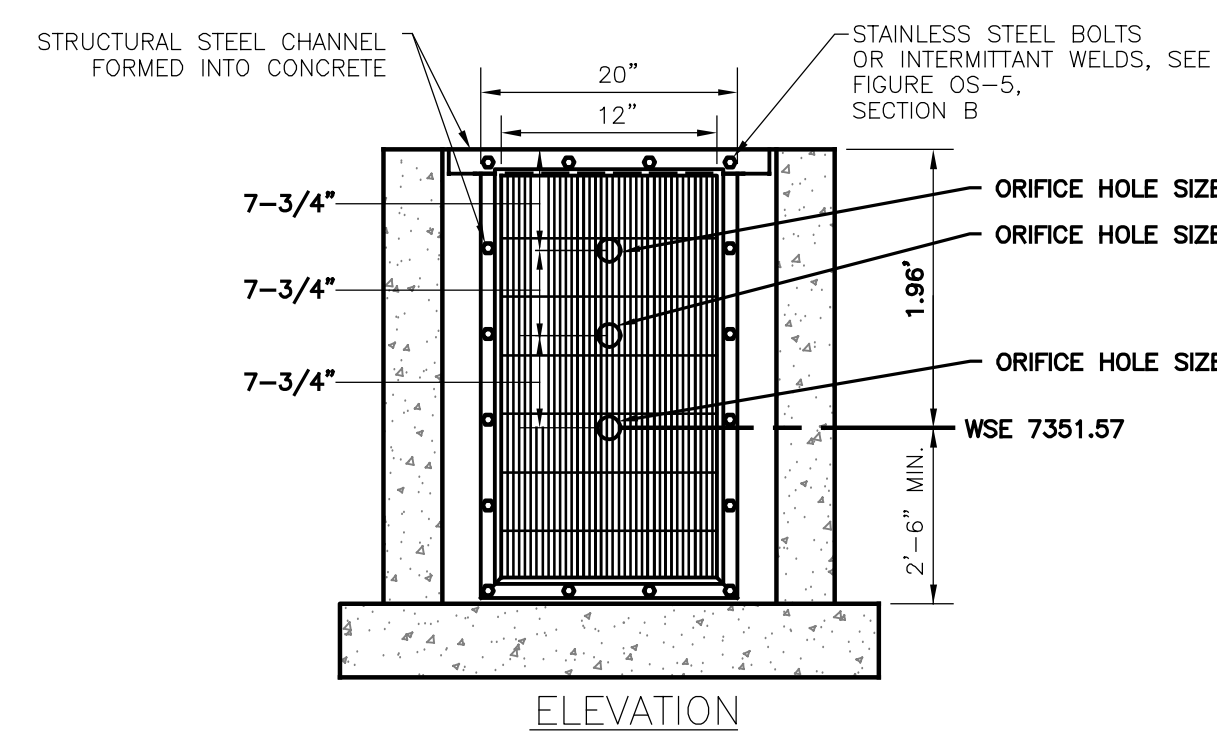
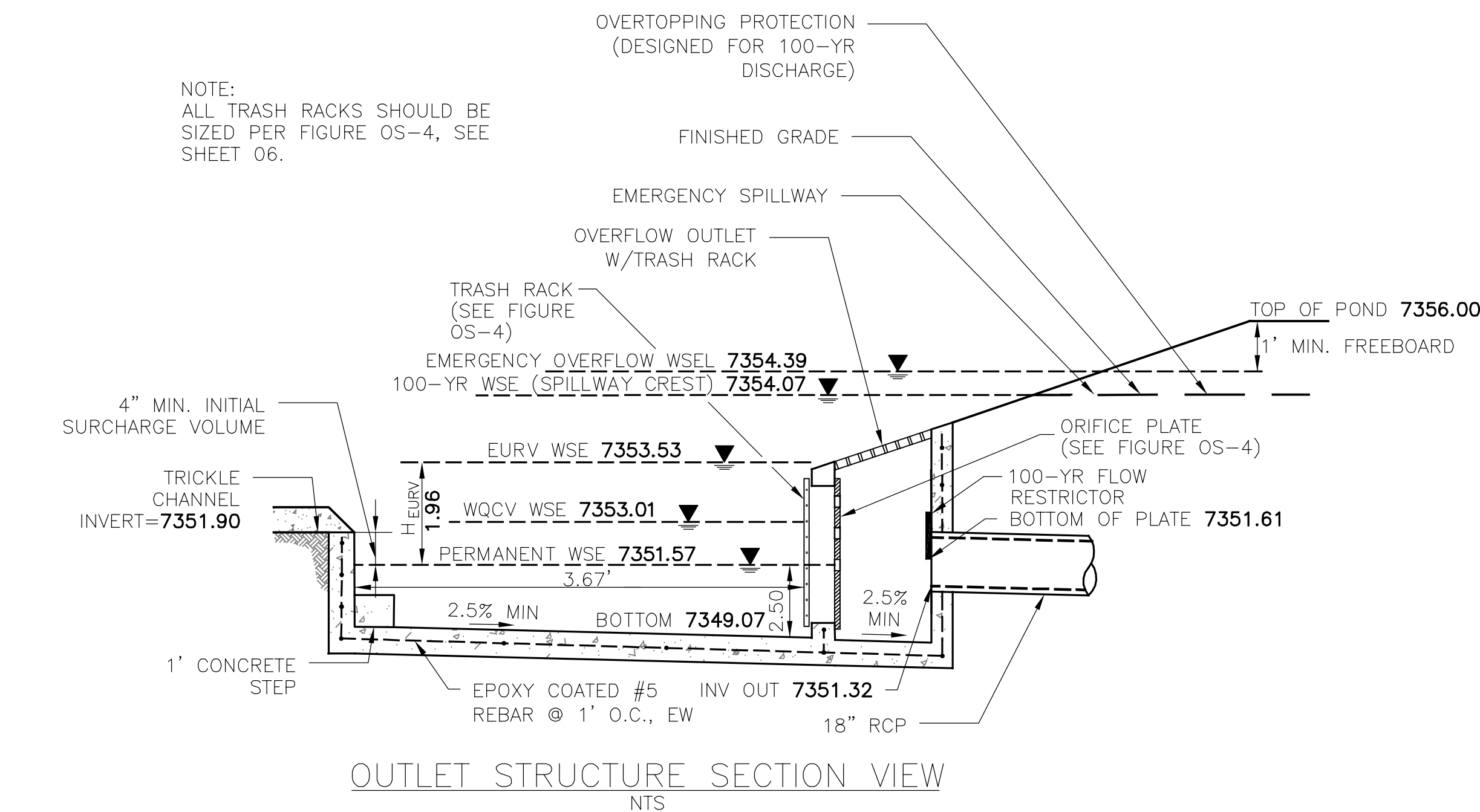
PROJECT NUMBER:  
19015

ISSUED DATE:  
08-07-20

DESIGNED BY:  
TEW

REVIEWED BY:  
RCE

OUTLET  
STRUCTURE  
DETAILS

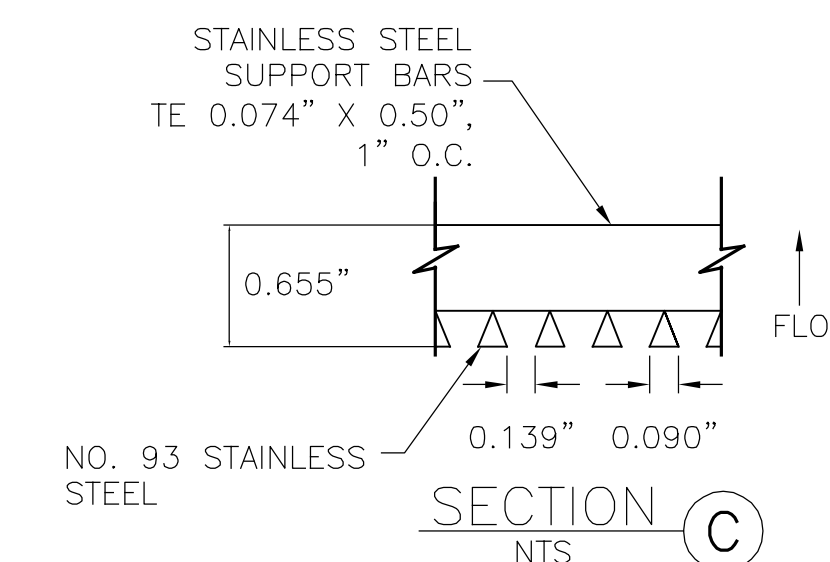
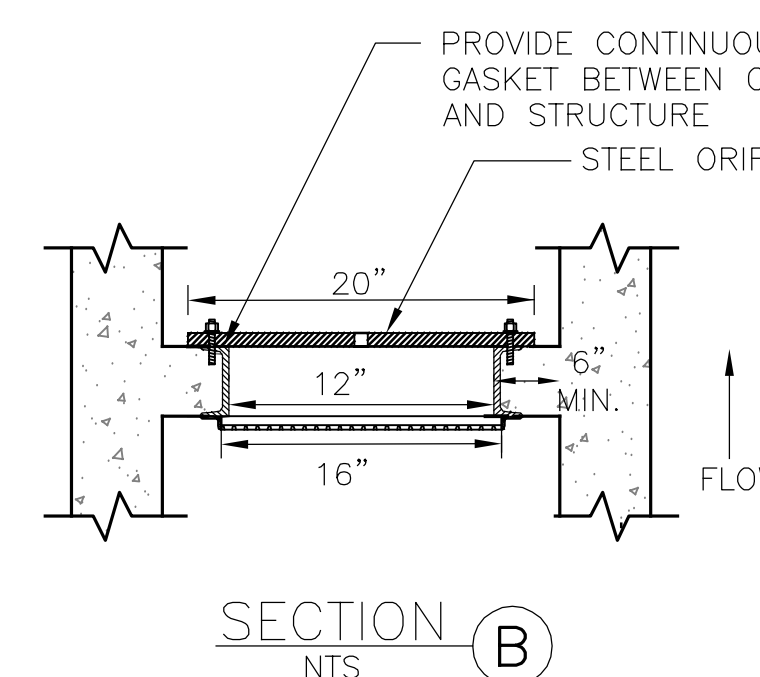
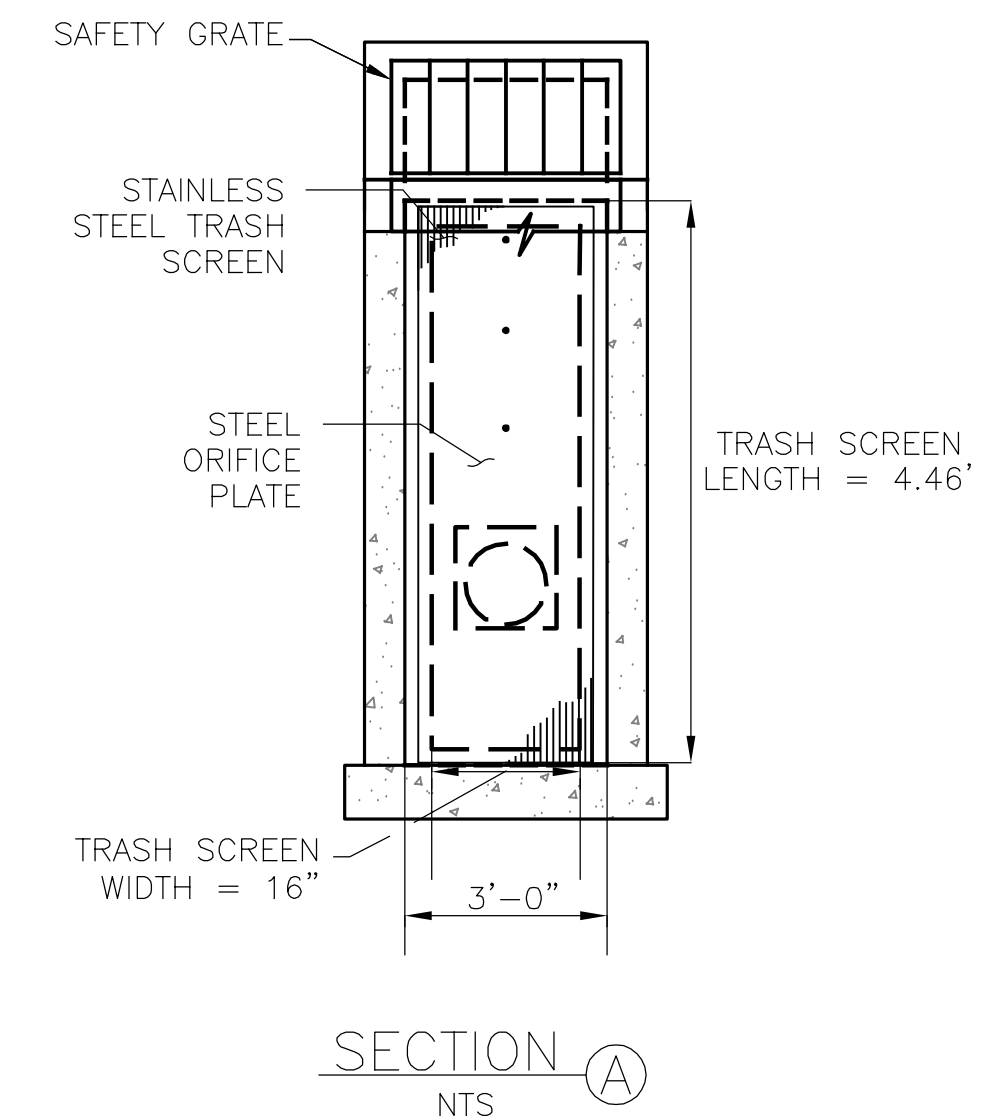
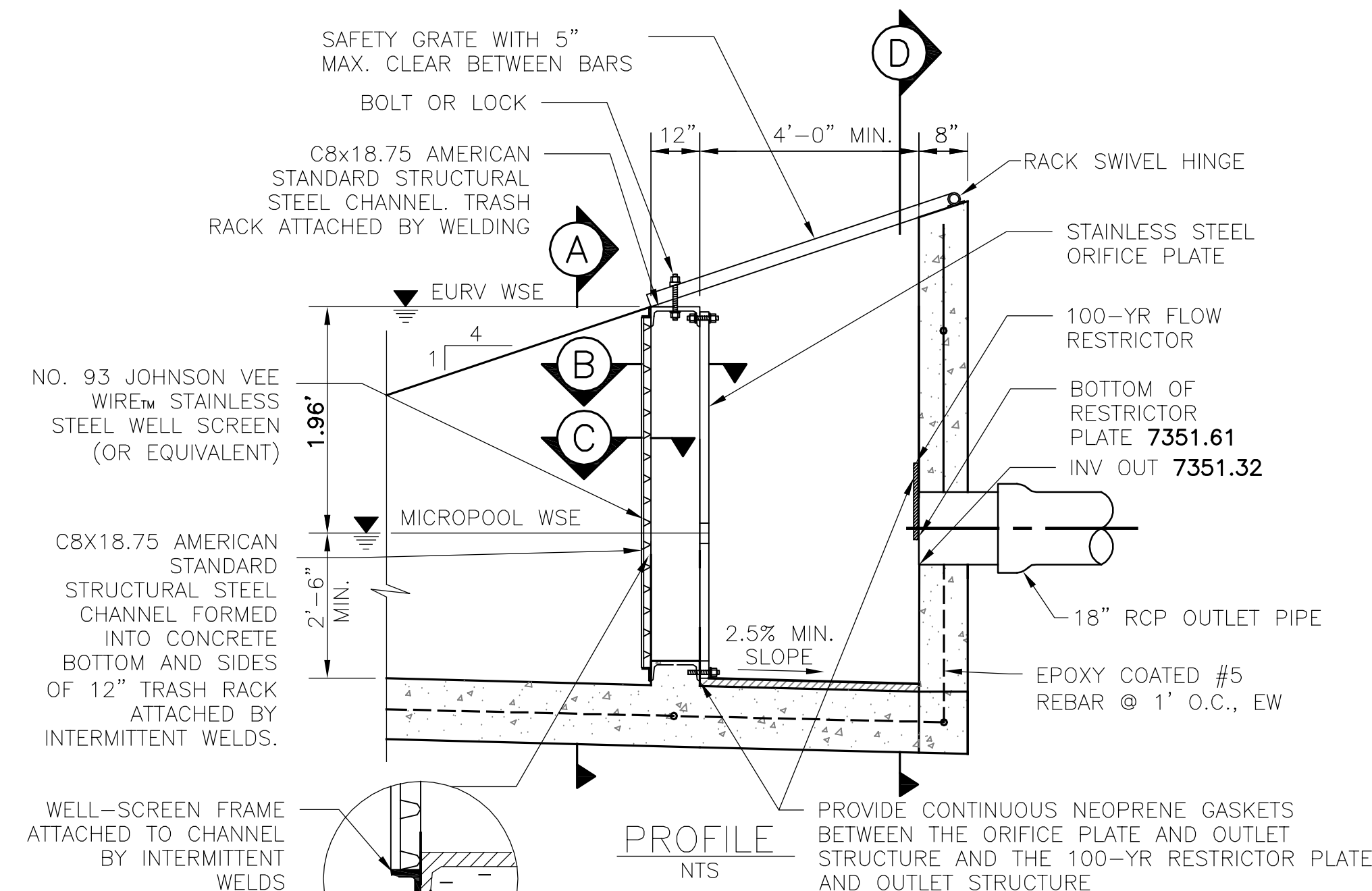


- ORIFICE PLATE NOTES:
1. PROVIDE CONTINUOUS NEOPRENE GASKET MATERIAL BETWEEN THE ORIFICE PLATE AND CONCRETE.
  2. BOLT PLATE TO CONCRETE 12" MAX. ON CENTER. SEE TABLE OS-2 FOR PLATE THICKNESS.

- EURV AND WQCV TRASH RACKS:
1. WELL-SCREEN TRASH RACKS SHALL BE STAINLESS STEEL AND SHALL BE ATTACHED BY INTERMITTENT WELDS ALONG THE EDGE OF THE MOUNTING FRAME.
  2. BAR GATE TRASH RACKS SHALL BE ALUMINUM AND SHALL BE BOLTED USING STAINLESS STEEL HARDWARE.
  3. TRASH RACK OPEN AREAS ARE FOR SPECIFIED TRASH RACK MATERIALS. TOTAL TRASH RACK SIZE MAY NEED TO BE ADJUSTED FOR MATERIALS HAVING DIFFERENT OPEN AREA/GROSS AREA RATIO (R VALUE).
  4. STRUCTURAL DESIGN OF TRASH RACKS SHALL BE BASED ON FULL HYDROSTATIC HEAD WITH ZERO HEAD DOWNSTREAM OF THE RACK.

- OVERFLOW SAFETY GRATES:
1. ALL SAFETY GRATES SHALL BE MOUNTED USING STAINLESS STEEL HARDWARE AND PROVIDED WITH HINGED AND LOCKABLE OR BOLTABLE ACCESS PANELS.
  2. SAFETY GRATES SHALL BE STAINLESS STEEL, ALUMINUM, OR STEEL. STEEL GRATES SHALL BE HOT DIP GALVANIZED AND MAY BE HOT POWDER COATED AFTER GALVANIZING.
  3. SAFETY GRATES SHALL BE DESIGNED SUCH THAT THE DIAGONAL DIMENSION OF EACH OPENING IS SMALLER THAN THE DIAMETER OF THE OUTLET PIPE.
  4. STRUCTURAL DESIGN OF SAFETY GRATES SHALL BE BASED ON FULL HYDROSTATIC HEAD WITH ZERO HEAD DOWNSTREAM OF THE RACK.

FIGURE OS-4 ORIFICE PLATE AND TRASH RACK  
DETAILS AND NOTES  
NTS



$$R \text{ VALUE} = (\text{NET OPEN AREA}) / (\text{GROSS RACK AREA}) = 0.60$$

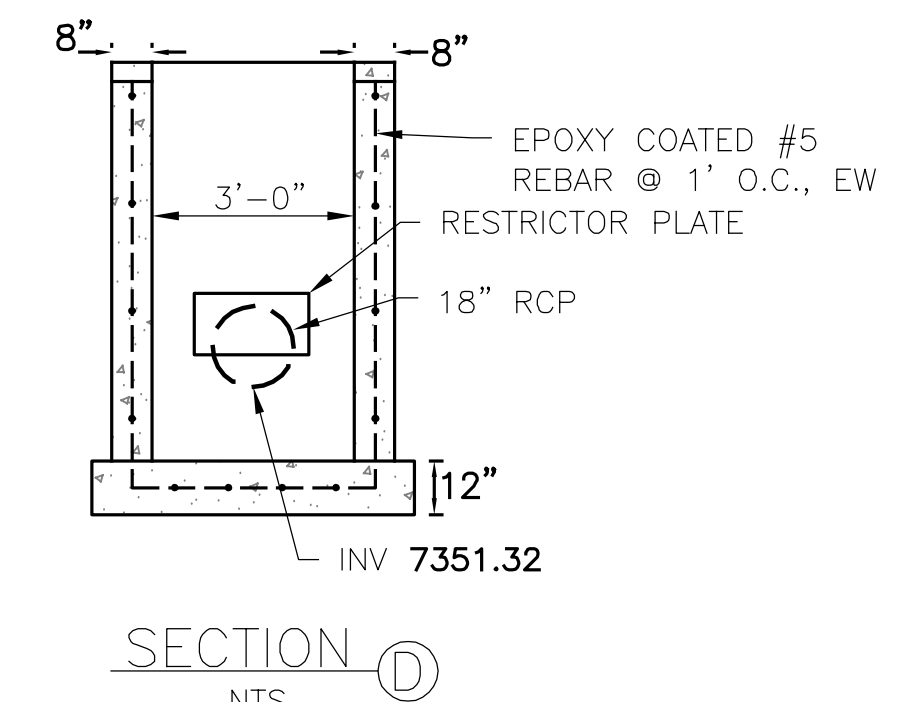
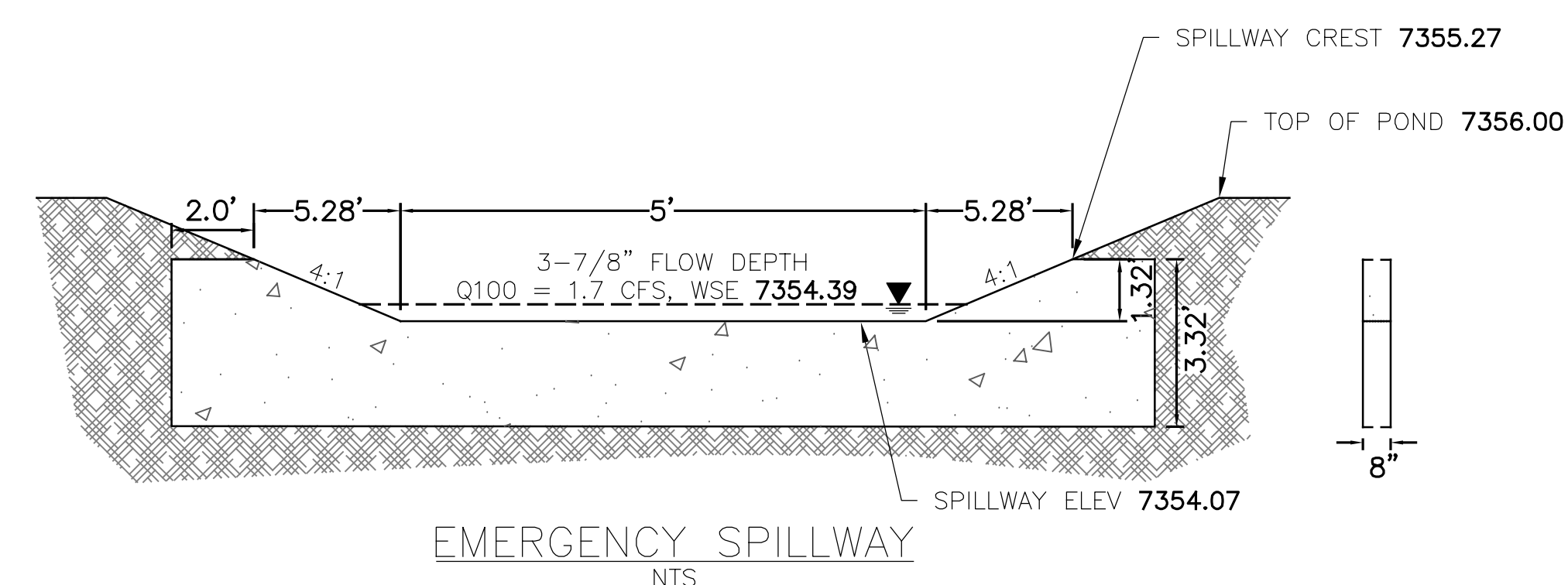
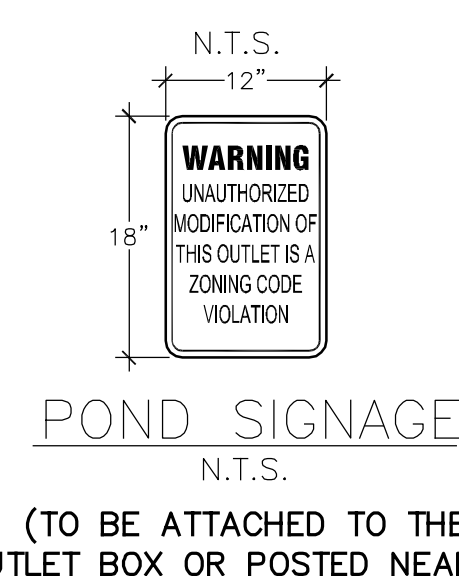
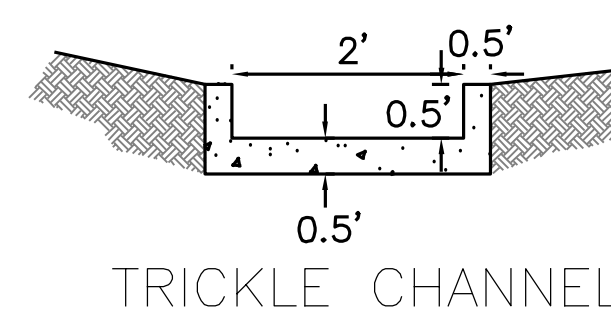
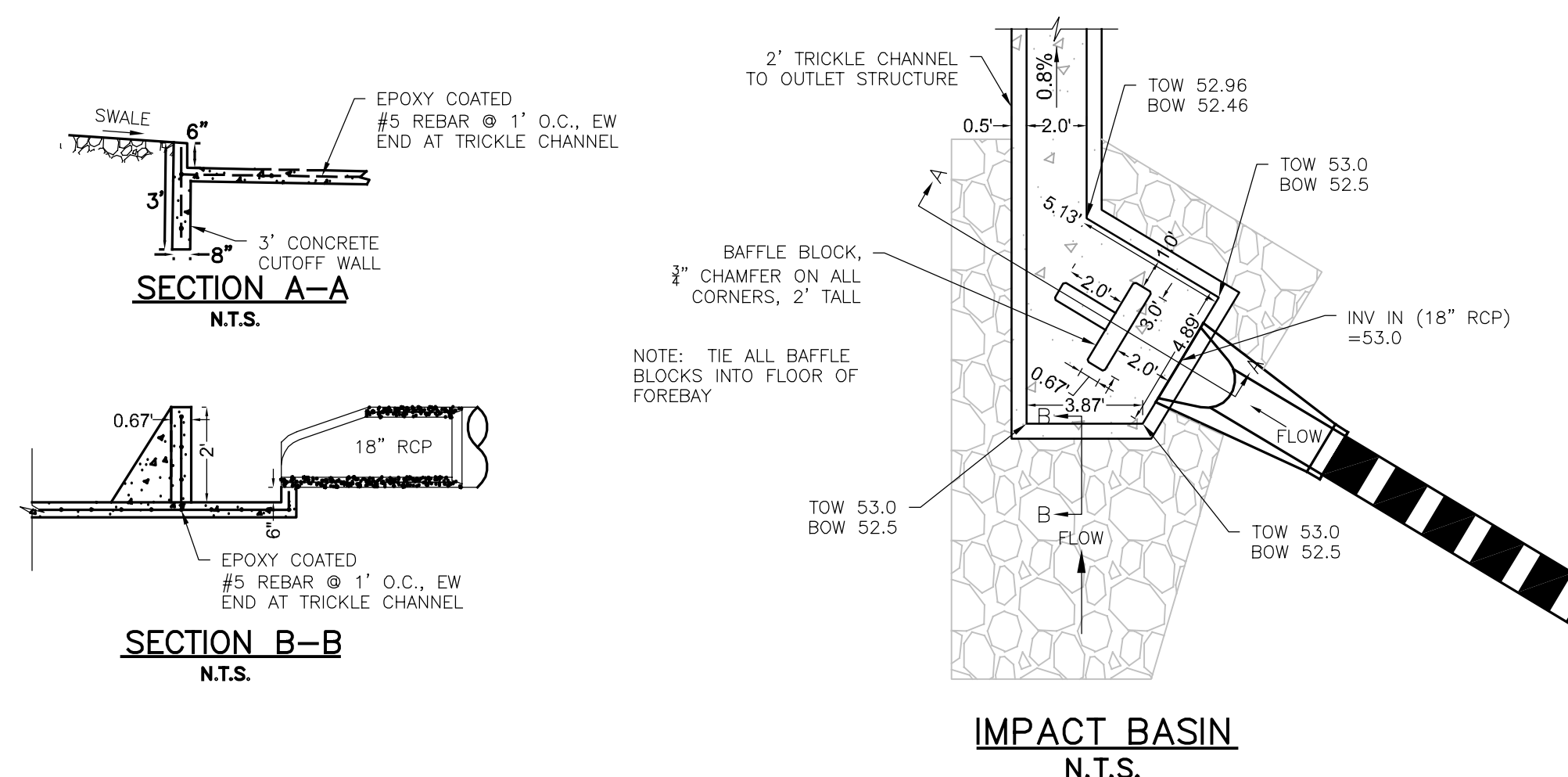


FIGURE OS-5 TYPICAL OUTLET STRUCTURE  
WITH WELL SCREEN TRASH RACK





BLACK FOREST OFFICE

N1/2 NE1/4 SE1/4 SE1/4 OF SECTION 07, TOWNSHIP 12 SOUTH, RANGE 65 WEST OF  
THE 6TH P.M., EL PASO COUNTY, COLORADO

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PREPARED FOR:  
BLACK FOREST, LLC  
12740 BLACK FOREST RD  
COLORADO SPRINGS, CO 80908

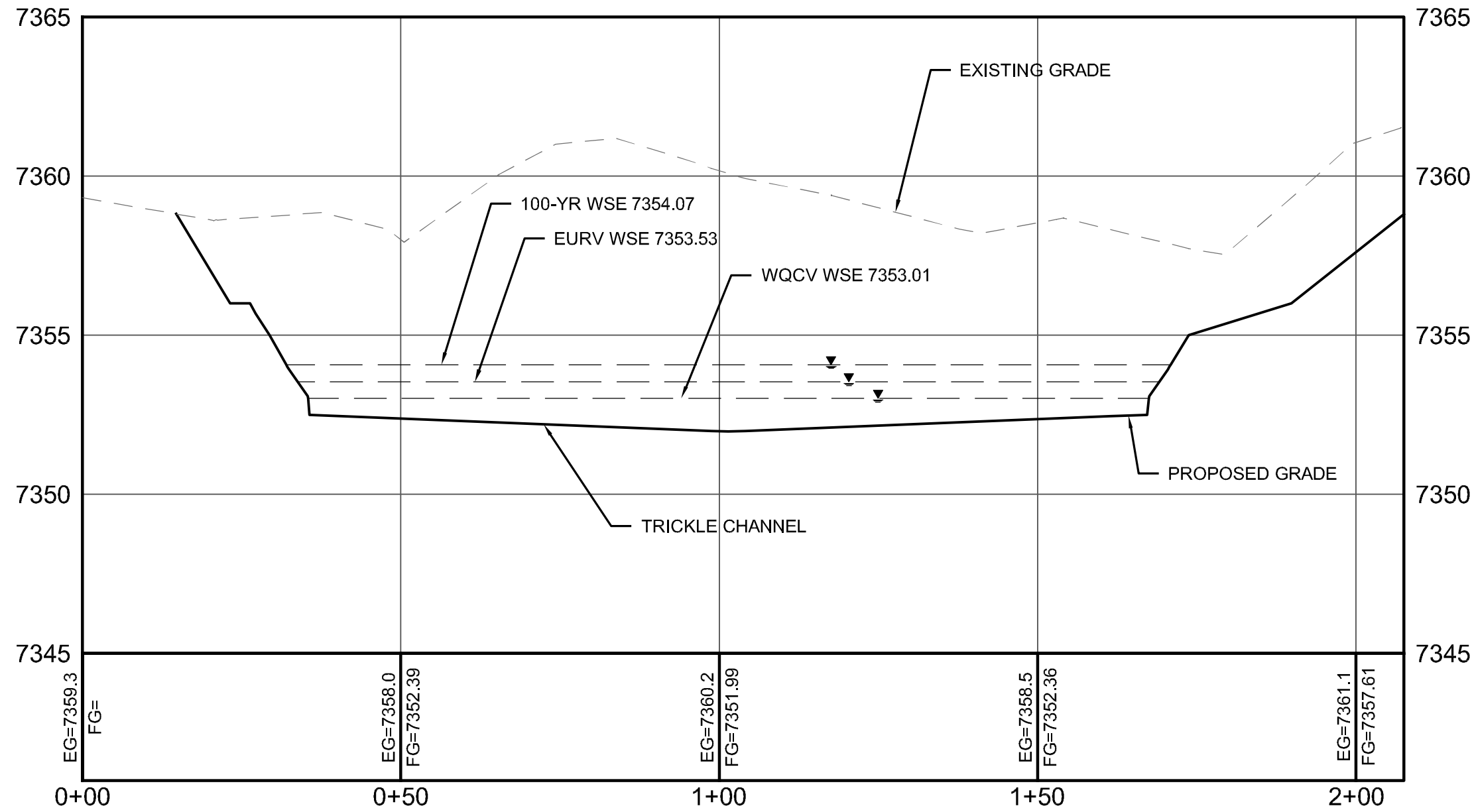
POND DETAILS  
BLACK FOREST OFFICE  
COLORADO SPRINGS, COLORADO

BY: DATE:

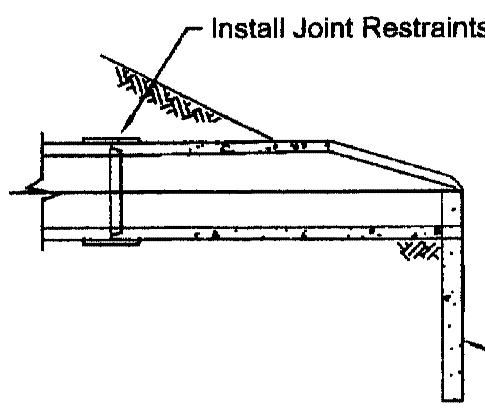
REVISIONS:  
1.  
2.  
3.  
4.

PROJECT NUMBER: 19015  
ISSUED DATE: 08-07-20  
DESIGNED BY: TEW  
REVIEWED BY: RCE

POND DETAILS



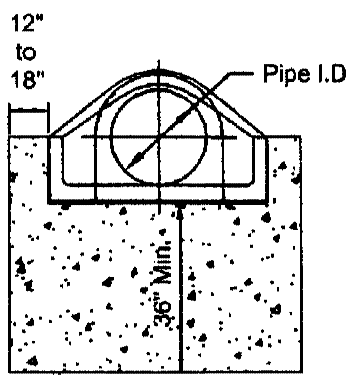
SECTION A-A PROFILE  
SCALE: (H) 1" = 20' (V) 1" = 4'  
START STA: 0+00.00, END STA: 2+07.51



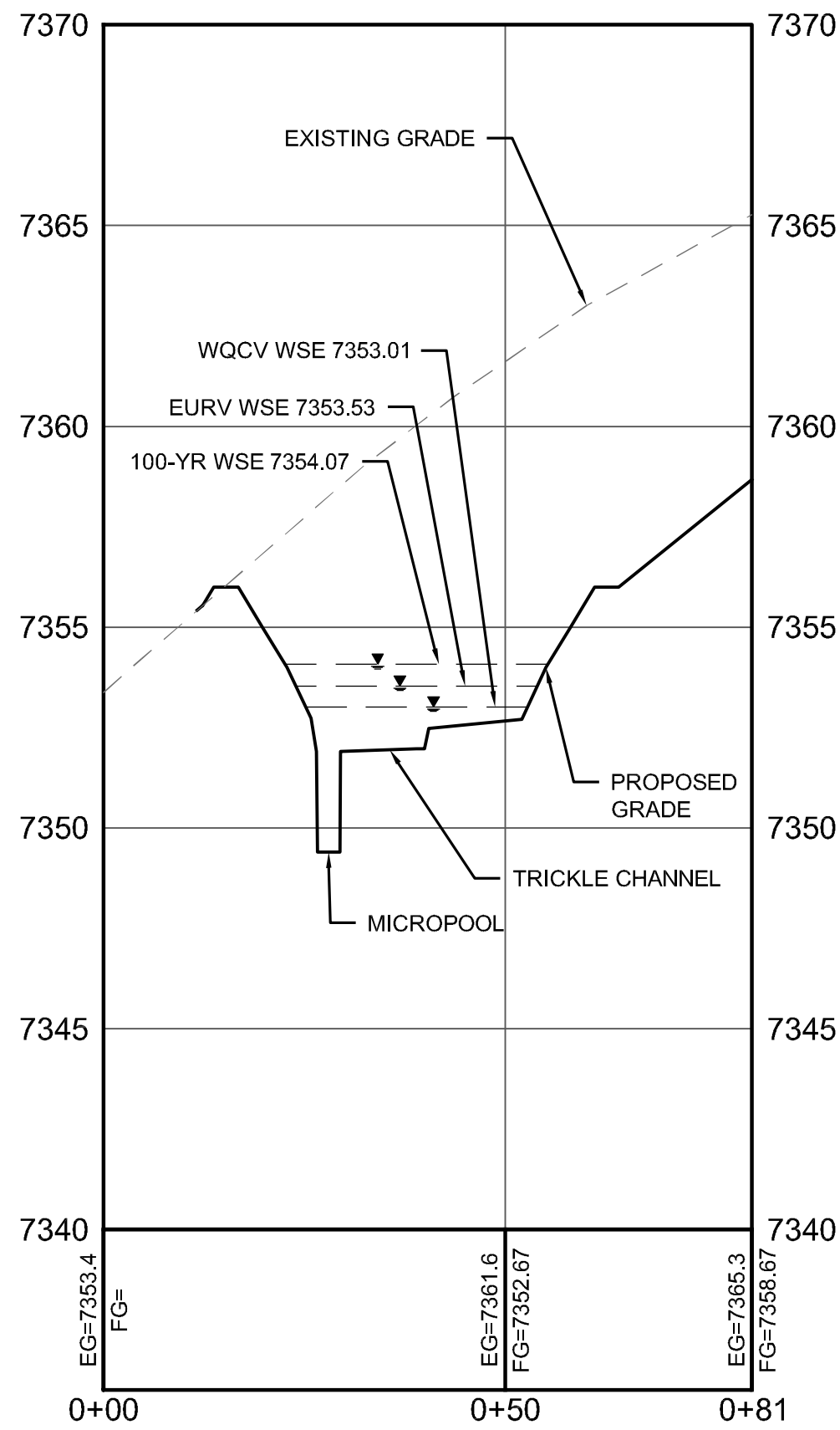
Section at Centerline

PIPE DIA.	W	L	D
18"	2.50'	6.0'	18"
24"	3.00'	6.0'	18"
30"	4.00'	8.0'	18"

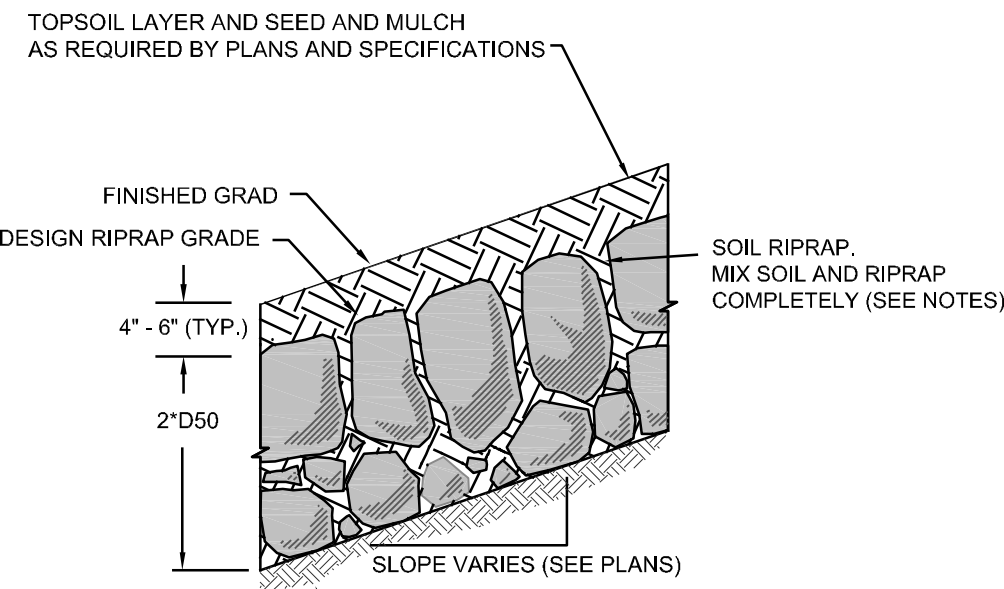
Concrete Flared End Section With Cutoff Wall



End View



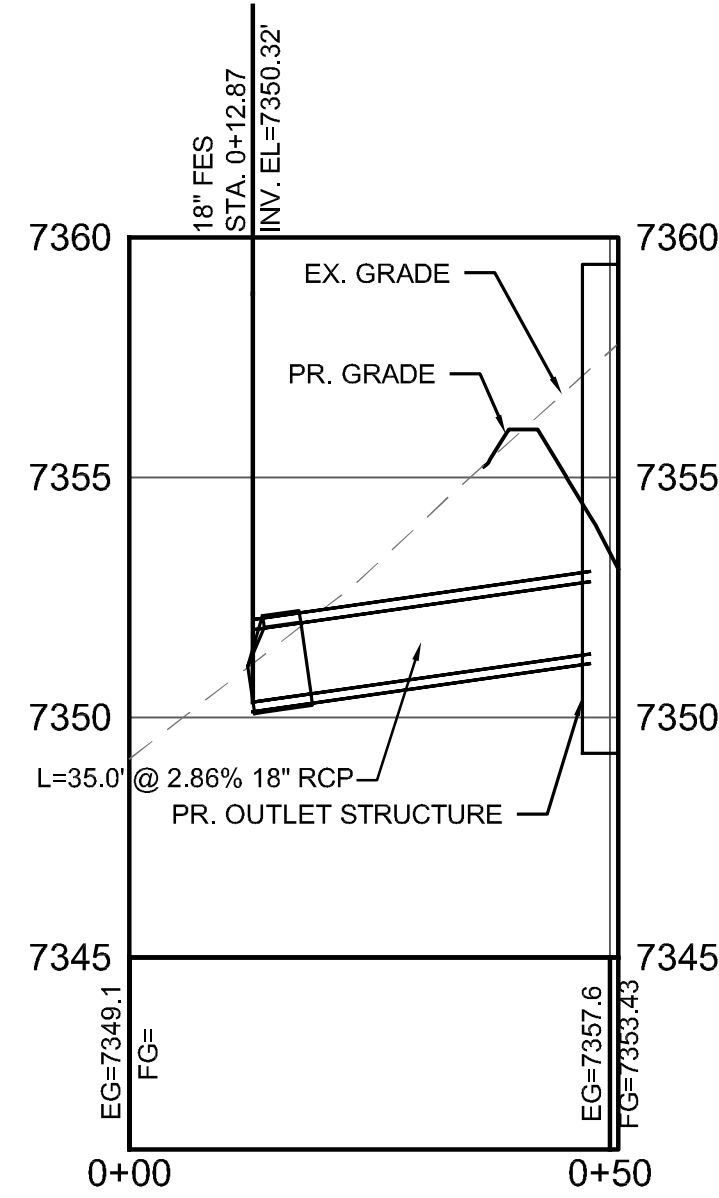
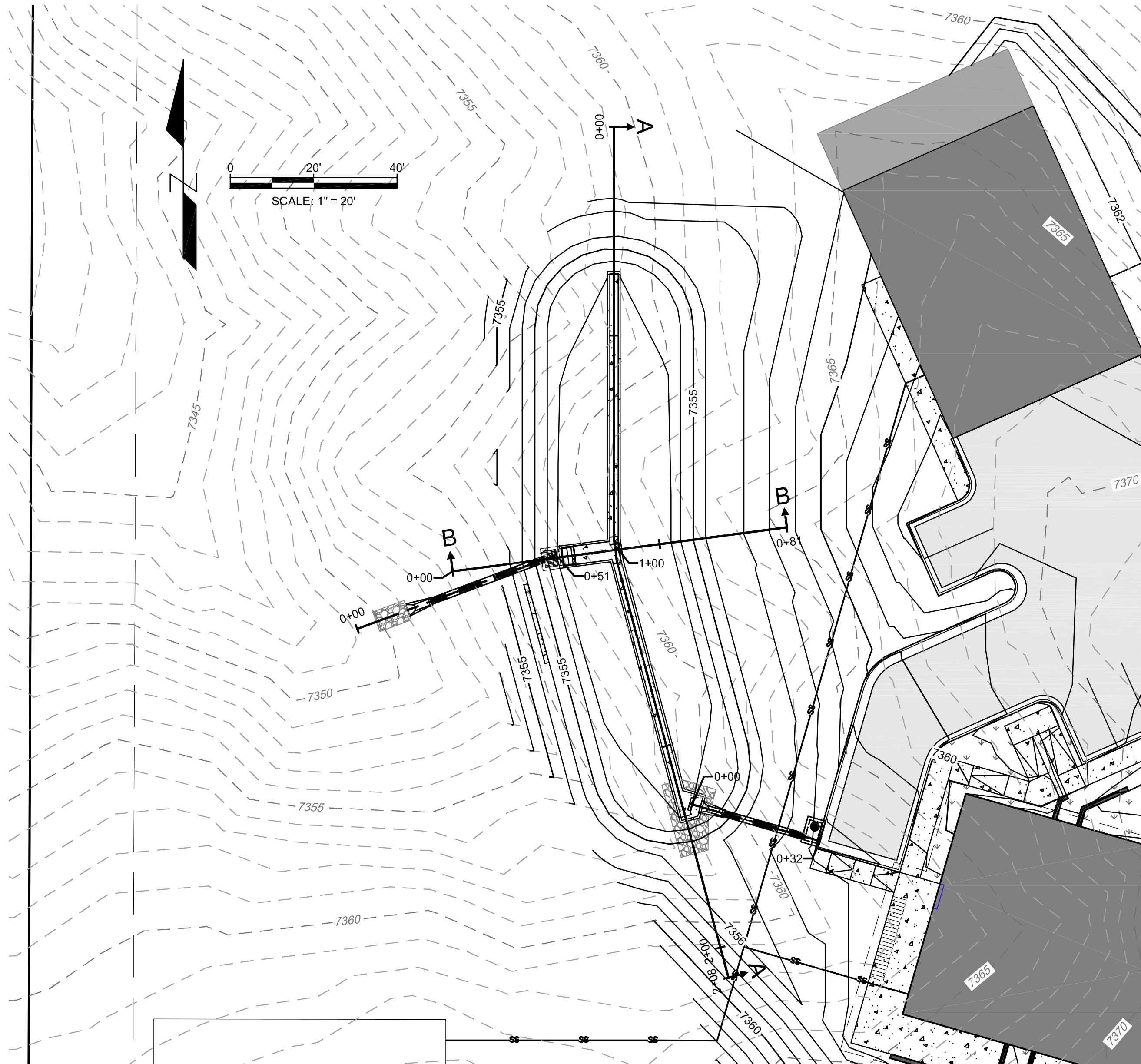
SECTION B-B PROFILE  
SCALE: (H) 1" = 20' (V) 1" = 4'  
START STA: 0+00.00, END STA: 0+80.77



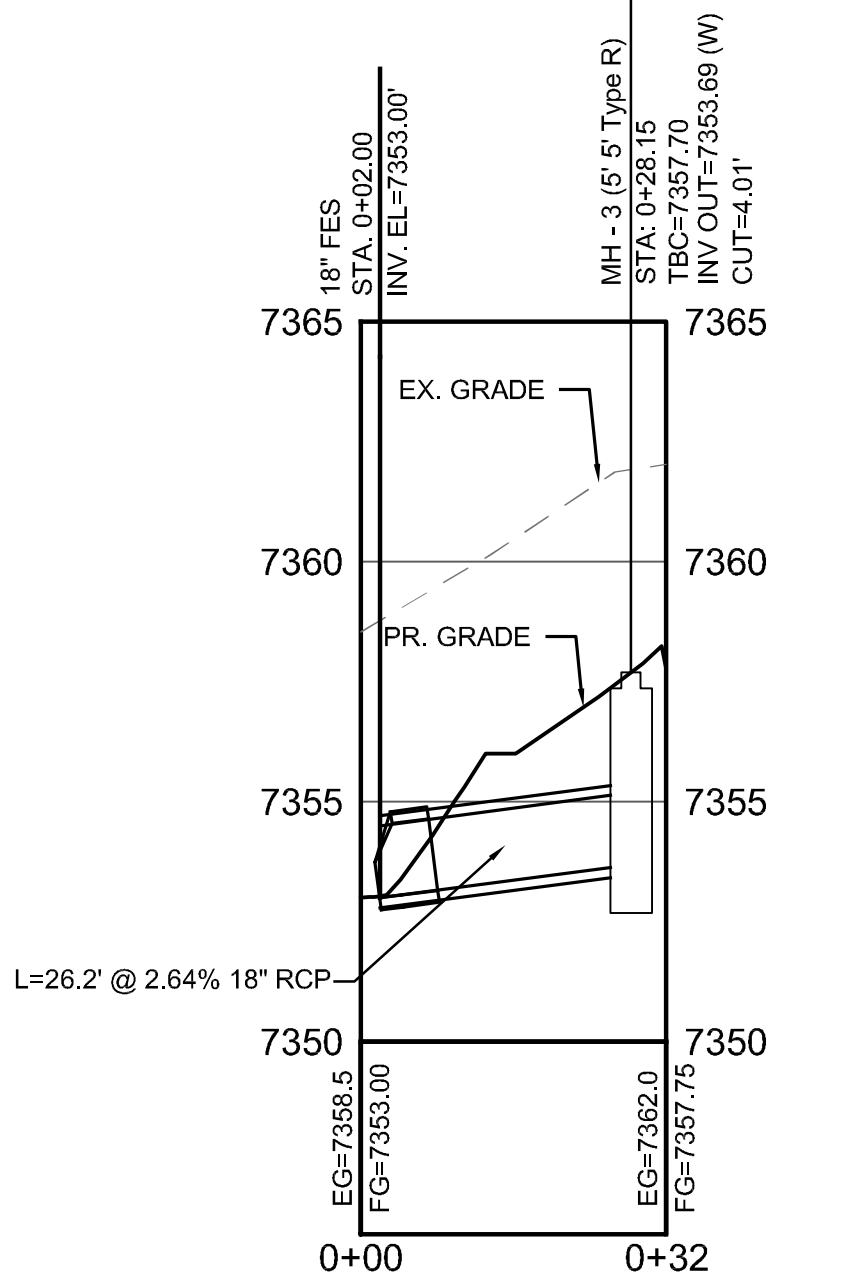
TYPICAL SECTION -  
SOIL RIPRAP WITH MULCH

NOTES:

1. SOIL RIPRAP DETAILS ARE APPLICABLE TO SLOPED AREAS. REFER TO THE SITE PLAN ACTUAL LOCATION AND LIMITS.
2. MIX UNIFORM ALLY 65% RIPRAP BY VOLUME WITH 35% OF APPROVED SOIL BY VOLUME PRIOR TO PLACEMENT.
3. PLACE STONE-SOIL MIX TO RESULT IN SECURELY INTERLOCKED ROCK AT THE DESIGN THICKNESS AND GRADE. COMPACT AND LEVEL TO ELIMINATE ALL VOIDS AND ROCKS PROJECTING ABOVE DESIGN RIPRAP TOP GRADE.
4. CRIMP OR TACKIFY MULCH OR USE APPROVED HYDROMULCH AS CALLED FOR IN THE PLANS AND SPECIFICATIONS.



STORM - POND OUTFALL PROFILE  
SCALE: (H) 1" = 20' (V) 1" = 4'  
START STA: 0+00.00, END STA: 0+50.87



STORM PROFILE  
SCALE: (H) 1" = 20' (V) 1" = 4'  
START STA: 0+00.00, END STA: 0+31.82