Final Drainage Letter

Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad
Aurora Condition Use Permit
City of Aurora Case No. DA-2155-00

Prepared for:

ConocoPhillips Company
34501 E. Quincy Ave., Bldg. 1
Watkins, CO 80137
303-268-3773
Kathy Denzer

Prepared by:

Ascent Geomatics Solutions
8620 Wolff Court
Westminster, CO 80031
303-928-7128
Michael Welker

Rev. 3 January 27, 2020

3

FACSIMILE

This electronic plan is a facsimile of the signed and sealed PDF set.

DATE: 01/27/2020

3

Michael C. Welker

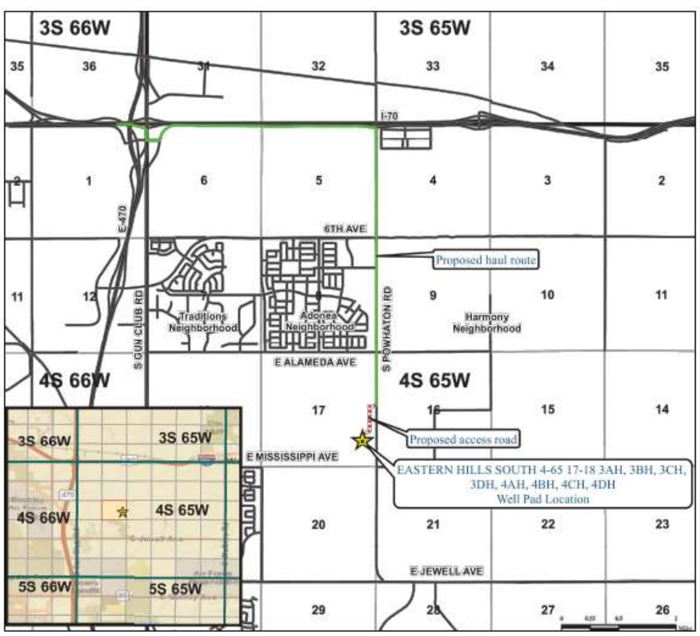
Rev. 3 January 27, 2020 3

Craig Perl, P.E. Senior Engineer
City of Aurora
Public Works Department
Engineering Control Division
15151 E. Alameda Avenue
Aurora, CO 80012

RE: Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad
City of Aurora Oil and Gas Well Permit
Final Drainage Letter
City of Aurora Case No. DA-2155-00

Dear Mr. Perl,

The Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad (hereafter referred to as "Site") is located in Section 17, Township 4 South, Range 65 West of the 6th Principal Meridian, in the City of Aurora, Arapahoe County, Colorado. The pad is generally located approximately 2.8 miles south of I-70 and approximately 2.5 miles east of Highway E-470. More specifically the pad is located along South Powhaton Road approximately 6,500 feet north of East Jewell Avenue (County Road 18) and 8,000 feet south of East 3rd Avenue. The 3rd Avenue and Powhaton Road intersection serves as a secondary entrance to the Traditions residential development. The Site is also 1 mile northeast of the Murphy Creek residential development. A vicinity map is included as Figure 1 below.



The existing landscape and land use of the proposed Site is rangeland or grazing land and the Site is zoned Northeastern Plains Residential. The existing topography generally drains from southeast to northwest at an existing grade of the disturbed area is approximately 0.3 -1%, with the undisturbed upstream basin having slopes of approximately 1% to 11% slope. According to the USDA Web Soil Survey contains exclusively Nunn-Bresser-Ascalon complex, hydrologic Type B soils in the disturbed areas. The upstream basin contains a percentage of Truckton loamy sand, Type A hydrologic soils in the southeast corner of the basin. The web Soil Map and Descriptions are attached.

Proposed improvements include a 500 foot by 580 foot graded pad in support of drilling oil and gas wells. Also proposed is a 1,450-linear foot, 23-foot wide gravel access road, connecting to another site access approximately 1,300 feet north the Site. This access road connects another drill pad to the northwest to South Powhaton Road, which is immediately to the east of the pad.

Eight proposed wellheads are located 375 feet west of the east edge of the pad, spaced 25 feet apart with the northern-most well located 150 feet south of the north edge of the pad and the southern-most well located 174 feet north of the south edge of the pad.

The Site is located within the Coal Creek drainage basin. As indicated by the attached FEMA FIRMette, the proposed Site is within FIRM Panel Number 08005C0208L, panel 208 of 725, dated February 17, 2017. The pad is shown to be located within unshaded Flood Zone X, an area outside the 0.2% annual chance floodplain. The Site is not included within a Special Flood Hazard Area and therefore FEMA considers it an area of minimal flooding.

The design of the Site drainage, is based on the Urban Drainage and Flood Control District Urban Storm Drainage Criteria Manual (USCM) design guides and best practices, and the deviations from these best practices listed in the City of Aurora's *Rules and Regulations Regarding Stormwater Discharges Associated with Construction Activities* and *Storm Drainage and Technical Criteria*.

The onsite and offsite diversion ditches, and the sediment capture volumes were calculated using the rational method due to the relatively small sub basin sizes. These sub-basins are illustrated in the attached Drainage Basin Boundary Map. The proposed onsite and offsite diversion ditches, and culverts were sized for the 100 year 1 hour storm using Figure RA-6 from UDFCD Volume 1, see attached. The hydrologic calculations were used in the Urban Drainage Rational Workbook attached.

The Site gravel pad was assumed to be the 40 percent impervious for gravel roads, and the offsite drainage was assumed to be the 2% Historic Flow Analysis, Greenbelts, and Agricultural imperviousness listed in the Aurora Drainage and Technical Criteria Appendix Table 1. The onsite and offsite ditches we divided into east and west by the high point on the southeast corner of the Site.

The onsite pad for the drilling phase is 7.82 acres with an overall surface disturbance of 11.45 acres. The disturbance area is comprised of the onsite basin, seeded topsoil stockpile, seeded excess stockpiles, Sediment Basin, and diversion swales. The production phase pad surface (4.42 acres) itself is not included in the tributary area used to size the sediment basin as agreed upon by the Aurora Water Department. Therefore, the sediment basin was sized for 7.03 acres (11.45ac.- 4.42ac.). The sediment basin is located near the northwest corner of the pad, includes 1' of freeboard, and will be used as a permanent BMP (to be maintained by the Site owner) to enhance the water quality of the runoff from the Site as long as there is activity on the Site. Due to vertical constraints the sediment basin is shallower than the preferred, standard basin but will have a larger footprint to meet storage requirements. The basin was sized according to COA Storm Drainage Design and Technical Criteria Manual Table 1 and UDFCD Table SB-1. An outlet structure has been designed with four orifice holes (2"H x 4"W) to drain the sediment basin in less than 72 hours. Please see the attached Drainage Basin Boundary Map, Sediment Basin Stage-Storage, and Stormwater Detention and Infiltration spreadsheets. 3

Four culverts are proposed for the Site. Culvert A is for Diversion Ditch 1 collecting the eastern flows under the proposed access road connection the pad within Onsite Basin 1. This culvert is designed as a 1.25'x7.5' open channel with cattle guard. 3 Culvert B is designed to carry flow from Offsite Basin 2 under the proposed access road near its northern terminus. This culvert is designed as a 1'x7' open channel with cattle guard. Culvert C is located in the proposed access road approximately 310 feet north of the pad at the existing drainage swale. Culvert C is designed as a 24" RCP to handle offsite flows from Offsite Basin 3 under the raised access road. Finally, Culvert D is located in the proposed access road approximately 145 feet north of the pad at the existing drainage swale. Culvert D is designed as a 12" RCP to handle offsite flows from Offsite Basin 4 under the raised access road. Type M (12") riprap reinforcement will be placed at each of the culvert outlets. Culvert calculations are detailed in the UD Culvert workbooks attached.

The Rational Method was used to compute peak flows draining into the two onsite diversion ditches. The catchment area draining into Onsite Diversion Ditch 1 was found to be 12.04 acres with an imperviousness of 11% resulting in a 100-year flow rate of 17.72 cfs. Onsite Diversion Ditch 1 capable of conveying 18.68 cfs has been designed, with a 3:1 side slope, a minimum slope of 0.11%, a total depth of 1.25', and a bottom width of 7.5'. Flow in Diversion Ditch 1 will pass through Culvert A before reaching the sediment basin. The catchment area draining into Onsite Diversion Ditch 2 was found to be 4.13 acres with an imperviousness of 35% resulting in a 100-year flow rate of 11.70 cfs. Onsite Diversion Ditch 2 capable of conveying 15.76 cfs has been designed, with a 3:1 side slope, a minimum slope of 0.11%, a total depth of 1.25', and a bottom width of 6'. Onsite Diversion Ditch 2 will be relocated after the drilling phase for the production phase. The relocated ditch will carry less flow during the production phase but will be left at the minimum USDCM depth to provide a conservative capacity.

The Rational Method was used to compute peak flows draining into one offsite diversion ditch. The catchment area draining into Offsite Diversion Ditch 1 was found to be 16.28 acres with an imperviousness of 2% resulting in a 100-year flow rate of 21.48 cfs. Offsite Diversion Ditch 1 capable of conveying 24.32 cfs has been designed, with a 3:1 side slope, a minimum slope of 0.25%, a total depth of 1.25', and a bottom width of 5.0'. Offsite Diversion Ditch 1 will redirect offsite flows from Offsite Basin 1 around the site where it will be discharged west of the site and resume historic flow patterns.

The 23' wide access road is crowned with 1.25' deep swales along portions of each side. The swale on the east side of the access road within Offsite Basin 2 will collect a small amount of runoff and direct it to Culvert B where it will resume historic flow patterns. The swale on the east side of the access road within Offsite Basin 3 will collect a small amount of runoff and direct it to Culvert C where it will resume historic flow patterns. The swale on the south side of the access road within Offsite Basin 4 will collect a small amount of runoff and direct it to Culvert D where it will resume historic flow patterns.

Calculations for the diversion ditches, culverts, and riprap sizing are provided with this letter.

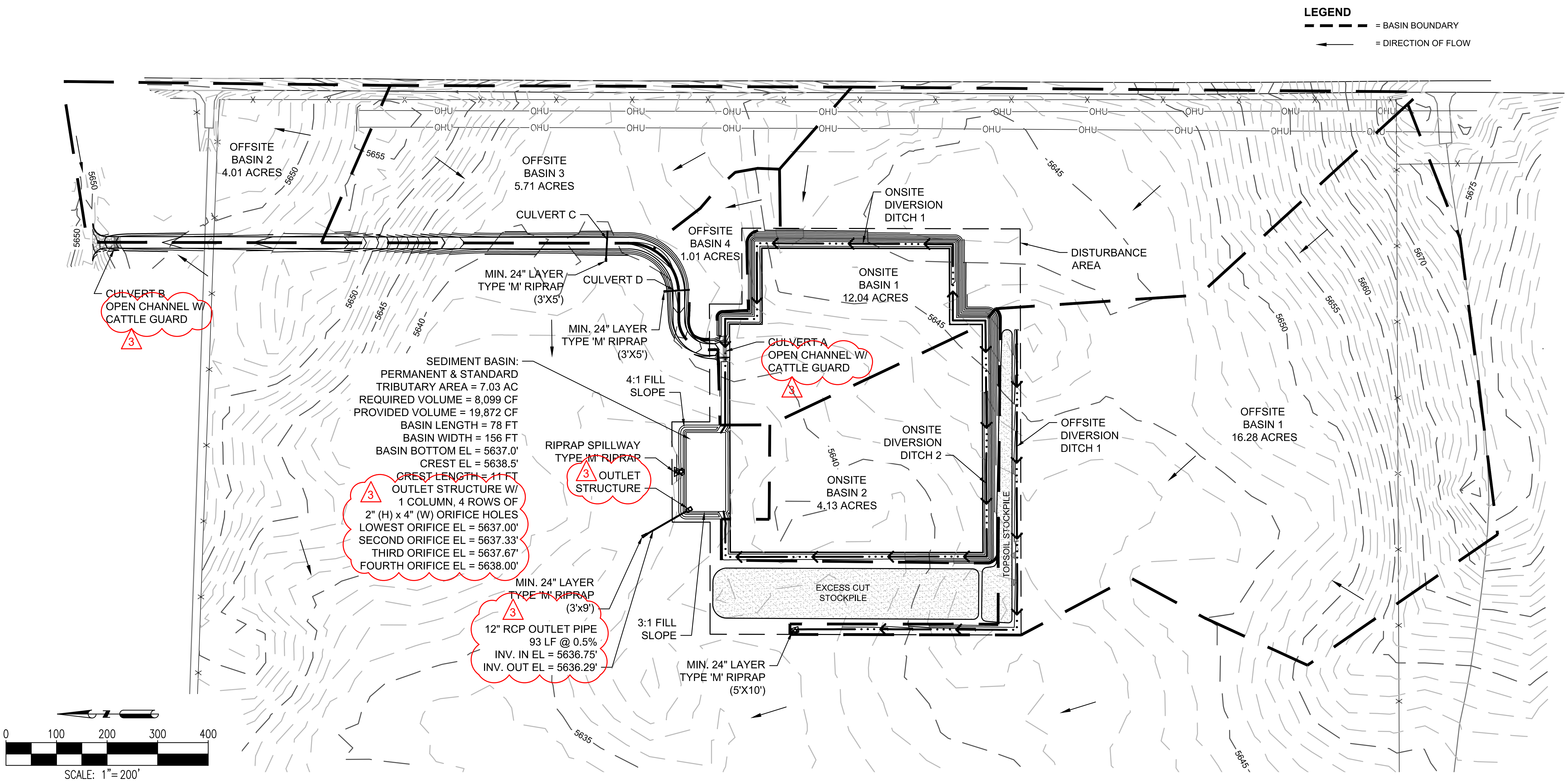
No adverse drainage impacts to the surrounding Site, properties, or floodplain resulting from the construction of the Site are anticipated. If the drainage patterns or imperviousness characteristics substantially deviate from what was considered in this drainage letter and the accompanying SWMP & Site Plan, the City of Aurora shall be notified. If you have any questions regarding the drainage associated with this project, please do not hesitate to call me at 303.928.7128.

Sincerely,

Michael Welker, PE, CFM
Ascent Geomatics Solutions

Appendix A

EASTERN HILLS SOUTH 4-65 17-18 3AH-3DH, 4AH-4DH PAD
DRAINAGE BASIN BOUNDARY MAP



DIG SAFELY
BEFORE YOU DIG CALL:
1-800-922-1987
UTILITY NOTIFICATION CENTER OF COLORADO

This plot does not represent a monumented land survey and should not be relied upon to determine boundary lines, property ownership or other property interests. Parcel lines, if depicted have not been field verified and may be based upon publicly available data that also has not been independently verified.

DATA SOURCES:

PUBLICLY AVAILABLE DATA SOURCES HAVE NOT BEEN INDEPENDENTLY VERIFIED BY ASCENT.

ASCENT GEOMATICS SOLUTIONS
8620 Wolff Court
Westminster, CO 80031
(303) 928-7128
www.ascentgeomatics.com

FIELD DATE:		SITE NAME:	PREPARED FOR:
02-15-18		EASTERN HILLS SOUTH 4-65 17-18, 3AH-3DH, 4AH-4DH PAD	ConocoPhillips
DRAWING DATE:		SURFACE LOCATION:	
01-27-20		E 1/2 SE 1/4 SEC. 17, T4S, R65W, 6TH P.M.	
BY: LM	CHECKED: DP	ARAPAHOE COUNTY, COLORADO	

National Flood Hazard Layer FIRMette

FEMA

39°42'9.82"N

104°41'2.35"W

104°40'24.90"W

39°41'42.14"N

Feet 1:6,000

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

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

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

N

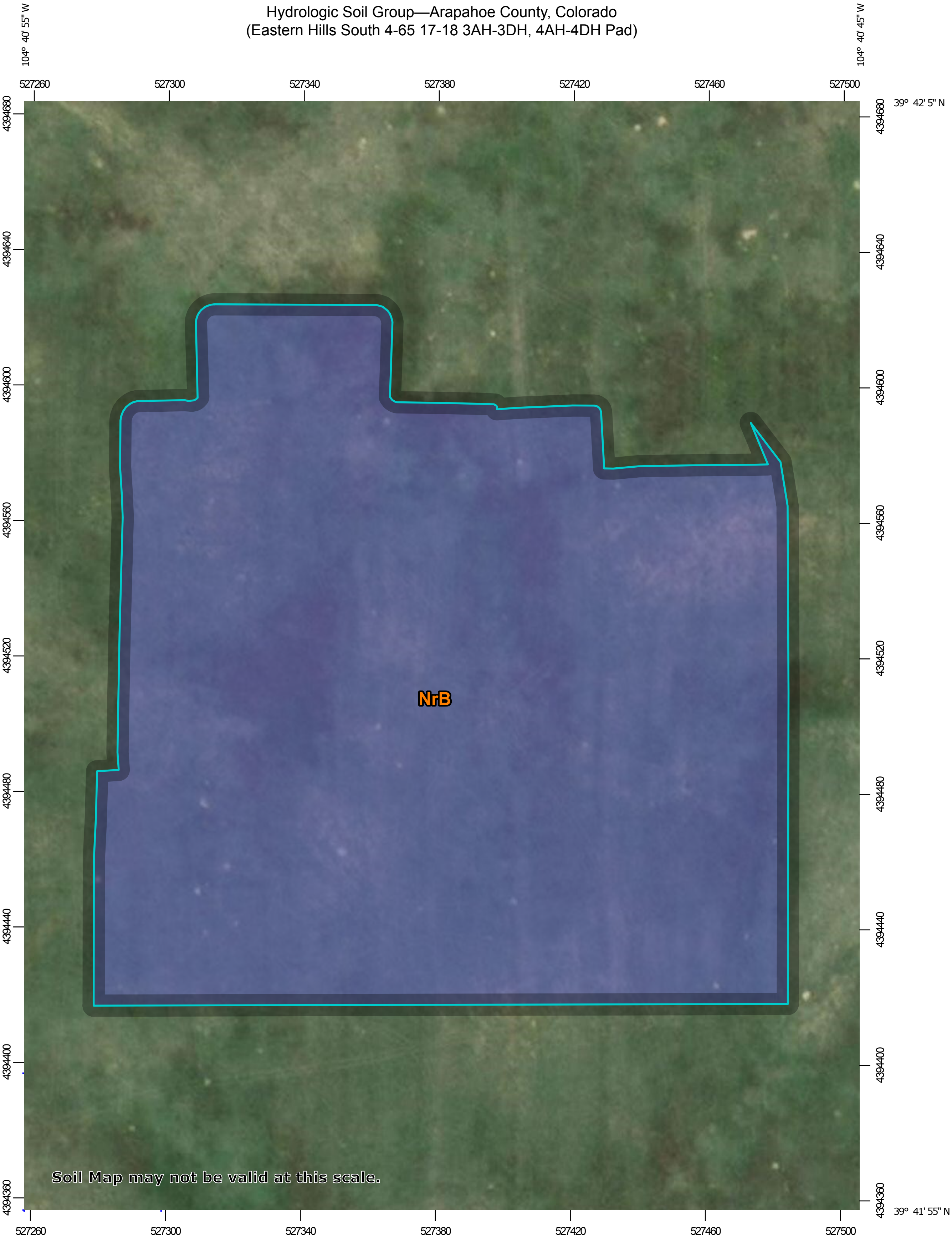
The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 8/21/2018 at 5:46:30 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.

Hydrologic Soil Group—Arapahoe County, Colorado
(Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad)



Map Scale: 1:1,600 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 20, 40, 80, 120

Feet: 0, 50, 100, 200, 300

N

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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

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

Soil Rating Lines

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

Soil Rating Points

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

Water Features

Streams and Canals

Transportation

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

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

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: Arapahoe County, Colorado
Survey Area Data: Version 14, Sep 10, 2018

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

Date(s) aerial images were photographed: Jul 17, 2015—Oct 2, 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

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
NrB	Nunn-Bresser-Ascalon complex, 0 to 3 percent slopes	B	9.0	100.0%
Totals for Area of Interest			**9.0**	**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

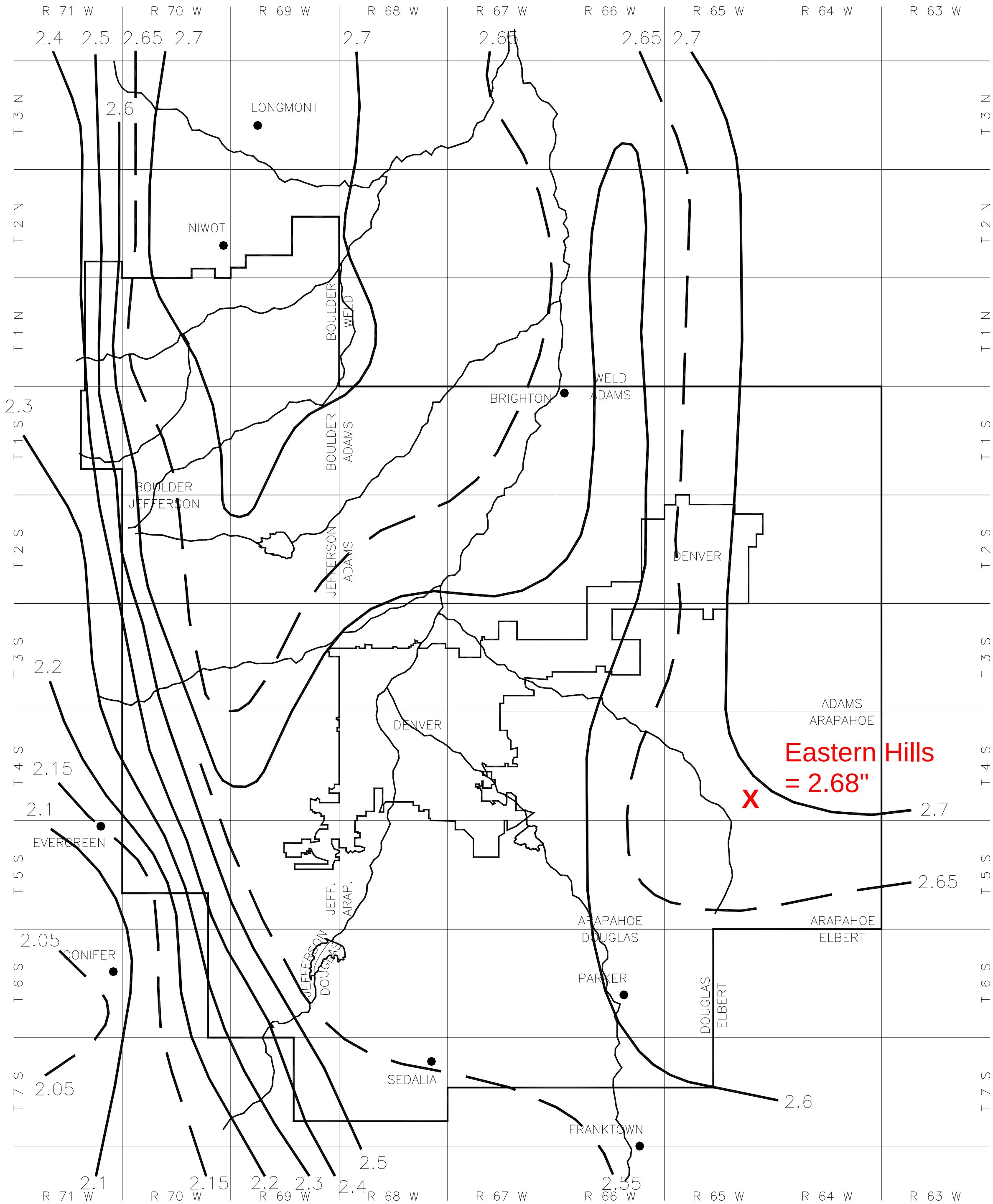


Figure RA-6—Rainfall Depth-Duration-Frequency: 100-Year, 1-Hour Rainfall

Appendix B

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad
Catchment ID: ONSITE BASIN 1

I. Catchment Hydrologic Data

Catchment ID = ON-1
Area = 12.04 Acres
Percent Imperviousness = 11.00 %
NRCS Soil Type = B A, B, C, or D

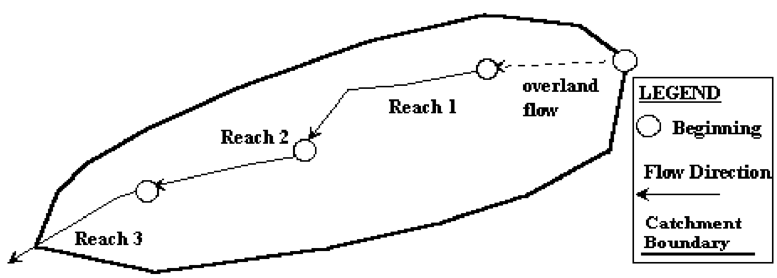
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.68	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.41
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.14
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0810	300	0.14	N/A	0.33	15.01
1	0.0120	1,511		10.00	1.10	22.99
2						
3						
4						
5						
Sum		1,811			Computed Tc =	37.99
					Regional Tc =	20.06
					User-Entered Tc =	38.59

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I =	3.64	inch/hr	Peak Flowrate, Qp =	17.89	cfs
Rainfall Intensity at User-Defined Tc, I =	3.61	inch/hr	Peak Flowrate, Qp =	17.72	cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad
Catchment ID: ONSITE BASIN 2

I. Catchment Hydrologic Data

Catchment ID = ON-2
Area = 4.13 Acres
Percent Imperviousness = 35.00 %
NRCS Soil Type = B A, B, C, or D

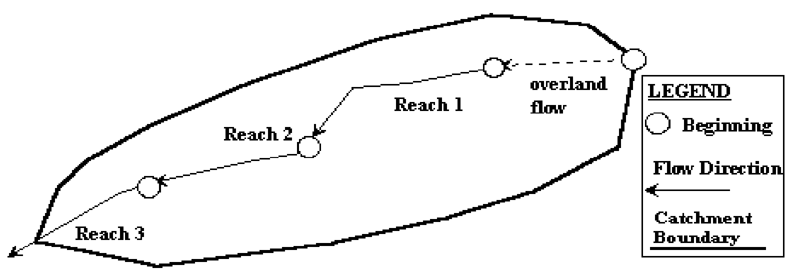
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 100 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 2.68 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.48
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.27
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.3300	22	0.27	N/A	0.17	2.21
1	0.0011	1,082		10.00	0.33	54.37
2						
3						
4						
5						
Sum		1,104			Computed Tc =	56.58
					Regional Tc =	16.13
					User-Entered Tc =	16.13

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I = 2.82 inch/hr Peak Flowrate, Qp = 5.61 cfs
Rainfall Intensity at User-Defined Tc, I = 5.88 inch/hr Peak Flowrate, Qp = 11.70 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad
Catchment ID: OFFSITE BASIN 1

I. Catchment Hydrologic Data

Catchment ID = OFF-1
Area = 16.28 Acres
Percent Imperviousness = 2.00 %
NRCS Soil Type = B A, B, C, or D

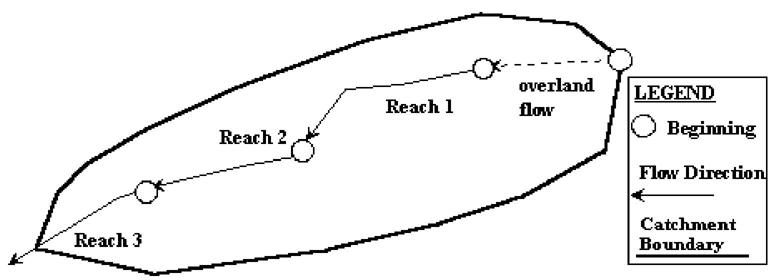
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.68	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.36
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.08
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0690	300	0.08	N/A	0.30	16.84
1	0.0130	1,376		10.00	1.14	20.11
2						
3						
4						
5						
Sum		1,676			Computed Tc =	36.95
					Regional Tc =	19.31
					User-Entered Tc =	38.02

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I =	3.71	inch/hr	Peak Flowrate, Qp =	21.86	cfs
Rainfall Intensity at User-Defined Tc, I =	3.64	inch/hr	Peak Flowrate, Qp =	21.48	cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad
Catchment ID: OFFSITE BASIN 2

I. Catchment Hydrologic Data

Catchment ID = OFF-2
Area = 4.01 Acres
Percent Imperviousness = 3.00 %
NRCS Soil Type = B A, B, C, or D

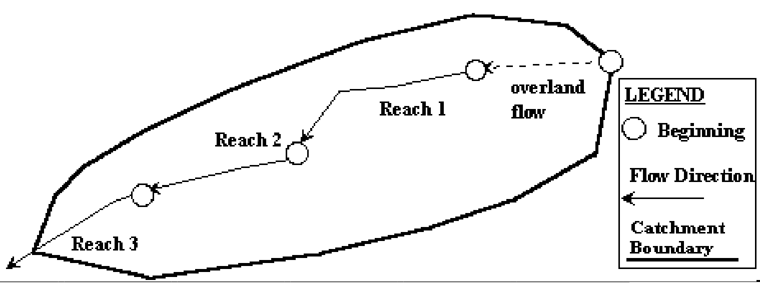
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 100 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 2.68 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.37
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.08
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.020	35	0.08	N/A	0.07	8.63
1	0.007	402		15.00	1.25	5.34
2						
3						
4						
5						
Sum		437				
				Computed Tc =		13.96
				Regional Tc =		12.43
				User-Entered Tc =		12.43

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I = 6.29 inch/hr Peak Flowrate, Qp = 9.28 cfs
Rainfall Intensity at User-Defined Tc, I = 6.63 inch/hr Peak Flowrate, Qp = 9.78 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title: Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad
Catchment ID: OFFSITE BASIN 3

I. Catchment Hydrologic Data

Catchment ID = OFF-3
Area = 5.71 Acres
Percent Imperviousness = 3.00 %
NRCS Soil Type = B A, B, C, or D

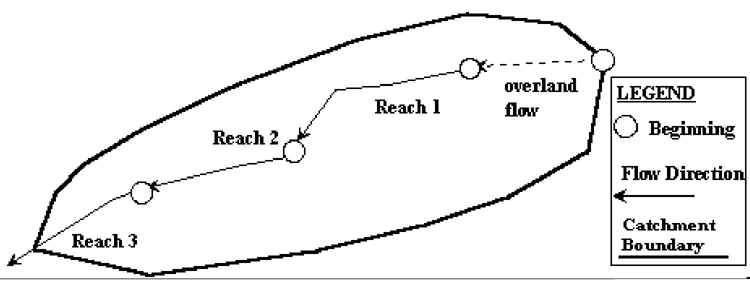
II. Rainfall Information I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr = 100 years (input return period for design storm)
C1 = 28.50 (input the value of C1)
C2= 10.00 (input the value of C2)
C3= 0.786 (input the value of C3)
P1= 2.68 inches (input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C = 0.37
Overide Runoff Coefficient, C = (enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 = 0.08
Overide 5-yr. Runoff Coefficient, C = (enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.0350	300	0.08	N/A	0.24	20.99
1	0.0050	235		10.00	0.71	5.54
2						
3						
4						
5						
Sum		535			Computed Tc =	26.53
					Regional Tc =	12.97
					User-Entered Tc =	28.06

IV. Peak Runoff Prediction

Rainfall Intensity at Computed Tc, I = 4.52 inch/hr Peak Flowrate, Qp = 9.49 cfs
Rainfall Intensity at User-Defined Tc, I = 4.37 inch/hr Peak Flowrate, Qp = 9.19 cfs

CALCULATION OF A PEAK RUNOFF USING RATIONAL METHOD

Project Title:	**Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad**
Catchment ID:	**OFFSITE BASIN 4**

I. Catchment Hydrologic Data

Catchment ID =	OFF-4	
Area =	1.01	Acres
Percent Imperviousness =	2.00	%
NRCS Soil Type =	B	A, B, C, or D

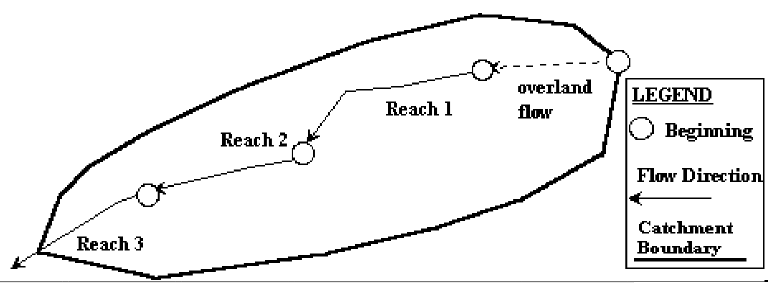
II. Rainfall Information   I (inch/hr) = C1 * P1 /(C2 + Td)^C3

Design Storm Return Period, Tr =	100	years	(input return period for design storm)
C1 =	28.50		(input the value of C1)
C2=	10.00		(input the value of C2)
C3=	0.786		(input the value of C3)
P1=	2.68	inches	(input one-hr precipitation--see Sheet "Design Info")

III. Analysis of Flow Time (Time of Concentration) for a Catchment

Runoff Coefficient, C =	0.36	
Overide Runoff Coefficient, C =		(enter an overide C value if desired, or leave blank to accept calculated C.)
5-yr. Runoff Coefficient, C-5 =	0.08	
Overide 5-yr. Runoff Coefficient, C =		(enter an overide C-5 value if desired, or leave blank to accept calculated C-5.)

Illustration



NRCS Land Type	Heavy Meadow	Tillage/ Field	Short Pasture/ Lawns	Nearly Bare Ground	Grassed Swales/ Waterways	Paved Areas & Shallow Paved Swales (Sheet Flow)
Conveyance	2.5	5	7	10	15	20

Calculations:

Reach ID	Slope S ft/ft input	Length L ft input	5-yr Runoff Coeff C-5 output	NRCS Convey-ance input	Flow Velocity V fps output	Flow Time Tf minutes output
Overland	0.020	292	0.08	N/A	0.19	25.00
1	0.0050	119		10.00	0.71	2.80
2						
3						
4						
5						
Sum		411			Computed Tc =	27.80
					Regional Tc =	12.28
					User-Entered Tc =	12.28

IV. Peak Runoff Prediction

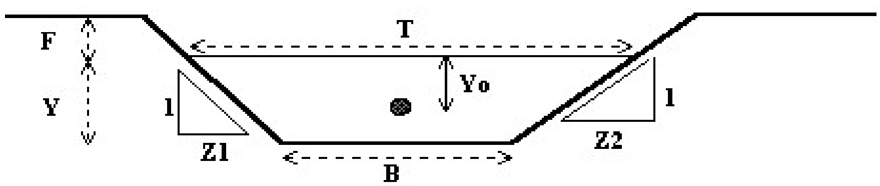
Rainfall Intensity at Computed Tc, I =	4.40	inch/hr	Peak Flowrate, Qp =	1.61	cfs
Rainfall Intensity at User-Defined Tc, I =	6.66	inch/hr	Peak Flowrate, Qp =	2.44	cfs

Appendix C

Normal Flow Analysis - Trapezoidal Channel

Project: **Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad**

Channel ID: **Onsite Diversion Ditch 1**
Design Flow = Q-100yr = 17.72 cfs (ON-1)

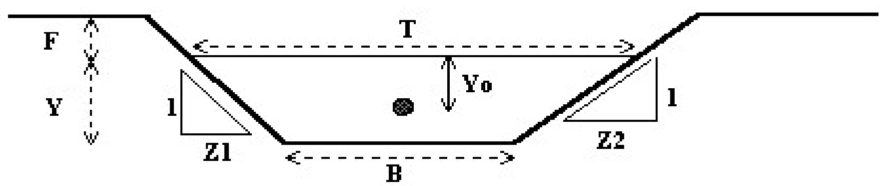


Design Information (Input)			
Channel Invert Slope	So =	0.0011	ft/ft
Manning's n	n =	0.035	
Bottom Width	B =	7.50	ft
Left Side Slope	Z1 =	3.00	ft/ft
Right Side Slope	Z2 =	3.00	ft/ft
Freeboard Height	F =	0.00	ft
Design Water Depth	Y =	**1.25**	ft

Normal Flow Condtion (Calculated)			
Discharge	**Q =**	**18.68**	cfs
Froude Number	**Fr =**	**0.24**	
Flow Velocity	**V =**	**1.33**	fps
Flow Area	A =	14.06	sq ft
Top Width	T =	15.00	ft
Wetted Perimeter	P =	15.41	ft
Hydraulic Radius	R =	0.91	ft
Hydraulic Depth	D =	0.94	ft
Specific Energy	Es =	1.28	ft
Centroid of Flow Area	Yo =	0.55	ft
Specific Force	Fs =	0.53	kip

Normal Flow Analysis - Trapezoidal Channel

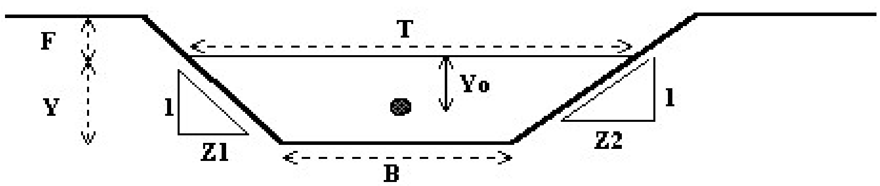
Project:	**Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad**
Channel ID:	**Onsite Diversion Ditch 2** **Design Flow = Q-100yr = 11.70 cfs. (ON-2)**



Design Information (Input)			
Channel Invert Slope	So =	0.0011	ft/ft
Manning's n	n =	0.035	
Bottom Width	B =	6.00	ft
Left Side Slope	Z1 =	3.00	ft/ft
Right Side Slope	Z2 =	3.00	ft/ft
Freeboard Height	F =	0.00	ft
Design Water Depth	Y =	**1.25**	ft
Normal Flow Condtion (Calculated)			
Discharge	**Q =**	**15.76**	cfs
Froude Number	**Fr =**	**0.24**	
Flow Velocity	**V =**	**1.29**	fps
Flow Area	A =	12.19	sq ft
Top Width	T =	13.50	ft
Wetted Perimeter	P =	13.91	ft
Hydraulic Radius	R =	0.88	ft
Hydraulic Depth	D =	0.90	ft
Specific Energy	Es =	1.28	ft
Centroid of Flow Area	Yo =	0.54	ft
Specific Force	Fs =	0.45	kip

Normal Flow Analysis - Trapezoidal Channel

Project:	**Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad**
Channel ID:	**Offsite Diversion Ditch 1** **Design Flow = Q-100yr = 21.48 cfs. (OFF-1)**

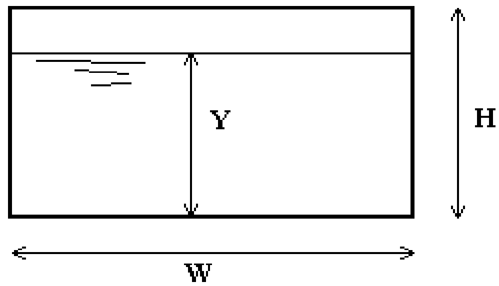


Design Information (Input)			
Channel Invert Slope	So =	0.0025	ft/ft
Manning's n	n =	0.030	
Bottom Width	B =	5.00	ft
Left Side Slope	Z1 =	3.00	ft/ft
Right Side Slope	Z2 =	3.00	ft/ft
Freeboard Height	F =	0.00	ft
Design Water Depth	Y =	**1.25**	ft

Normal Flow Condtion (Calculated)			
Discharge	**Q =**	**24.32**	cfs
Froude Number	**Fr =**	**0.42**	
Flow Velocity	**V =**	**2.22**	fps
Flow Area	A =	10.94	sq ft
Top Width	T =	12.50	ft
Wetted Perimeter	P =	12.91	ft
Hydraulic Radius	R =	0.85	ft
Hydraulic Depth	D =	0.88	ft
Specific Energy	Es =	1.33	ft
Centroid of Flow Area	Yo =	0.53	ft
Specific Force	Fs =	0.47	kip

BOX CONDUIT FLOW (Normal & Critical Depth Computation)

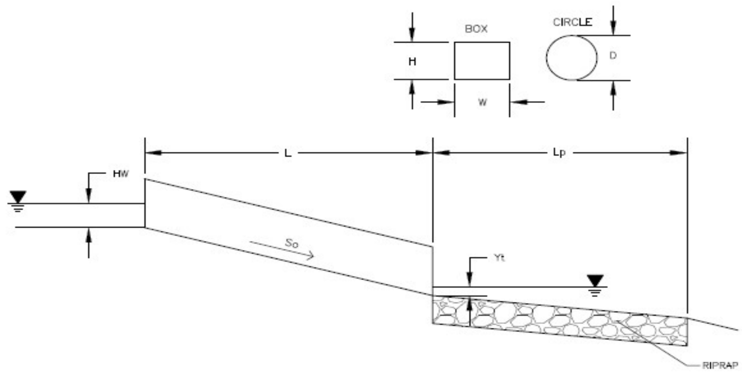
Project: **Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad**
Box ID: **Culvert A - Open Channel w/ Cattle Guard (ON-1)**



Design Information (Input)			
Box conduit invert slope	So =	0.0068	ft/ft
Box Manning's n-value	n =	0.0130	
Box Width	W =	7.50	ft
Box Height	H =	1.25	ft
Design discharge	**Q =**	**17.72**	**cfs**
Full-flow capacity (Calculated)			
Full-flow area	Af =	9.38	sq ft
Full-flow wetted perimeter	Pf =	17.50	ft
Full-flow capacity	Qf =	58.45	cfs
Calculations of Normal Flow Condition			
Normal flow depth (<H)	Yn =	0.46	ft
Flow area	An =	3.42	sq ft
Wetted perimeter	Pn =	8.41	ft
Flow velocity	Vn =	5.18	fps
Discharge	Qn =	17.72	cfs
Percent Full	Flow =	30.3%	of full flow
Normal Depth Froude Number	Fr_n =	1.35	supercritical
Calculation of Critical Flow Condition			
Critical flow depth	Yc =	0.56	ft
Critical flow area	Ac =	4.18	sq ft
Critical flow velocity	Vc =	4.24	fps
Critical Depth Froude Number	Fr_c =	1.00	

Determination of Culvert Headwater and Outlet Protection

Project: Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad
Basin ID: Culvert A



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

Supercritical Flow! Using Ha to calculate protection type.

Design Information (Input):

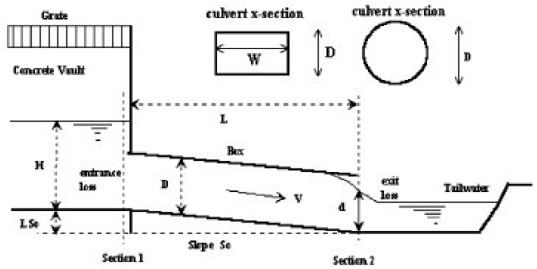
Design Discharge	Q =	17.72	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =		inches
Inlet Edge Type (Choose from pull-down list)		Grooved End Projection	
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	Height (Rise) =	1.25	ft
Barrel Width (Span) in Feet	Width (Span) =	7.5	ft
Inlet Edge Type (Choose from pull-down list)		Square Edge w/ 90-15 Deg. Headwall	
Number of Barrels	No =	1	
Inlet Elevation	Elev IN =	5638.28	ft
Outlet Elevation **OR** Slope	Elev OUT =	5637.95	ft
Culvert Length	L =	48.5	ft
Manning's Roughness	n =	0.013	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	Elev Y_t =		ft
Max Allowable Channel Velocity	V =	7	ft/s

Required Protection (Output):

Tailwater Surface Height	Y_t =	0.50	ft
Flow Area at Max Channel Velocity	A_t =	2.53	ft^2
Culvert Cross Sectional Area Available	A =	9.38	ft^2
Entrance Loss Coefficient	k_e =	0.50	
Friction Loss Coefficient	k_f =	1.12	
Sum of All Losses Coefficients	k_s =	2.62	ft
Culvert Normal Depth	Y_n =	0.46	ft
Culvert Critical Depth	Y_c =	0.56	ft
Tailwater Depth for Design	d =	0.90	ft
Adjusted Diameter **OR** Adjusted Rise	H_a =	0.85	ft
Expansion Factor	1/(2*tan(Θ)) =	6.65	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/WH^1.5 =	1.69	$ft^{0.5}/s$
Froude Number	Fr =	1.35	Supercritical!
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/H =	0.59	
Inlet Control Headwater	HW_I =	0.94	ft
Outlet Control Headwater	HW_O =	0.72	
Design Headwater Elevation	**HW =**	**5,639.22**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/H =**	**0.75**	
Minimum Theoretical Riprap Size	d_{50} =	1	in
Nominal Riprap Size	d_{50} =	6	in
UDFCD Riprap Type	**Type =**	**VL**	
Length of Protection	**L_p =**	**4**	**ft**
Width of Protection	**T =**	**9**	**ft**

CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad
Basin ID: Culvert A
Status:



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D =		inches
	Inlet Edge Type (choose from pull-down list)		Grooved End Projection	
OR:				
Box Culvert:	Barrel Height (Rise) in Feet	Height (Rise) =	1.25	ft.
	Barrel Width (Span) in Feet	Width (Span) =	7.5	ft.
	Inlet Edge Type (choose from pull-down list)		Square Edge w/ 90-15 Deg. Headwall	
	Number of Barrels	No =	1	
	Inlet Elevation at Culvert Invert	Inlet Elev =	5638.28	ft. elev.
	Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.)	Outlet Elev =	5637.95	ft. elev.
	Culvert Length in Feet	L =	48.5	ft.
	Manning's Roughness	n =	0.013	
	Bend Loss Coefficient	K_b =	0	
	Exit Loss Coefficient	K_x =	1	

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.50
Friction Loss Coefficient	K_f =	1.12
Sum of All Loss Coefficients	K_s =	2.62
Orifice Inlet Condition Coefficient	C_d =	0.83
Minimum Energy Condition Coefficient	KE_{low} =	0.3969

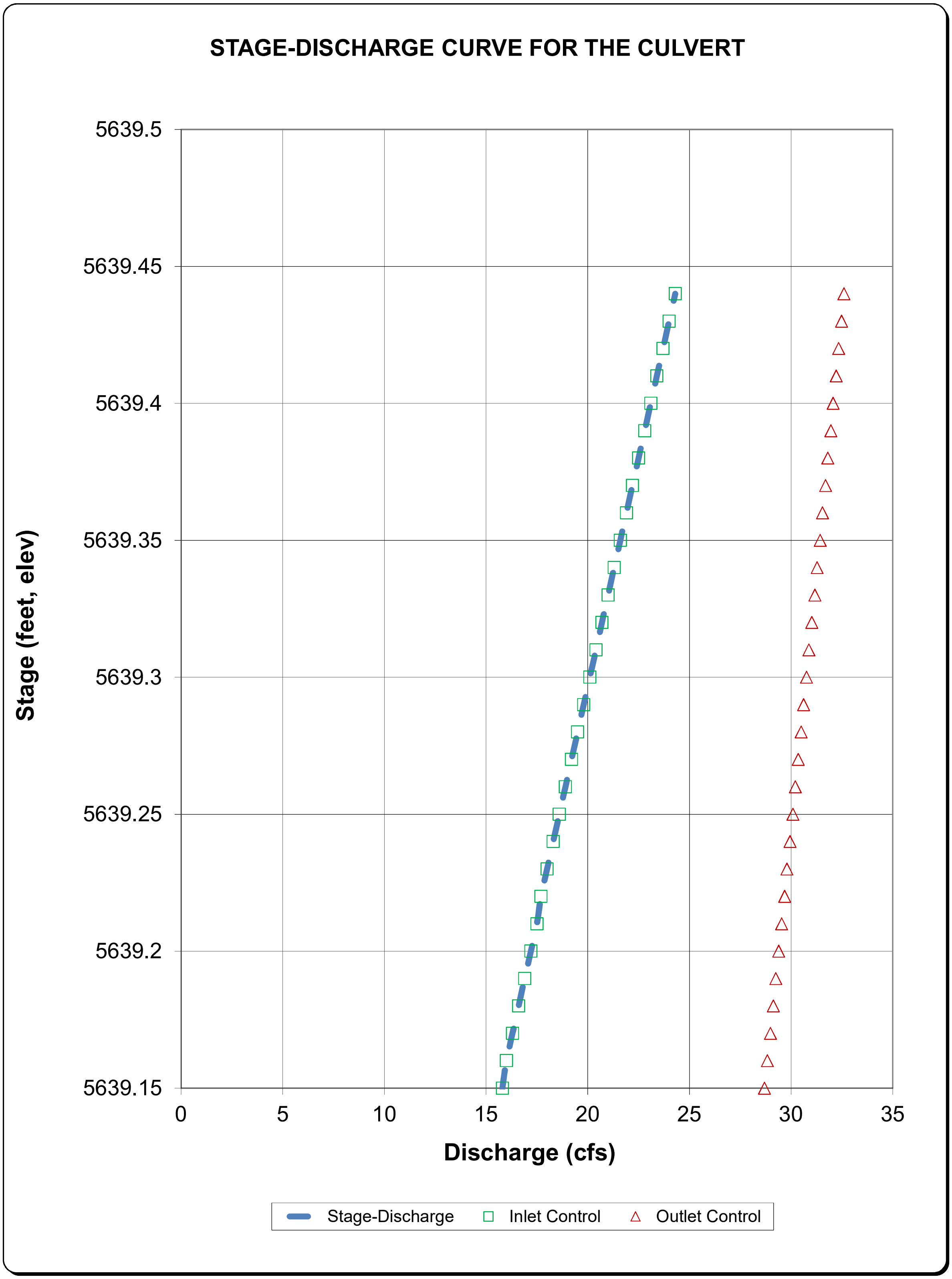
Calculations of Culvert Capacity (output):

Water Surface Elevation (ft., linked)	Tailwater Surface Elevation ft	Culvert Inlet-Control Flowrate cfs	Culvert Outlet-Control Flowrate cfs	Controlling Culvert Flowrate cfs (output)	Inlet Equation Used:	Flow Control Used
5639.15		15.80	28.69	**15.80**	Regression Eqn.	INLET
5639.16		16.00	28.83	**16.00**	Regression Eqn.	INLET
5639.17		16.30	28.98	**16.30**	Regression Eqn.	INLET
5639.18		16.60	29.12	**16.60**	Regression Eqn.	INLET
5639.19		16.90	29.24	**16.90**	Regression Eqn.	INLET
5639.20		17.20	29.39	**17.20**	Regression Eqn.	INLET
5639.21		17.50	29.53	**17.50**	Regression Eqn.	INLET
5639.22		17.70	29.68	**17.70**	Regression Eqn.	INLET
5639.23		18.00	29.80	**18.00**	Regression Eqn.	INLET
5639.24		18.30	29.94	**18.30**	Regression Eqn.	INLET
5639.25		18.60	30.09	**18.60**	Regression Eqn.	INLET
5639.26		18.90	30.20	**18.90**	Regression Eqn.	INLET
5639.27		19.20	30.35	**19.20**	Regression Eqn.	INLET
5639.28		19.50	30.49	**19.50**	Regression Eqn.	INLET
5639.29		19.80	30.61	**19.80**	Regression Eqn.	INLET
5639.30		20.10	30.76	**20.10**	Regression Eqn.	INLET
5639.31		20.40	30.87	**20.40**	Regression Eqn.	INLET
5639.32		20.70	31.02	**20.70**	Regression Eqn.	INLET
5639.33		21.00	31.17	**21.00**	Regression Eqn.	INLET
5639.34		21.30	31.28	**21.30**	Regression Eqn.	INLET
5639.35		21.60	31.43	**21.60**	Regression Eqn.	INLET
5639.36		21.90	31.54	**21.90**	Regression Eqn.	INLET
5639.37		22.20	31.69	**22.20**	Regression Eqn.	INLET
5639.38		22.50	31.81	**22.50**	Regression Eqn.	INLET
5639.39		22.80	31.95	**22.80**	Regression Eqn.	INLET
5639.40		23.10	32.07	**23.10**	Regression Eqn.	INLET
5639.41		23.40	32.21	**23.40**	Regression Eqn.	INLET
5639.42		23.70	32.33	**23.70**	Regression Eqn.	INLET
5639.43		24.00	32.48	**24.00**	Regression Eqn.	INLET
5639.44		24.30	32.59	**24.30**	Regression Eqn.	INLET

Processing Time: 01.05 Seconds

CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

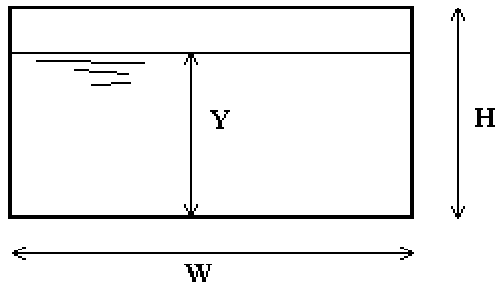
Project: Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad
Basin ID: Culvert A



BOX CONDUIT FLOW (Normal & Critical Depth Computation)

Project: **Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad**

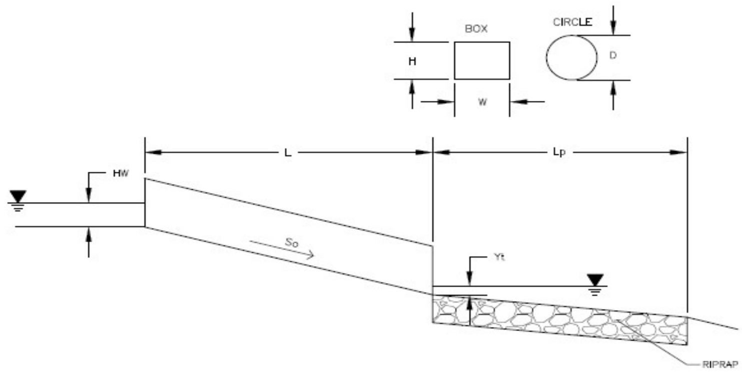
Box ID: **Culvert B - Open Channel w/ Culvert Cattle Guard (OFF-2)**



Design Information (Input)			
Box conduit invert slope	So =	0.024	ft/ft
Box Manning's n-value	n =	0.0130	
Box Width	W =	7.00	ft
Box Height	H =	1.00	ft
Design discharge	**Q =**	**9.78**	**cfs**
Full-flow capacity (Calculated)			
Full-flow area	Af =	7.00	sq ft
Full-flow wetted perimeter	Pf =	16.00	ft
Full-flow capacity	Qf =	71.63	cfs
Calculations of Normal Flow Condition			
Normal flow depth (<H)	Yn =	0.22	ft
Flow area	An =	1.56	sq ft
Wetted perimeter	Pn =	7.45	ft
Flow velocity	Vn =	6.27	fps
Discharge	Qn =	9.78	cfs
Percent Full	Flow =	13.7%	of full flow
Normal Depth Froude Number	Fr_n =	2.34	supercritical
Calculation of Critical Flow Condition			
Critical flow depth	Yc =	0.39	ft
Critical flow area	Ac =	2.75	sq ft
Critical flow velocity	Vc =	3.56	fps
Critical Depth Froude Number	Fr_c =	1.00	

Determination of Culvert Headwater and Outlet Protection

Project: Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad
Basin ID: Culvert B



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

Supercritical Flow! Using Ha to calculate protection type.

Design Information (Input):

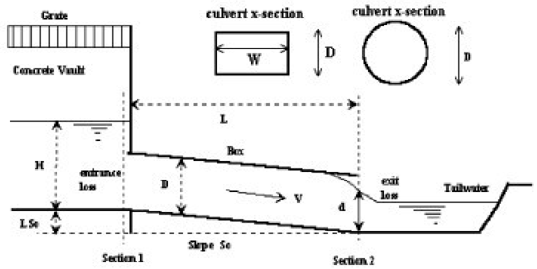
	Design Discharge	Q =	9.78	cfs
Circular Culvert:				
	Barrel Diameter in Inches	D =		inches
	Inlet Edge Type (Choose from pull-down list)			
Box Culvert:			**OR**	
	Barrel Height (Rise) in Feet	Height (Rise) =	1	ft
	Barrel Width (Span) in Feet	Width (Span) =	7	ft
	Inlet Edge Type (Choose from pull-down list)	Square Edge w/ 90-15 Deg. Headwall		
	Number of Barrels	No =	1	
	Inlet Elevation	Elev IN =	5650.81	ft
	Outlet Elevation **OR** Slope	Elev OUT =	5650.21	ft
	Culvert Length	L =	25.5	ft
	Manning's Roughness	n =	0.013	
	Bend Loss Coefficient	k_b =	0	
	Exit Loss Coefficient	k_x =	1	
	Tailwater Surface Elevation	Elev Y_t =		ft
	Max Allowable Channel Velocity	V =	7	ft/s

Required Protection (Output):

Tailwater Surface Height	Y_t =	0.40	ft
Flow Area at Max Channel Velocity	A_t =	1.40	ft^2
Culvert Cross Sectional Area Available	A =	7.00	ft^2
Entrance Loss Coefficient	k_e =	0.50	
Friction Loss Coefficient	k_f =	0.79	
Sum of All Losses Coefficients	k_s =	2.29	ft
Culvert Normal Depth	Y_n =	0.22	ft
Culvert Critical Depth	Y_c =	0.39	ft
Tailwater Depth for Design	d =	0.70	ft
Adjusted Diameter **OR** Adjusted Rise	H_a =	0.61	ft
Expansion Factor	1/(2*tan(Θ)) =	6.65	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/WH^1.5 =	1.40	$ft^{0.5}/s$
Froude Number	Fr =	2.32	**Supercritical!**
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/H =	0.65	
Inlet Control Headwater	HW_I =	0.66	ft
Outlet Control Headwater	HW_O =	0.17	ft
Design Headwater Elevation	**HW =**	**5,651.47**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/H =**	**0.66**	
Minimum Theoretical Riprap Size	d_{50} =	0	in
Nominal Riprap Size	d_{50} =	6	in
UDFCD Riprap Type	**Type =**	**VL**	
Length of Protection	L_p **=**	**3**	**ft**
Width of Protection	**T =**	**8**	**ft**

CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: **Eastern Hills 4-64 17-18 3AH-3DH, 4AH-4DH Pad**
Basin ID: **Culvert B**
Status:



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D =		inches
	Inlet Edge Type (choose from pull-down list)		Grooved End with Headwall	
OR:				
Box Culvert:	Barrel Height (Rise) in Feet	Height (Rise) =	1.00	ft.
	Barrel Width (Span) in Feet	Width (Span) =	7.00	ft.
	Inlet Edge Type (choose from pull-down list)		Square Edge w/ 0 deg. Flared Wingwall	
	Number of Barrels	No =	1	
	Inlet Elevation at Culvert Invert	Inlet Elev =	5650.81	ft. elev.
	Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.)	Outlet Elev =	5650.21	ft. elev.
	Culvert Length in Feet	L =	25.5	ft.
	Manning's Roughness	n =	0.013	
	Bend Loss Coefficient	K_b =	0	
	Exit Loss Coefficient	K_x =	1	

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.70
Friction Loss Coefficient	K_f =	0.79
Sum of All Loss Coefficients	K_s =	2.49
Orifice Inlet Condition Coefficient	C_d =	0.78
Minimum Energy Condition Coefficient	KE_{low} =	0.3087

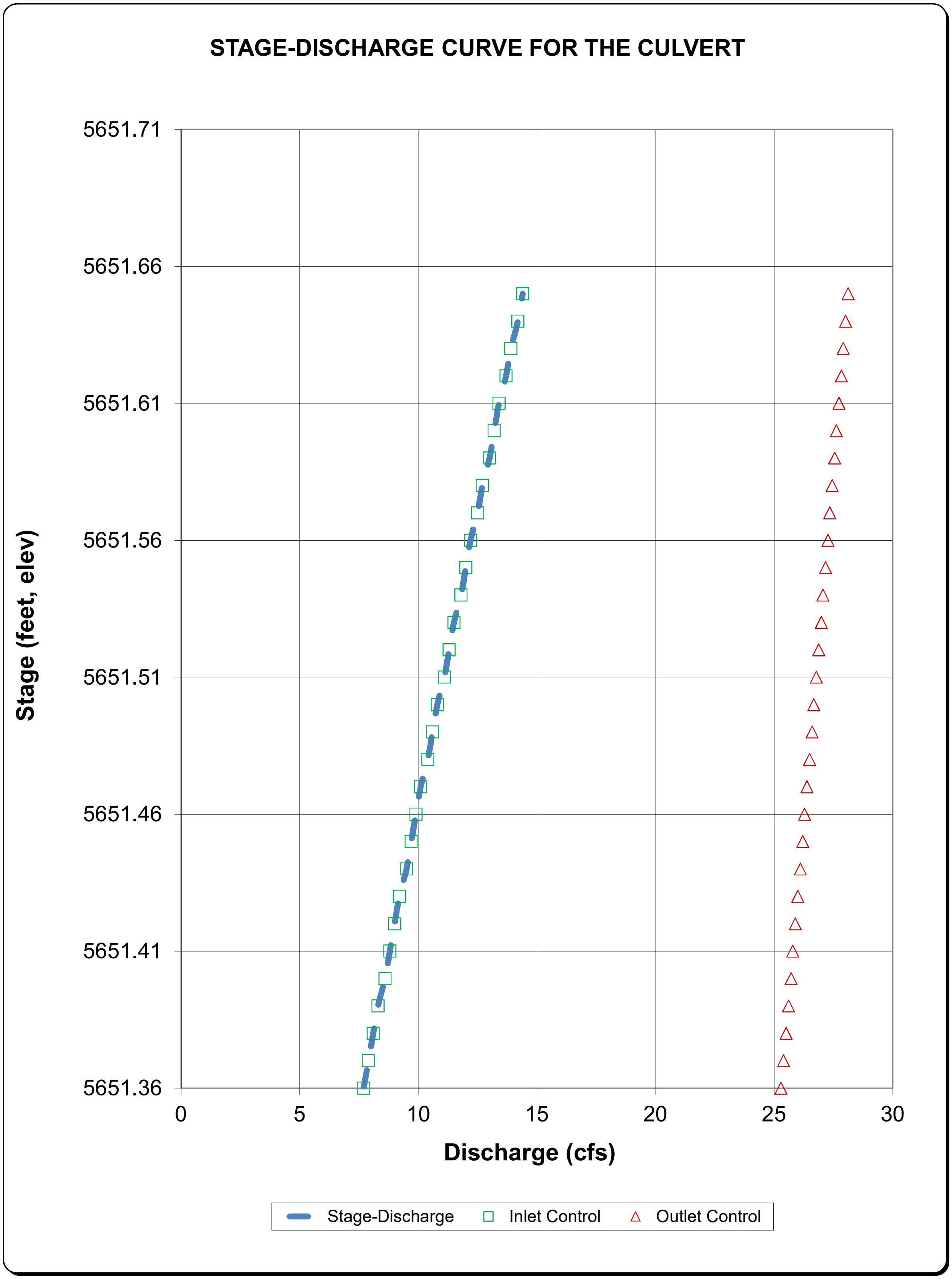
Calculations of Culvert Capacity (output):

Water Surface Elevation (ft., linked)	Tailwater Surface Elevation ft	Culvert Inlet-Control Flowrate cfs	Culvert Outlet-Control Flowrate cfs	Controlling Culvert Flowrate cfs (output)	Inlet Equation Used:	Flow Control Used
5651.36		7.70	25.29	**7.70**	Regression Eqn.	INLET
5651.37		7.90	25.39	**7.90**	Regression Eqn.	INLET
5651.38		8.10	25.50	**8.10**	Regression Eqn.	INLET
5651.39		8.30	25.61	**8.30**	Regression Eqn.	INLET
5651.40		8.60	25.71	**8.60**	Regression Eqn.	INLET
5651.41		8.80	25.78	**8.80**	Regression Eqn.	INLET
5651.42		9.00	25.89	**9.00**	Regression Eqn.	INLET
5651.43		9.20	26.00	**9.20**	Regression Eqn.	INLET
5651.44		9.50	26.10	**9.50**	Regression Eqn.	INLET
5651.45		9.70	26.21	**9.70**	Regression Eqn.	INLET
5651.46		9.90	26.28	**9.90**	Regression Eqn.	INLET
5651.47		10.10	26.38	**10.10**	Regression Eqn.	INLET
5651.48		10.40	26.49	**10.40**	Regression Eqn.	INLET
5651.49		10.60	26.60	**10.60**	Regression Eqn.	INLET
5651.50		10.80	26.67	**10.80**	Regression Eqn.	INLET
5651.51		11.10	26.77	**11.10**	Regression Eqn.	INLET
5651.52		11.30	26.88	**11.30**	Regression Eqn.	INLET
5651.53		11.50	26.99	**11.50**	Regression Eqn.	INLET
5651.54		11.80	27.06	**11.80**	Regression Eqn.	INLET
5651.55		12.00	27.16	**12.00**	Regression Eqn.	INLET
5651.56		12.20	27.27	**12.20**	Regression Eqn.	INLET
5651.57		12.50	27.34	**12.50**	Regression Eqn.	INLET
5651.58		12.70	27.45	**12.70**	Regression Eqn.	INLET
5651.59		13.00	27.55	**13.00**	Regression Eqn.	INLET
5651.60		13.20	27.62	**13.20**	Regression Eqn.	INLET
5651.61		13.40	27.73	**13.40**	Regression Eqn.	INLET
5651.62		13.70	27.83	**13.70**	Regression Eqn.	INLET
5651.63		13.90	27.90	**13.90**	Regression Eqn.	INLET
5651.64		14.20	28.01	**14.20**	Regression Eqn.	INLET
5651.65		14.40	28.12	**14.40**	Regression Eqn.	INLET

Processing Time: 01.04 Seconds

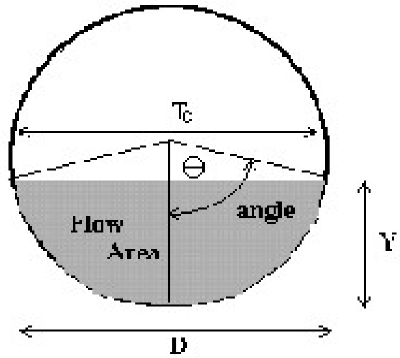
CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Eastern Hills 4-64 17-18 3AH-3DH, 4AH-4DH Pad
Basin ID: Culvert B



CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

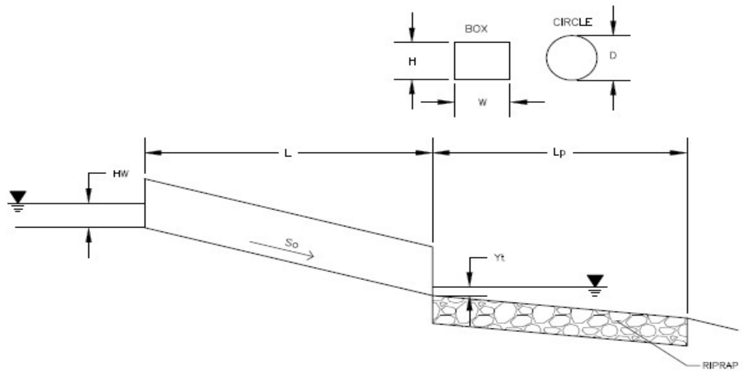
Project: Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad
Pipe ID: Culvert C



Design Information (Input)			
Pipe Invert Slope	So =	0.0060	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	24.00	inches
Design discharge	**Q =**	**9.19**	**cfs**
Full-flow Capacity (Calculated)			
Full-flow area	Af =	3.14	sq ft
Full-flow wetted perimeter	Pf =	6.28	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	17.57	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.60	radians
Flow area	An =	1.62	sq ft
Top width	Tn =	2.00	ft
Wetted perimeter	Pn =	3.20	ft
Flow depth	Yn =	1.03	ft
Flow velocity	Vn =	5.66	fps
Discharge	Qn =	9.19	cfs
Percent Full Flow	Flow =	52.3%	of full flow
Normal Depth Froude Number	Fr_n =	1.11	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	1.65	radians
Critical flow area	Ac =	1.74	sq ft
Critical top width	Tc =	1.99	ft
Critical flow depth	Yc =	1.08	ft
Critical flow velocity	Vc =	5.29	fps
Critical Depth Froude Number	Fr_c =	1.00	

Determination of Culvert Headwater and Outlet Protection

Project: Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad
Basin ID: Culvert C



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

Supercritical Flow! Using Da to calculate protection type.

Design Information (Input):

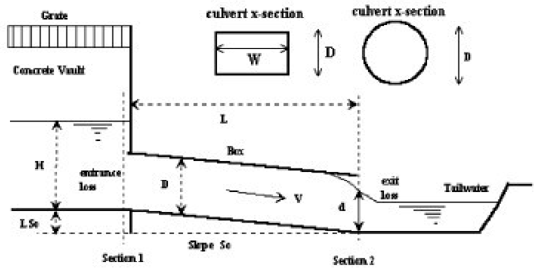
Design Discharge	Q =	9.19	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	24	inches
Inlet Edge Type (Choose from pull-down list)	Grooved End Projection		
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	Height (Rise) =		ft
Barrel Width (Span) in Feet	Width (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	No =	1	
Inlet Elevation	Elev IN =	5639.90	ft
Outlet Elevation **OR** Slope	So =	0.006	ft/ft
Culvert Length	L =	55.0	ft
Manning's Roughness	n =	0.013	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	Elev Y_t =		ft
Max Allowable Channel Velocity	V =	7	ft/s

Required Protection (Output):

Tailwater Surface Height	Y_t =	0.80	ft
Flow Area at Max Channel Velocity	A_t =	1.31	ft^2
Culvert Cross Sectional Area Available	A =	3.14	ft^2
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	0.68	
Sum of All Losses Coefficients	k_s =	1.88	ft
Culvert Normal Depth	Y_n =	1.03	ft
Culvert Critical Depth	Y_c =	1.08	ft
Tailwater Depth for Design	d =	1.54	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	1.51	ft
Expansion Factor	1/(2*tan(Θ)) =	6.70	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	1.62	$ft^{0.5}/s$
Froude Number	Fr =	1.11	**Supercritical!**
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	0.53	
Inlet Control Headwater	HW_I =	1.55	ft
Outlet Control Headwater	HW_O =	1.46	
Design Headwater Elevation	**HW =**	**5,641.45**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**0.78**	
Minimum Theoretical Riprap Size	d_{50} =	3	in
Nominal Riprap Size	d_{50} =	6	in
UDFCD Riprap Type	**Type =**	**VL**	
Length of Protection	**L_p =**	**6**	**ft**
Width of Protection	**T =**	**3**	**ft**

CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad
Basin ID: Culvert C
Status:



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D =	24	inches
	Inlet Edge Type (choose from pull-down list)		Grooved End Projection	
OR:				
Box Culvert:	Barrel Height (Rise) in Feet	Height (Rise) =		ft.
	Barrel Width (Span) in Feet	Width (Span) =		ft.
	Inlet Edge Type (choose from pull-down list)		Square Edge w/ 30-78 deg. Flared Wingwall	
	Number of Barrels	No =	1	
	Inlet Elevation at Culvert Invert	Inlet Elev =	5639.90	ft. elev.
	Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.)	Slope =	0.006	ft vert. / ft horiz.
	Culvert Length in Feet	L =	55.0	ft.
	Manning's Roughness	n =	0.013	
	Bend Loss Coefficient	K_b =	0	
	Exit Loss Coefficient	K_x =	1	

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.20
Friction Loss Coefficient	K_f =	0.68
Sum of All Loss Coefficients	K_s =	1.88
Orifice Inlet Condition Coefficient	C_d =	0.95
Minimum Energy Condition Coefficient	KE_{low} =	-0.0342

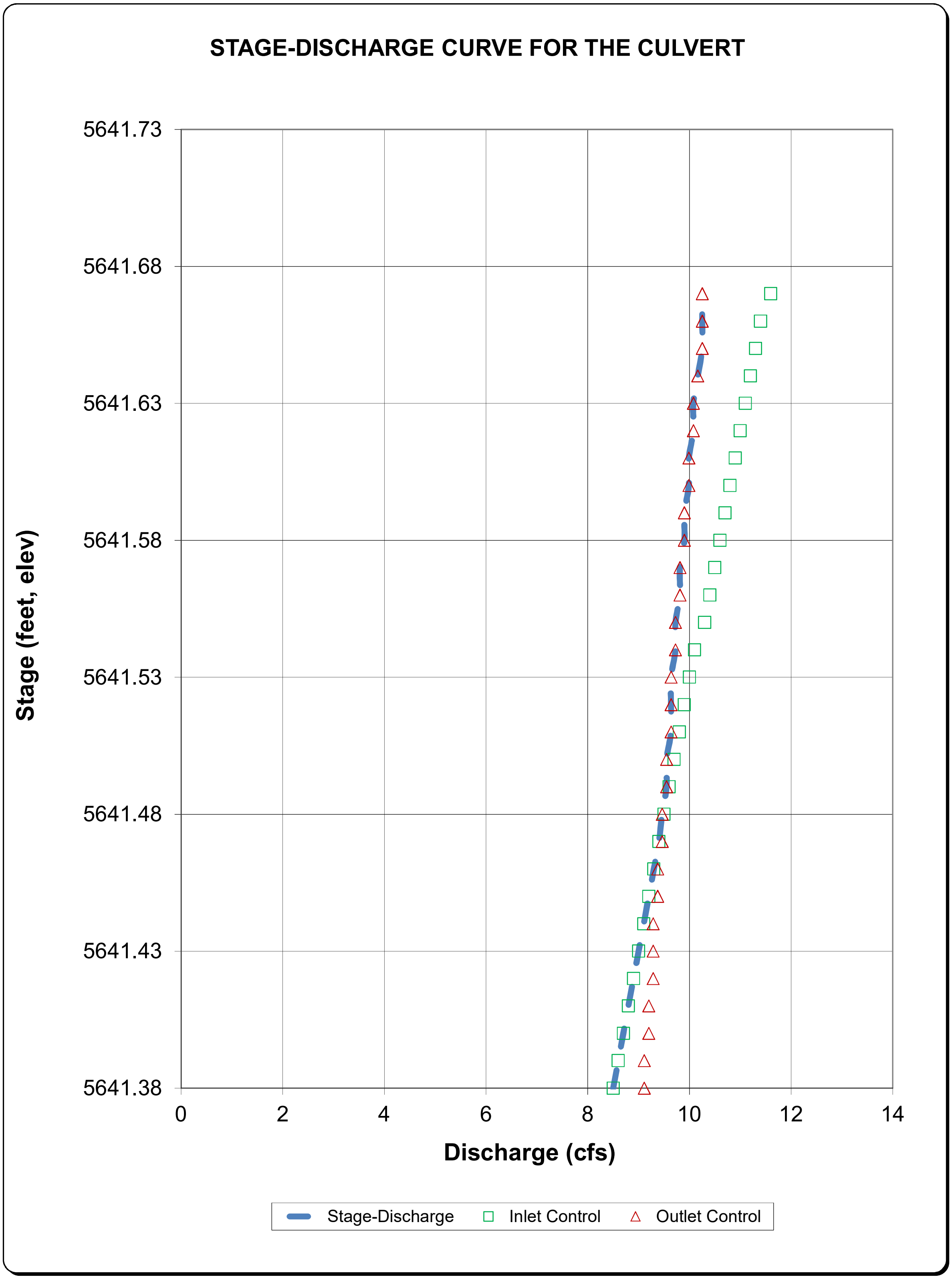
Calculations of Culvert Capacity (output):

Water Surface Elevation (ft., linked)	Tailwater Surface Elevation ft	Culvert Inlet-Control Flowrate cfs	Culvert Outlet-Control Flowrate cfs	Controlling Culvert Flowrate cfs (output)	Inlet Equation Used:	Flow Control Used
5641.38		8.50	9.11	**8.50**	Regression Eqn.	INLET
5641.39		8.60	9.11	**8.60**	Regression Eqn.	INLET
5641.40		8.70	9.20	**8.70**	Regression Eqn.	INLET
5641.41		8.80	9.20	**8.80**	Regression Eqn.	INLET
5641.42		8.90	9.29	**8.90**	Regression Eqn.	INLET
5641.43		9.00	9.29	**9.00**	Regression Eqn.	INLET
5641.44		9.10	9.29	**9.10**	Regression Eqn.	INLET
5641.45		9.20	9.38	**9.20**	Regression Eqn.	INLET
5641.46		9.30	9.38	**9.30**	Regression Eqn.	INLET
5641.47		9.40	9.46	**9.40**	Regression Eqn.	INLET
5641.48		9.50	9.46	**9.46**	Regression Eqn.	OUTLET
5641.49		9.60	9.55	**9.55**	Regression Eqn.	OUTLET
5641.50		9.70	9.55	**9.55**	Regression Eqn.	OUTLET
5641.51		9.80	9.64	**9.64**	Regression Eqn.	OUTLET
5641.52		9.90	9.64	**9.64**	Regression Eqn.	OUTLET
5641.53		10.00	9.64	**9.64**	Regression Eqn.	OUTLET
5641.54		10.10	9.73	**9.73**	Regression Eqn.	OUTLET
5641.55		10.30	9.73	**9.73**	Regression Eqn.	OUTLET
5641.56		10.40	9.81	**9.81**	Regression Eqn.	OUTLET
5641.57		10.50	9.81	**9.81**	Regression Eqn.	OUTLET
5641.58		10.60	9.90	**9.90**	Regression Eqn.	OUTLET
5641.59		10.70	9.90	**9.90**	Regression Eqn.	OUTLET
5641.60		10.80	9.99	**9.99**	Regression Eqn.	OUTLET
5641.61		10.90	9.99	**9.99**	Regression Eqn.	OUTLET
5641.62		11.00	10.08	**10.08**	Regression Eqn.	OUTLET
5641.63		11.10	10.08	**10.08**	Regression Eqn.	OUTLET
5641.64		11.20	10.16	**10.16**	Regression Eqn.	OUTLET
5641.65		11.30	10.25	**10.25**	Regression Eqn.	OUTLET
5641.66		11.40	10.25	**10.25**	Regression Eqn.	OUTLET
5641.67		11.60	10.25	**10.25**	Regression Eqn.	OUTLET

Processing Time: 01.02 Seconds

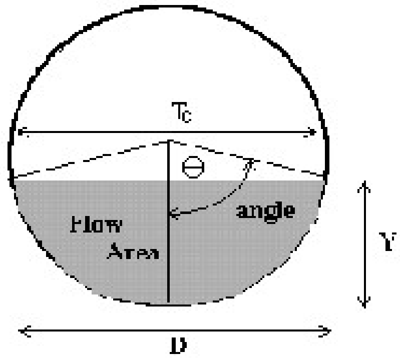
CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad
Basin ID: Culvert C



CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

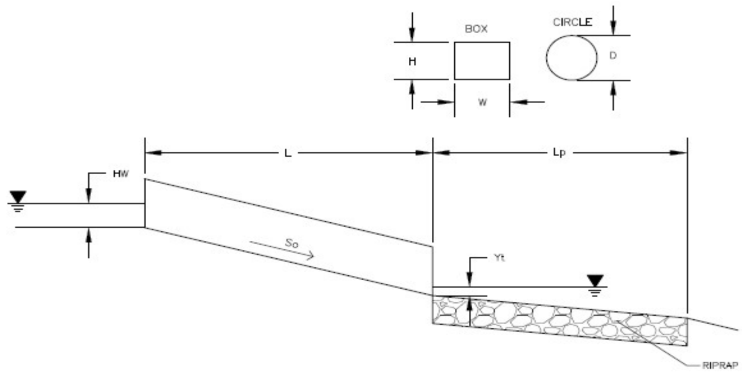
Project: **Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad**
Pipe ID: **Culvert D**



Design Information (Input)			
Pipe Invert Slope	So =	0.0130	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	12.00	inches
Design discharge	**Q =**	**2.44**	**cfs**
Full-flow Capacity (Calculated)			
Full-flow area	Af =	0.79	sq ft
Full-flow wetted perimeter	Pf =	3.14	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	4.07	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.69	radians
Flow area	An =	0.45	sq ft
Top width	Tn =	0.99	ft
Wetted perimeter	Pn =	1.69	ft
Flow depth	Yn =	0.56	ft
Flow velocity	Vn =	5.42	fps
Discharge	Qn =	2.44	cfs
Percent Full Flow	Flow =	60.0%	of full flow
Normal Depth Froude Number	Fr_n =	1.42	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	1.92	radians
Critical flow area	Ac =	0.56	sq ft
Critical top width	Tc =	0.94	ft
Critical flow depth	Yc =	0.67	ft
Critical flow velocity	Vc =	4.37	fps
Critical Depth Froude Number	Fr_c =	1.00	

Determination of Culvert Headwater and Outlet Protection

Project: Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad
Basin ID: Culvert D



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

Supercritical Flow! Using Da to calculate protection type.

Design Information (Input):

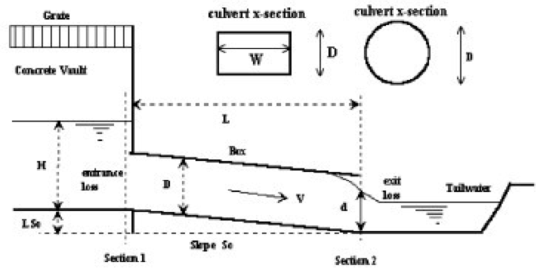
Design Discharge	Q =	2.44	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	12	inches
Inlet Edge Type (Choose from pull-down list)		Grooved End Projection	
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	Height (Rise) =		ft
Barrel Width (Span) in Feet	Width (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	No =	1	
Inlet Elevation	Elev IN =	5640.32	ft
Outlet Elevation **OR** Slope	Elev OUT =	5639.73	ft
Culvert Length	L =	45.5	ft
Manning's Roughness	n =	0.013	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	Elev Y_t =		ft
Max Allowable Channel Velocity	V =	7	ft/s

Required Protection (Output):

Tailwater Surface Height	Y_t =	0.40	ft
Flow Area at Max Channel Velocity	A_t =	0.35	ft^2
Culvert Cross Sectional Area Available	A =	0.79	ft^2
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	1.42	
Sum of All Losses Coefficients	k_s =	2.62	ft
Culvert Normal Depth	Y_n =	0.56	ft
Culvert Critical Depth	Y_c =	0.67	ft
Tailwater Depth for Design	d =	0.83	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	0.78	ft
Expansion Factor	1/(2*tan(Θ)) =	6.38	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	2.44	$ft^{0.5}/s$
Froude Number	Fr =	1.42	Supercritical!
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	0.51	
Inlet Control Headwater	HW_I =	0.99	ft
Outlet Control Headwater	HW_O =	0.64	
Design Headwater Elevation	**HW =**	**5,641.31**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**0.99**	
Minimum Theoretical Riprap Size	d_{50} =	2	in
Nominal Riprap Size	d_{50} =	6	in
UDFCD Riprap Type	**Type =**	**VL**	
Length of Protection	**L_p =**	**3**	**ft**
Width of Protection	**T =**	**2**	**ft**

CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: **Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad**
Basin ID: **Culvert D**
Status:



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D =	12	inches
	Inlet Edge Type (choose from pull-down list)		Grooved End Projection	
OR:				
Box Culvert:	Barrel Height (Rise) in Feet	Height (Rise) =		ft.
	Barrel Width (Span) in Feet	Width (Span) =		ft.
	Inlet Edge Type (choose from pull-down list)		Square Edge w/ 30-78 deg. Flared Wingwall	
	Number of Barrels	No =	1	
	Inlet Elevation at Culvert Invert	Inlet Elev =	5640.32	ft. elev.
	Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.)	Slope =	0.013	ft vert. / ft horiz.
	Culvert Length in Feet	L =	45.5	ft.
	Manning's Roughness	n =	0.013	
	Bend Loss Coefficient	K_b =	0	
	Exit Loss Coefficient	K_x =	1	

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.20
Friction Loss Coefficient	K_f =	1.42
Sum of All Loss Coefficients	K_s =	2.62
Orifice Inlet Condition Coefficient	C_d =	0.95
Minimum Energy Condition Coefficient	KE_{low} =	-0.0898

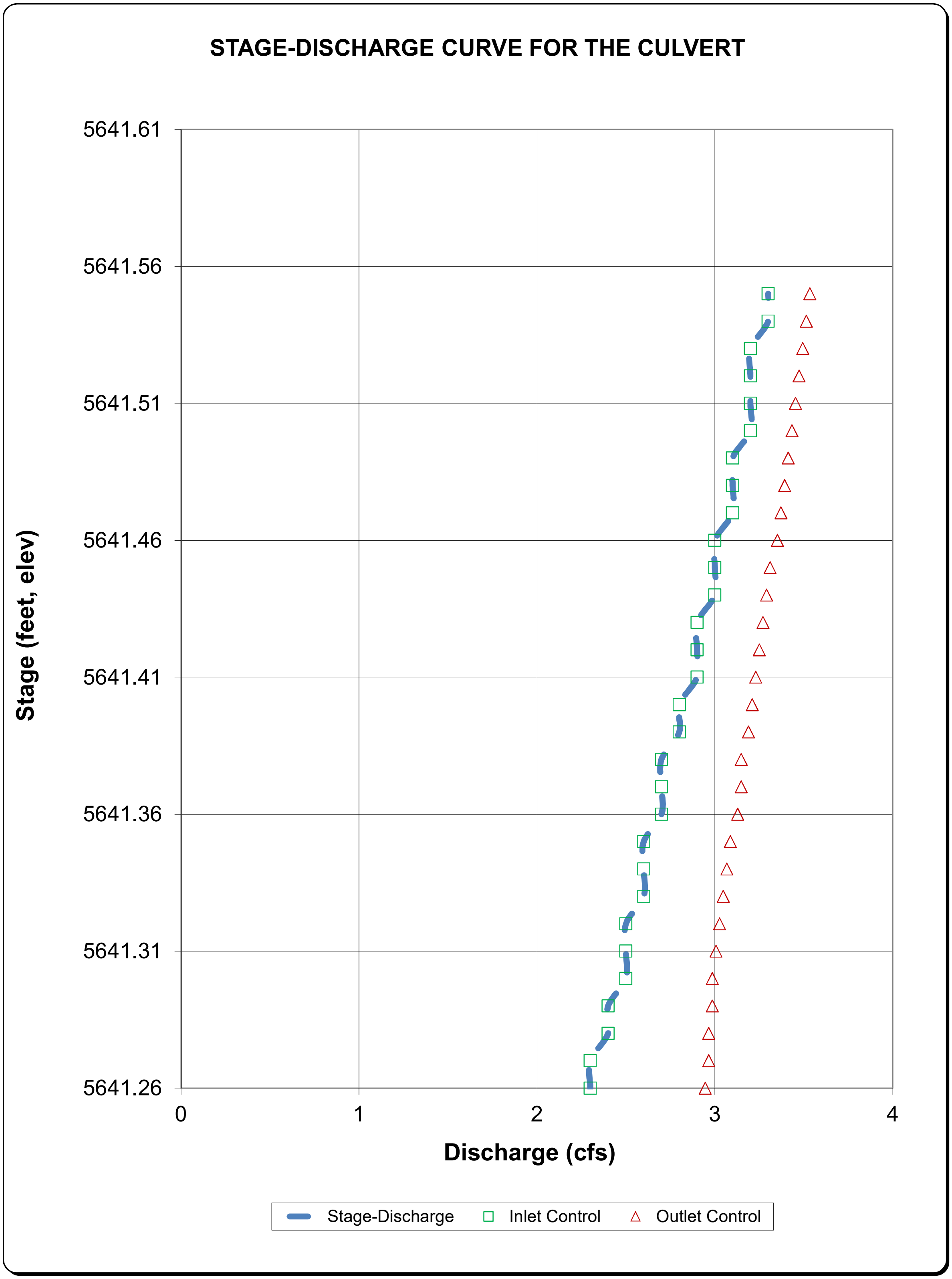
Calculations of Culvert Capacity (output):

Water Surface Elevation (ft., linked)	Tailwater Surface Elevation ft	Culvert Inlet-Control Flowrate cfs	Culvert Outlet-Control Flowrate cfs	Controlling Culvert Flowrate cfs (output)	Inlet Equation Used:	Flow Control Used
5641.26		2.30	2.95	**2.30**	Regression Eqn.	INLET
5641.27		2.30	2.97	**2.30**	Regression Eqn.	INLET
5641.28		2.40	2.97	**2.40**	Regression Eqn.	INLET
5641.29		2.40	2.99	**2.40**	Regression Eqn.	INLET
5641.30		2.50	2.99	**2.50**	Regression Eqn.	INLET
5641.31		2.50	3.01	**2.50**	Regression Eqn.	INLET
5641.32		2.50	3.03	**2.50**	Regression Eqn.	INLET
5641.33		2.60	3.05	**2.60**	Regression Eqn.	INLET
5641.34		2.60	3.07	**2.60**	Regression Eqn.	INLET
5641.35		2.60	3.09	**2.60**	Regression Eqn.	INLET
5641.36		2.70	3.13	**2.70**	Regression Eqn.	INLET
5641.37		2.70	3.15	**2.70**	Regression Eqn.	INLET
5641.38		2.70	3.15	**2.70**	Regression Eqn.	INLET
5641.39		2.80	3.19	**2.80**	Regression Eqn.	INLET
5641.40		2.80	3.21	**2.80**	Regression Eqn.	INLET
5641.41		2.90	3.23	**2.90**	Regression Eqn.	INLET
5641.42		2.90	3.25	**2.90**	Regression Eqn.	INLET
5641.43		2.90	3.27	**2.90**	Regression Eqn.	INLET
5641.44		3.00	3.29	**3.00**	Regression Eqn.	INLET
5641.45		3.00	3.31	**3.00**	Regression Eqn.	INLET
5641.46		3.00	3.35	**3.00**	Regression Eqn.	INLET
5641.47		3.10	3.37	**3.10**	Regression Eqn.	INLET
5641.48		3.10	3.39	**3.10**	Regression Eqn.	INLET
5641.49		3.10	3.41	**3.10**	Regression Eqn.	INLET
5641.50		3.20	3.43	**3.20**	Regression Eqn.	INLET
5641.51		3.20	3.45	**3.20**	Regression Eqn.	INLET
5641.52		3.20	3.47	**3.20**	Regression Eqn.	INLET
5641.53		3.20	3.49	**3.20**	Regression Eqn.	INLET
5641.54		3.30	3.51	**3.30**	Regression Eqn.	INLET
5641.55		3.30	3.53	**3.30**	Regression Eqn.	INLET

Processing Time: 01.30 Seconds

CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad
Basin ID: Culvert D



Trapezoidal Sediment Basin Stage-Storage Worksheet

Project Name: **Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad**
Location: **Aurora, Colorado**

Available Storage Calculation:

$$Volume = \frac{D}{3}\left(A_B + A_T + \sqrt{A_B A_T}\right)$$

where:

D = incremental depth (ft)

A_1 = Bottom Area for increment (ft^2)

A_2 = Top Area for increment (ft^2)

Design Parameters:

Bottom Width:	78	ft
Bottom Length:	156	ft
Bottom Elevation:	5637.00	

Elevation	Surface Area	(1/3)*A + B + (A*B)^0.5	Incremental Depth	Incramental Volume	Cumulative Volume
	(square feet)		(feet)	(cubic feet)	(cubic feet)
5637.00	12168	0.00	0.00	0.00	-
5637.25	12521	12344.08	0.25	3086.02	3,086.0
5637.50	12879	12699.58	0.25	3174.89	6,260.9
5638.00	13608	13241.83	0.50	6620.91	12,881.8
5638.50	14355	13979.84	0.50	6989.92	19,871.7

Available Storage at Spillway: **19,872 cf**

Required Storage Calculation:

Disturbance Area (11.45 ac.) - Reclaimed Pad (4.42 ac.) = 7.03 ac.
This 7.03 acre tributary area is comprised of approximately 6.48 acres of reclaimed grass and seeded stockpiles (10% impervious) in addition to the approximately 0.55 acre sediment basin (90% impervious). Table 1 of the COA Storm Drainage Design and Technical Criteria Manual was used to determine the percent impervious estimates.
Using UDFCD Table SB-1: (6.48 ac. X 800 cf/ac.) + (0.55 ac. X 5,300 cf/ac.) = 8,099 cf

Required Storage Volume:	**8,099 cf**

POND ADEQUATELY SIZED

Stormwater Detention and Infiltration Design Data Sheet

Workbook Protected　　　Worksheet Protected

Stormwater Facility Name: **Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad Sediment Basin**

Facility Location & Jurisdiction: **Section 17, T4S, R65W, City of Aurora, Arapahoe County, Colorado**

User Input: Watershed Characteristics

Watershed Slope =	0.011	ft/ft
Watershed Length =	865	ft
Watershed Area =	7.03	acres
Watershed Imperviousness =	10.0%	percent
Percentage Hydrologic Soil Group A =		percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =		percent

Location for 1-hr Rainfall Depths (use dropdown): Aurora - Municipal Center

WQCV Treatment Method = Extended Detention

User Defined Stage [ft]	User Defined Area [ft^2]	User Defined Stage [ft]	User Defined Discharge [cfs]
0.00	12,168.0	0.00	0.00
0.25	12,521.0	0.25	0.13
0.50	12,879.0	0.50	0.30
0.75	13,241.0	0.75	0.48
1.00	13,608.0	1.00	0.64
1.50	14,355.0	1.50	1.05
2.00	15,120.0	2.00	13.79

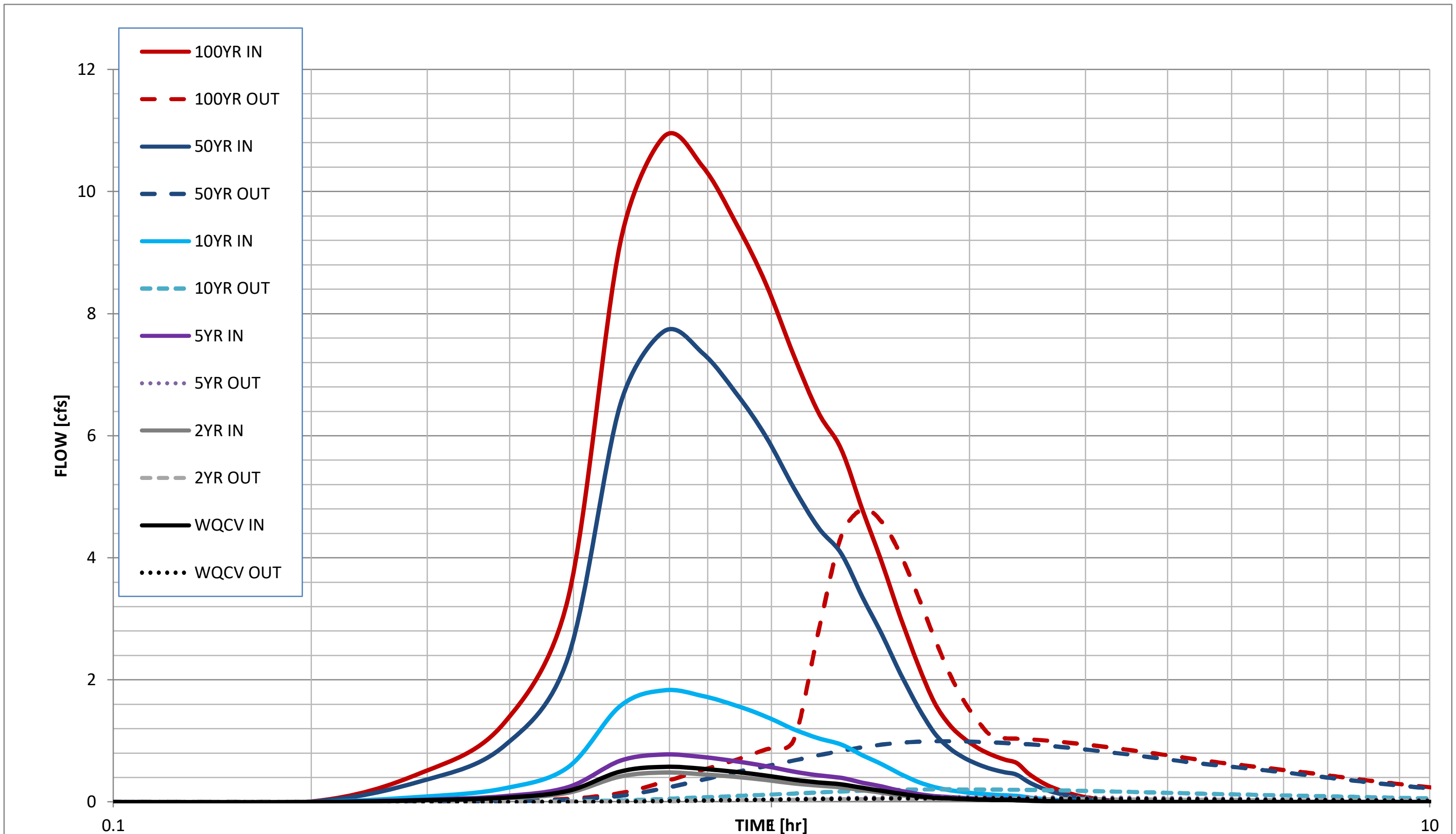
3

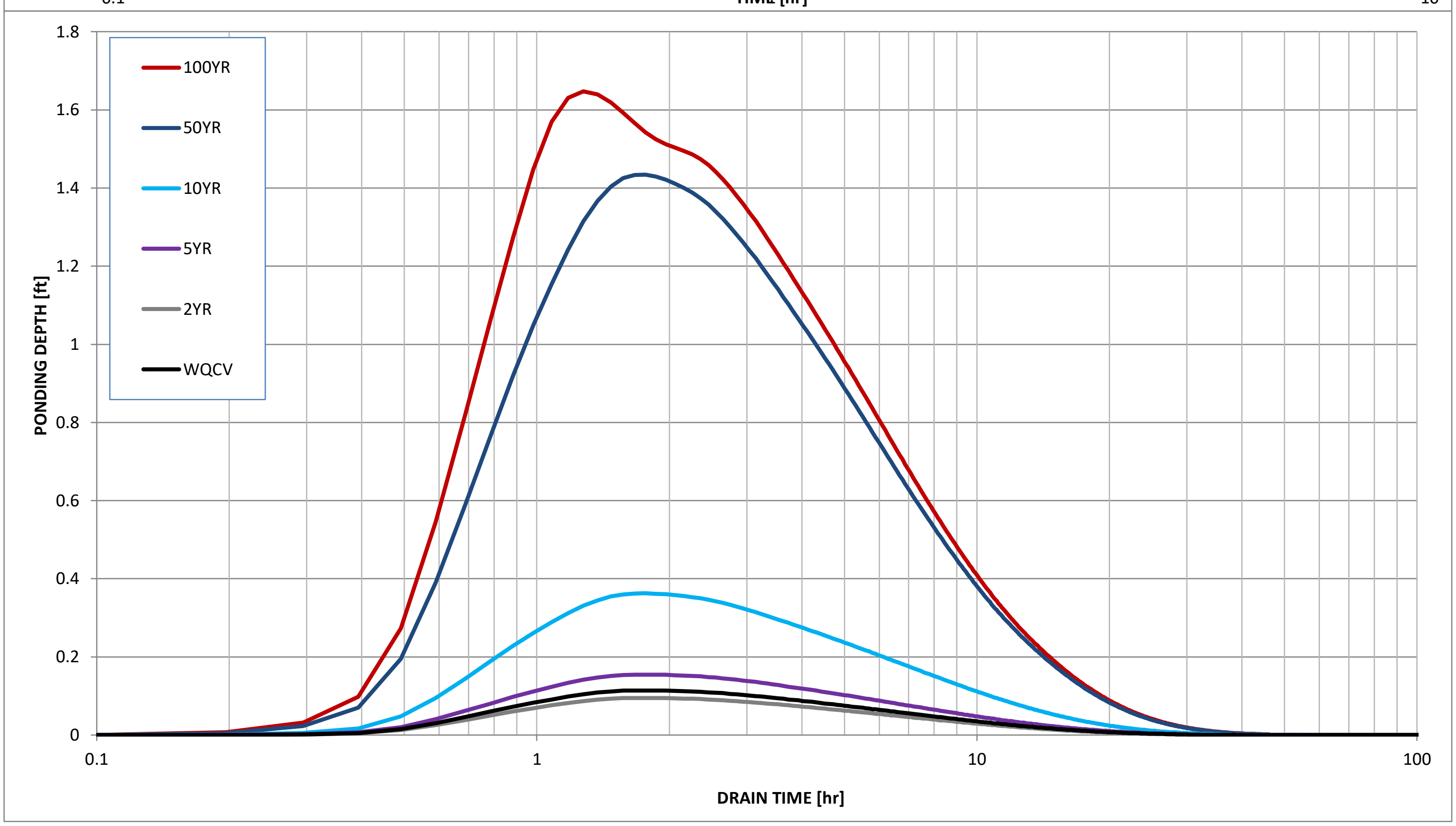
After completing and printing this worksheet to a pdf, go to:
https://maperture.digitaldataservices.com/gvh/?viewer=cswdif
create a new stormwater facility, and
attach the pdf of this worksheet to that record.

Routed Hydrograph Results

Design Storm Return Period =	WQCV	2 Year	5 Year	10 Year	50 Year	100 Year	
One-Hour Rainfall Depth =	0.53	0.87	1.14	1.39	2.08	2.42	in
Calculated Runoff Volume =	0.039	0.033	0.054	0.128	0.547	0.776	acre-ft
OPTIONAL Override Runoff Volume =							acre-ft
Inflow Hydrograph Volume =	0.039	0.033	0.053	0.127	0.546	0.775	acre-ft
Time to Drain 97% of Inflow Volume =	24.0	24.0	**24.0**	23.9	22.4	20.5	hours
Time to Drain 99% of Inflow Volume =	31.1	31.1	31.1	31.0	29.6	**27.7**	hours
Maximum Ponding Depth =	0.11	0.10	0.15	0.36	1.43	1.65	ft
Maximum Ponded Area =	0.28	0.28	0.28	0.29	0.33	**0.33**	acres
Maximum Volume Stored =	0.032	0.026	0.043	0.103	0.434	0.505	acre-ft

Stormwater Detention and Infiltration Design Data Sheet





STAGE-DISCHARGE SIZING OF THE WATER QUALITY CAPTURE VOLUME (WQCV) OUTLET

Project: Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad
Basin ID: Orifice Holes

WQCV Design Volume (Input):

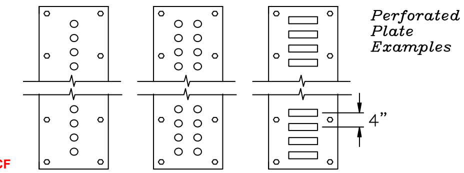
Catchment Imperviousness, I_a =	10.00	percent
Catchment Area, A =	7.03	acres
Depth at WQCV outlet above lowest perforation, H =	1.50	feet
Vertical distance between rows, h =	4.00	inches
Number of rows, NL =	4.00	
Orifice discharge coefficient, C_o =	0.60	
Slope of Basin Trickle Channel, S =	0.000	ft / ft
Time to Drain the Pond =	72	hours

Diameter of holes, D =		inches
Number of holes per row, N =		
OR		
Height of slot, H =	2.00	inches
Width of slot, W =	4.00	inches

5637.256

Watershed Design Information (Input):

Percent Soil Type A =	0	%
Percent Soil Type B =	100	%
Percent Soil Type C/D =	0	%



Outlet Design Information (Output):

Water Quality Capture Volume, WQCV =	0.059	watershed inches
Water Quality Capture Volume (WQCV) =	0.034	acre-feet
Design Volume (WQCV / 12 * Area * 1.2) Vol =	**0.128**	**acre-feet**
Outlet area per row, Ao =	0.12	square inches
Total opening area at each row based on user-input above, Ao =	8.00	square inches
Total opening area at each row based on user-input above, Ao =	0.056	square feet

5576 CF

3

Central Elevations of Rows of Holes in feet

Row 1	Row 2	Row 3	Row 4	Row 5	Row 6	Row 7	Row 8	Row 9	Row 10	Row 11	Row 12	Row 13	Row 14	Row 15	Row 16	Row 17	Row 18	Row 19	Row 20	Row 21	Row 22	Row 23	Row 23
5637.00	5637.33	5637.67	5638.00																				

Collection Capacity for Each Row of Holes in cfs

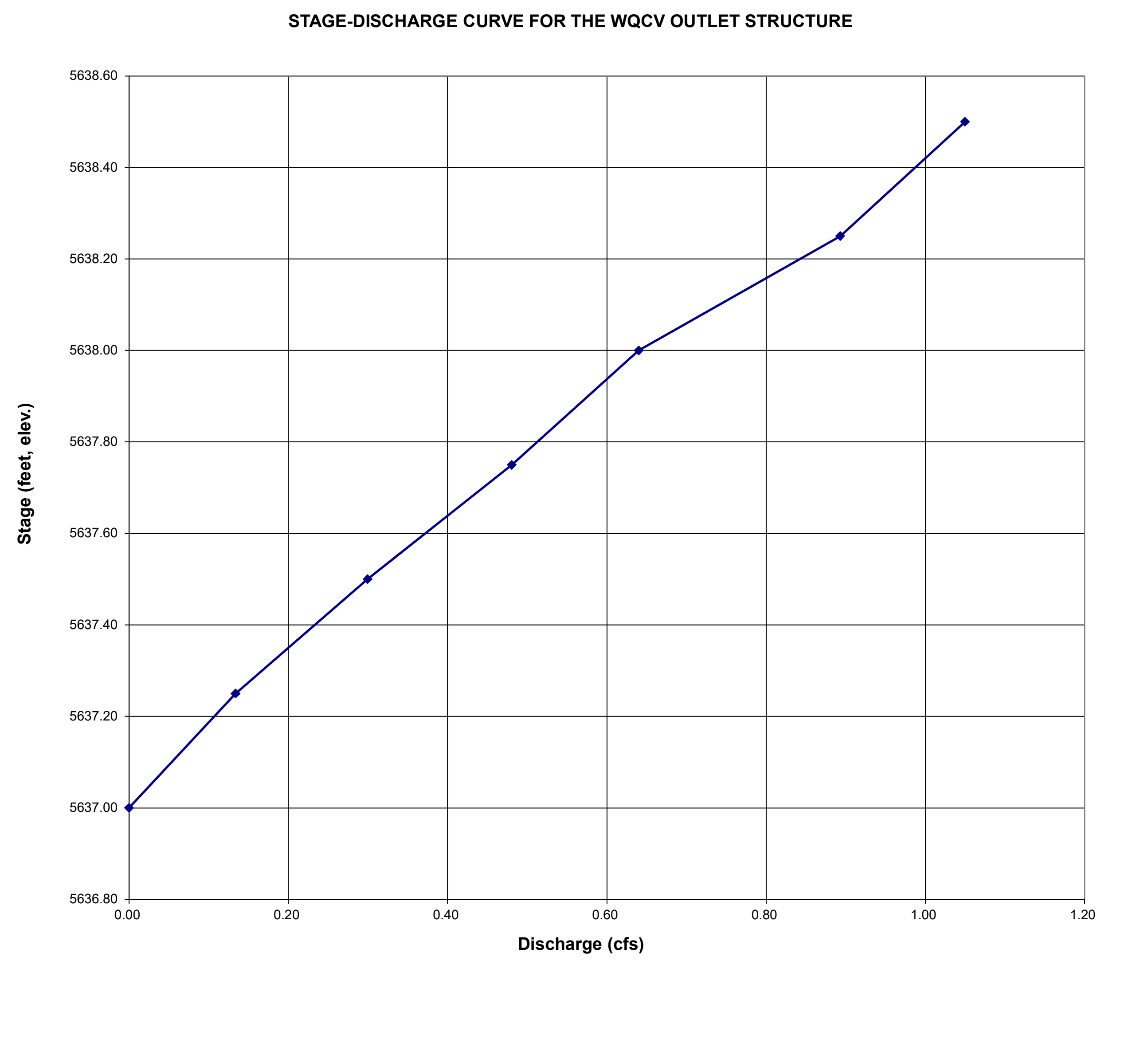
	Row 1	Row 2	Row 3	Row 4	Σ Flow
5637.00	0.0000	0.0000	0.0000	0.0000	**0.00**
5637.25	0.1337	0.0000	0.0000	0.0000	**0.13**
5637.50	0.1892	0.1103	0.0000	0.0000	**0.30**
5637.75	0.2317	0.1734	0.0757	0.0000	**0.48**
5638.00	0.2675	0.2190	0.1537	0.0000	**0.64**
5638.25	0.2991	0.2566	0.2037	0.1337	**0.89**
5638.50	0.3276	0.2893	0.2437	0.1892	**1.05**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**
	#N/A	#N/A	#N/A	#N/A	**#N/A**

Override Area Row 1	Override Area Row 2	Override Area Row 3	Override Area Row 4	Override Area Row 5	Override Area Row 6	Override Area Row 7	Override Area Row 8	Override Area Row 9	Override Area Row 10	Override Area Row 11	Override Area Row 12	Override Area Row 13	Override Area Row 14	Override Area Row 15	Override Area Row 16	Override Area Row 17	Override Area Row 18	Override Area Row 19	Override Area Row 20	Override Area Row 21	Override Area Row 22	Override Area Row 23	Override Area Row 24

STAGE-DISCHARGE SIZING OF THE WATER QUALITY CAPTURE VOLUME (WQCV) OUTLET

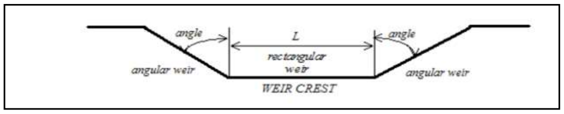
Project: Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad

Basin ID: Orifice Holes



STAGE-DISCHARGE SIZING OF THE SPILLWAY

Project: Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad
Basin ID: Sediment Basin - Spillway



Design Information (input):

Bottom Length of Weir	L =	11.00	feet
Angle of Side Slope Weir	Angle =	75.96	degrees
Elev. for Weir Crest	EL. Crest =	5,638.50	feet
Coef. for Rectangular Weir	C_w =	3.00	
Coef. for Trapezoidal Weir	C_t =	3.00	

Calculation of Spillway Capacity (output):

Water Surface Elevation ft. (linked)	Rect. Weir Flowrate cfs (output)	Triangle Weir Flowrate cfs (output)	Total Spillway Release cfs (output)	Total Pond Release cfs (output)
5637.00	0.00	0.00	0.00	0.00
5637.25	0.00	0.00	0.00	0.00
5637.50	0.00	0.00	0.00	0.00
5638.00	0.00	0.00	0.00	0.00
5638.50	0.00	0.00	0.00	0.00
5639.00	11.67	2.12	13.79	13.79
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A
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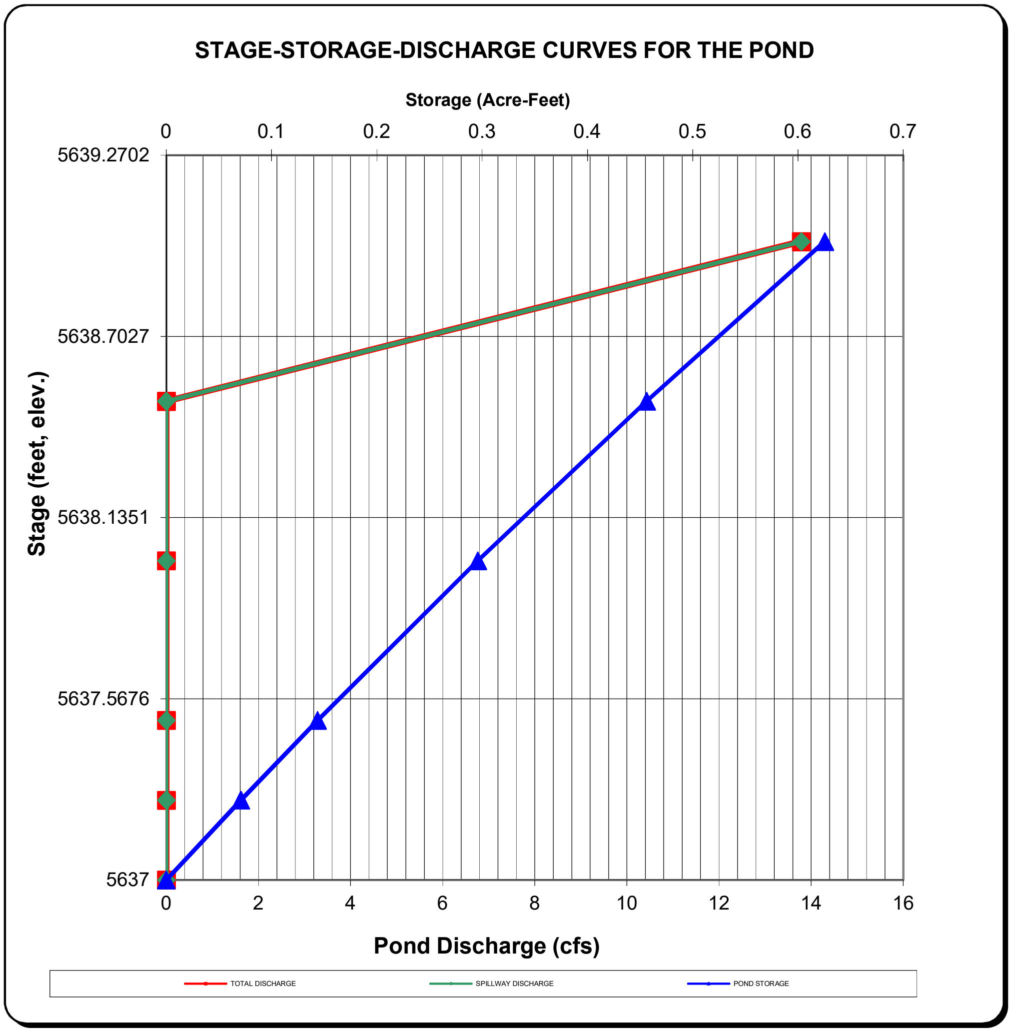
#N/A	#N/A	#N/A	#N/A	#N/A
#N/A	#N/A	#N/A	#N/A	#N/A

STAGE-DISCHARGE SIZING OF THE SPILLWAY

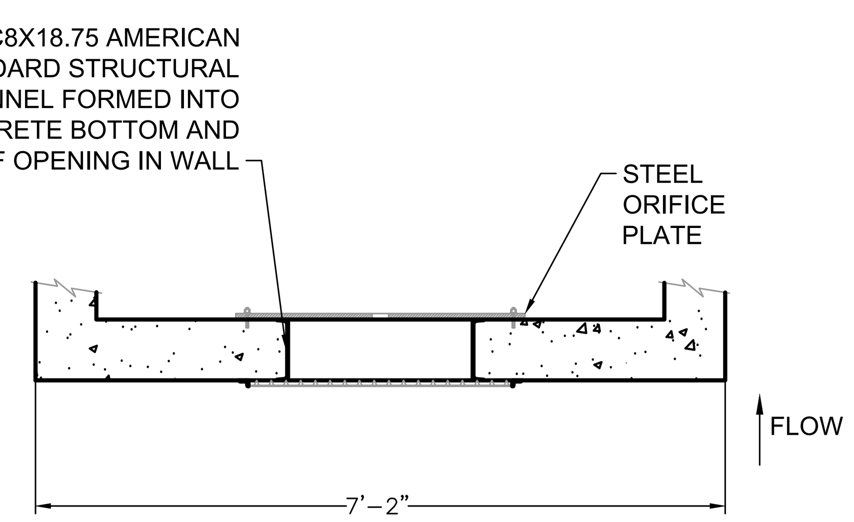
Project: Eastern Hills South 4-65 17-18 3AH-3DH, 4AH-4DH Pad
Basin ID: Sediment Basin - Spillway



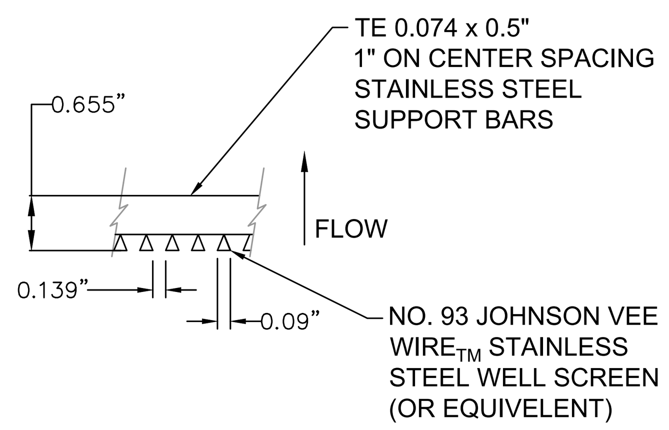
EASTERN HILLS SOUTH 4-65 17-18 3AH-3DH, 4AH-4DH PAD

OUTLET STRUCTURE TABLE						
POND ID	BOX TOP ELEVATION	WSE ①	MICROPOOL WSE ②	OUTLET PIPE INVERT ELEVATION ③	BOX BOTTOM ELEVATION ④	BOX HEIGHT FRONT (H) ft.
EASTERN HILLS	5638.50	5638.50	5637.00	5636.75	5633.50	5.00

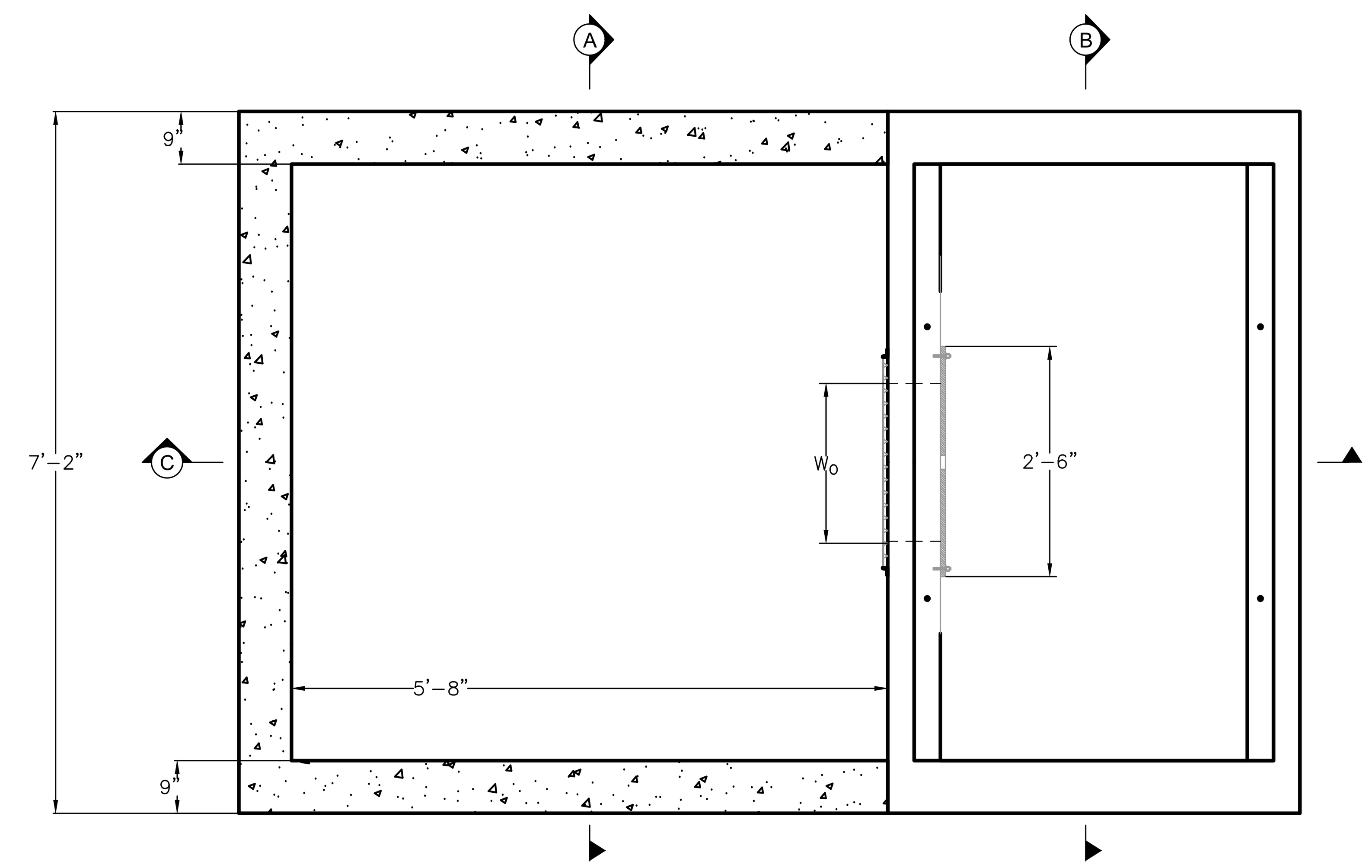
CONCRETE OPENING AND ORIFICE PLATE DETAIL TABLE									
POND ID	CONCRETE OPENING TOP ELEVATION ⑤	CONCRETE OPENING BOTTOM ELEVATION ⑥	CONCRETE OPENING HEIGHT (HO) ft.	CONCRETE OPENING WIDTH (WO) ft.	ORIFICE PLATE TOP ⑦	ORIFICE PLATE BOTTOM ⑧	BOTTOM HOLE ELEVATION ⑨	# OF ROWS	# OF COLUMNS
EASTERN HILLS	5638.50	5634.82	3.68	2.00	5638.50	5634.57	5637.00	4	1



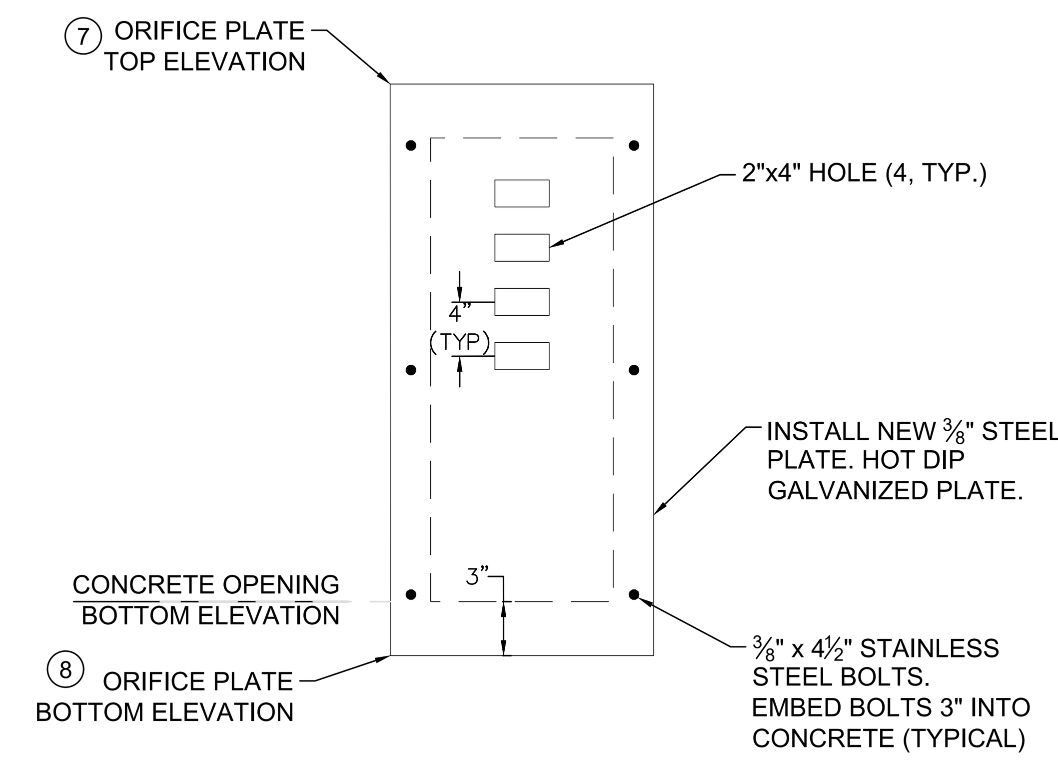
SECTION (D)
NTS



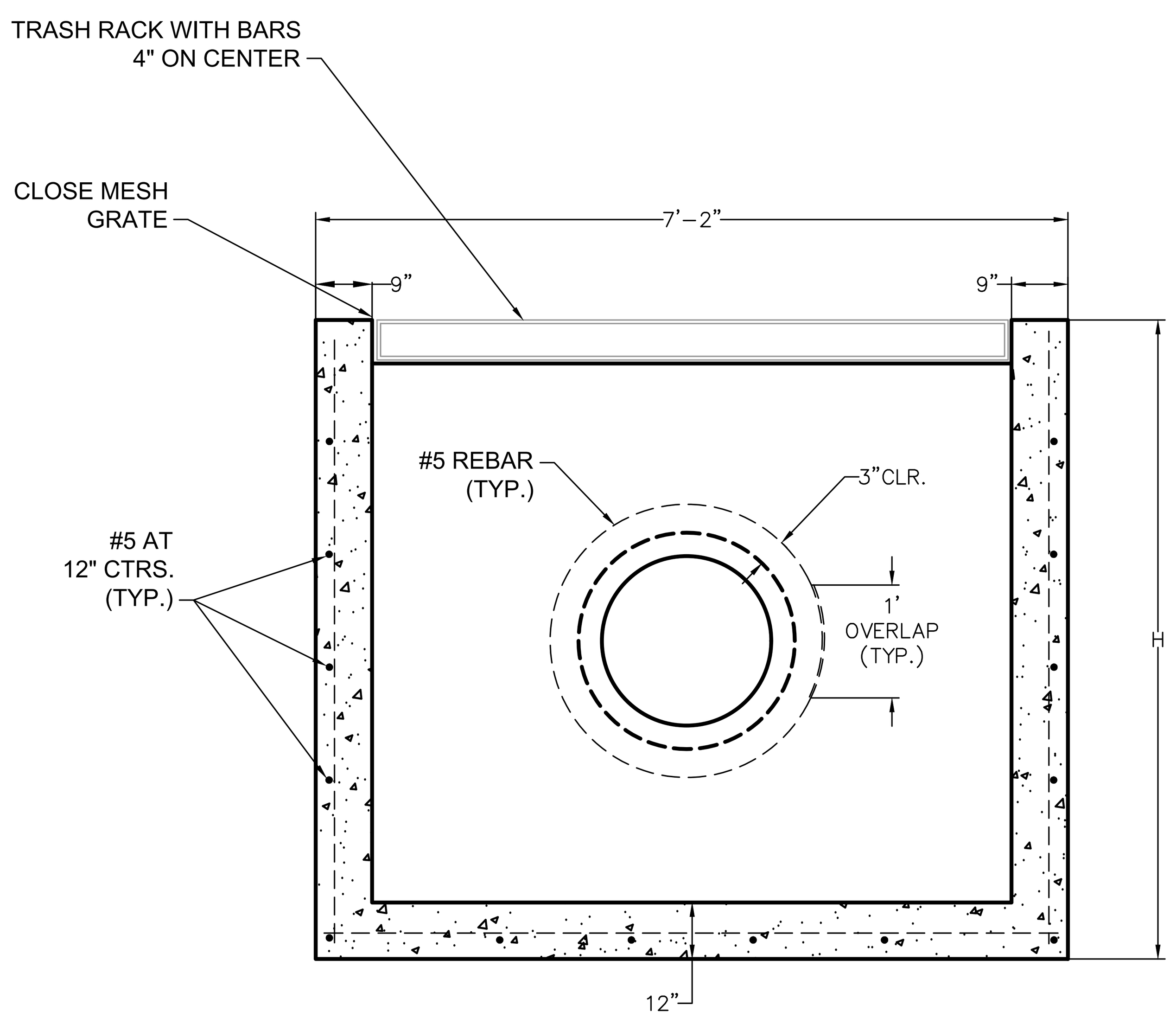
SECTION (E)
NTS



PLAN VIEW
(SHOWING ANCHOR BOLT LAYOUT)

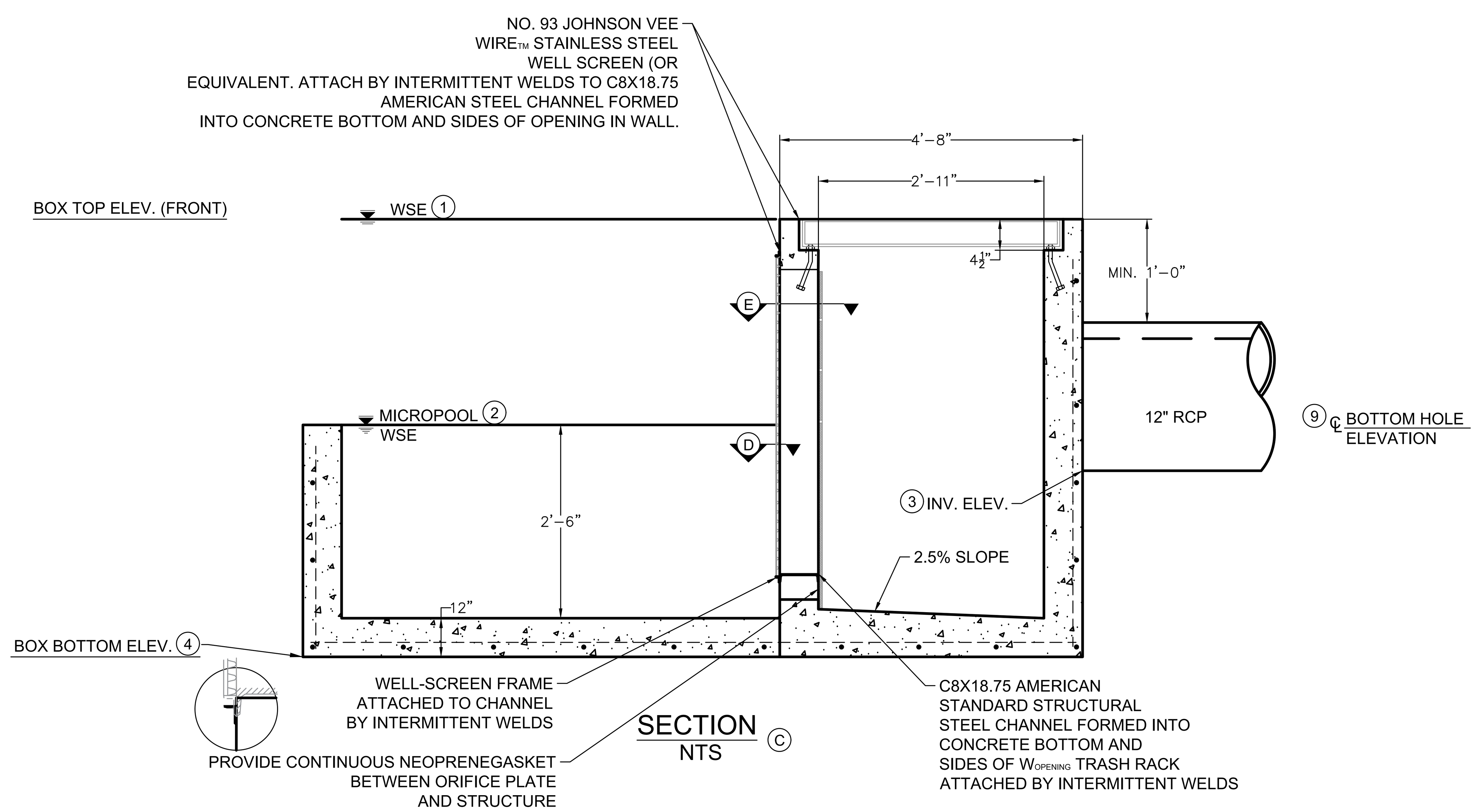


ORIFICE PLATE DETAIL
NTS

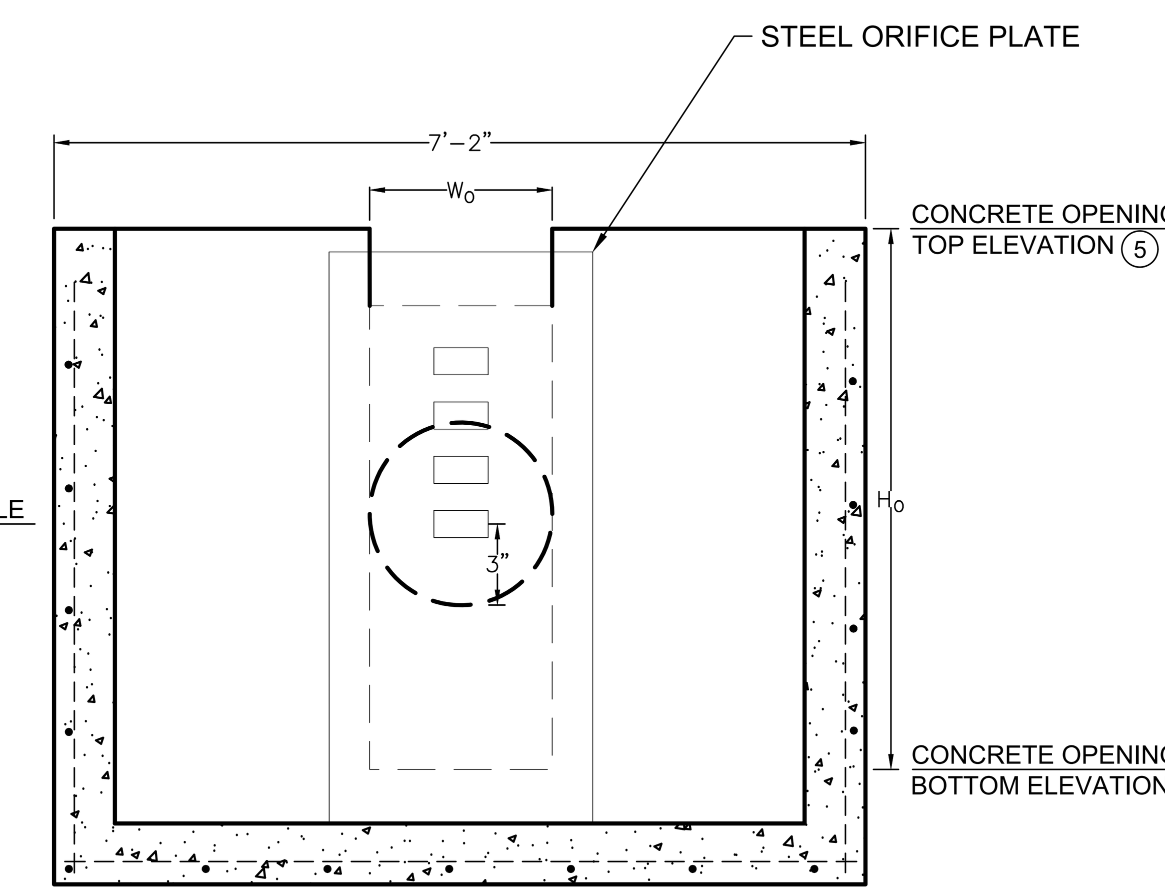


SECTION (B)
NTS

NOTE: REFER TO CDOT TYPE D INLET(M-604-11) FOR REINFORCING BAR SIZE & SPACING.



SECTION (C)
NTS



SECTION (A)
NTS

NOTE: SHOWN WITHOUT TRASH SCREEN

PREPARED BY:
Ascent Geomatics Solutions
8620 Wolff Court
Westminster, CO 80031

PREPARED FOR:
CONOCOPHILLIPS COMPANY
34501 E. QUINCY AVE., BLDG. 1
WATKINS, CO 80137

SHEET NAME: OUTLET STRUCTURE DETAILS

SURFACE LOCATION: E ½ SE ¼ SECTION 17, TOWNSHIP 4 SOUTH, RANGE 65 WEST, 6TH P.M., ARAPAHOE COUNTY, COLORADO

NO.	DATE:	REVISION DESCRIPTION	INT.
0	01/27/20	ISSUED FOR REVIEW	LM

FIELD DATE: 02-15-2018
DRAWING DATE: 01-24-2020
DRAFTED BY: LM
SHEET NO. D1