FINAL DRAINAGE REPORT
FOR
TIMBERRIDGE ESTATES
PART OF THE RETREAT AT TIMBERRIDGE
(NORTH OF ARROYA LANE)

March 2019

Prepared For:
TIMBERRIDGE ESTATES, LLC
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Prepared By:

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TNE Job No. 1733.00
County Job No. SF-18-027

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CERTIFICATION STATEMENT:

Engineers Statement

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

____
L DUCETT, P.E. 32339 Seal

Developers Statements

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

TIMBERRIDGE ESTATES, LLC.
Business Name

By:____
Title:____
Address:____
____

El Paso County Approval:

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

____ ________________________
Jennifer Irvine, Date
County Engineer / ECM Administrator

Conditions:

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PURPOSE

The purpose of this Final Drainage Report is to identify and analyze the proposed drainage patterns, determine proposed runoff quantities, size drainage structures for conveyance of developed runoff, and present solutions to drainage impacts on-site and off-site resulting from this development.

GENERAL DESCRIPTION

This Final Drainage Report (FDR) is an analysis of approximately 35.30 acres of undeveloped land located in the northern part of El Paso County off of Volmer Road and Arroya Lane. This site is being developed by our client to include 10 single family lots consisting of 2.5 acre lots. The site is located in the south west quarter of Section 22, Township 12 South, Range 65 West of the 6th Principal Meridian currently within El Paso County, Colorado. The site is bounded to the north, and west by open space (rural residential), to the east by Vantage Point farm (rural residential) and to the south by Arroya Lane. The site is contained within the Sand Creek Basin.

Soils for this project are delineated by the map in the appendix as Kettle gravelly loamy sand (40), 3 to 8 percent slopes, Kettle gravelly loamy sand (41), 8 to 40 percent slopes and Pring Coarse sandy loam (71), 3 to 8 percent slopes. Soils in the study area are shown as mapped by S.C.S. in the “Soils Survey of El Paso County Area” and contains soils of Hydrologic Group B.

FLOODPLAIN STATEMENT

No portion of this site is within a designated F.E.M.A. floodplain, as determined by Flood Insurance Rate Map No. 08041C0535 G, dated December 7, 2018 (see appendix).

EXISTING DRAINAGE CONDITIONS

The site is currently undeveloped and is open space. The site consists mostly of natural vegetative grass and weeds, with some areas of trees. The site has been broken down into five existing basins, one onsite basin and four offsite basins tributary to the site. Below is a description of these basins.

Basin OS-4A's 2.98 acres is an offsite basin located along the eastern boundary consisting of undeveloped open space. This basin is part of a parcel currently in use as a residential property, with the basin area being largely in a natural state. Runoff (Q_5=0.9 cfs and Q_{100}=6.5 cfs) sheet flows onto the southern half of the site (Design Point OS-1) and then is transported west across the site in existing channels to Design Point EX-1.

Basin OS-4B's 7.76 acres is an offsite basin located along the eastern boundary. This basin is part of a parcel currently in use as a residential property, with the basin area being largely in a natural state. Runoff (Q_5=1.8 cfs and Q_{100}=12.7 cfs) sheet flows to the southeast corner of the site, before flowing across Arroya Lane to the south (Design Point OS-2). Some of the flow at Design Point OS-2 may flow west along Arroya Lane for a short distance (less than 150 feet) before flowing across Arroya Lane to the south.

Basin OS-4C's 8.17 acres is an offsite basin located along the northern boundary consisting of undeveloped open space. This basin is part of two parcels currently in use as residential properties, with the basin area being largely in a natural state. Runoff (Q_5=1.6 cfs and Q_{100}=11.4 cfs) sheet flows onto the northern half of the site (Design Point OS-3) and then is transported southwest across the site in existing channels to Design Point EX-1.

Basin OS-4D's 3.39 acres is an offsite basin located along the northern boundary consisting of undeveloped open space. This basin is part of a parcel currently in use as a residential property, with the basin area being largely in a natural state. Runoff (Q_5=0.7 cfs and Q_{100}=5.4 cfs) sheet flows onto the northern half of the site (Design Point OS-4) and then is transported southwest across the site in existing channels to Design Point EX-1.

Basin EX-E1's 35.30 acres consists of undeveloped open space. Runoff (Q_5=6.5 cfs and Q_{100}=46.1 cfs) sheet flows to existing onsite drainage channels and then is routed southwest across the site in an existing channel to Design Point EX-1. At Design Point EX-1 the combined flow Q_5=11.5 cfs and Q_{100}=82.1 cfs of all four existing basins is routed south under Arroya Lane via an existing 60" CMP culvert.

PROPOSED DRAINAGE CONDITIONS

Runoff in the developed conditions consists of 16 basins, 10 onsite basins (including along Arroya Lane) and six offsite basins. Below is a description of the runoff in the developed conditions and how it will be safely routed, treated and detained. See appendix for calculations.

As in the existing condition Runoff (Q_5=1.6 cfs and Q_{100}=11.2 cfs) from Basin OS-1's 7.76 acres sheet flows to the southeast corner of the site before flowing across Arroya Lane to the south (Design Point OS-1). No modifications to the drainage of this basin are proposed as part of this development. Modifications to this basin can be expected when Arroya Lane is upgraded to a paved road (not a part of this development). Possible modifications to Arroya Lane include the installation of a culvert crossing to prevent overtopping at Design Point OS-1. Installation of a culvert at this location is not expected to affect the site (would be offsite) and would likely be entirely in the right of way of Arroya Lane.

Runoff (Q_5=0.9 cfs and Q_{100}=7.0 cfs) from Basin OS-2's 2.98 acres sheet and channel flows onto the eastern edge of the site and onto Basin A's 12.38 acres. Basin A will be comprised of large lot development. Runoff (Q_5=3.9 cfs and Q_{100}=21.4 cfs) sheet flow to existing channels. The combined flow (Q_5=4.8 cfs and Q_{100}=28.4 cfs) is routed west across the site via existing channels to a low point (Design Point 1). Dual 24" RCP culverts will route the flow under the new Nature Refuge Way road section and onto Basin C.

Runoff (Q_5=1.8 cfs and Q_{100}=12.9 cfs) from Basin OS-3's 8.17 acres sheet and channel flows (in an existing natural channel/swale) onto the northern half of the site and onto Basin C's 15.36 acres. Basin C will also be comprised of large lot development. Runoff (Q_5=4.8 cfs and Q_{100}=24.7 cfs) sheet flow to existing channels. The combined flow is routed southwest across the site via existing channels and proposed ditch sections to a proposed Full Spectrum Extended Detention Basin (Design Point 3).

Runoff (Q_5=0.8 cfs and Q_{100}= 6.1cfs) from Basin OS-4's 3.39 acres sheet and channel flows (in an existing natural channel/swale) onto the northern half of the site and onto Basin C's 15.36 acres. Basin C will also be comprised of large lot development. Runoff (Q_5=4.8 cfs and Q_{100}=24.7 cfs) sheet flow to existing channels. The combined flow is routed southwest across the site via existing channels to a proposed Full Spectrum Extended Detention Basin (Design Point 3).

Runoff (Q_5=0.7 cfs and Q_{100}=4.8 cfs) from Basin OS-5's 3.19 acres sheet and channel flows south onto Basin E before entering Sand Creek at Design Point 5. This basin is part of a parcel currently in use as a residential property, with the basin area being largely in a natural state.

Runoff (Q_5=1.2 cfs and Q_{100}=8.8 cfs) from Basin OS-6's 4.89 acres sheet and channel flows southeast onto Basin G before entering Sand Creek at Design Point 6. This basin is part of several parcels currently in use as a residential property or are undeveloped, with the basin area being largely in a natural state.

Basin A (12.38 acres) includes most of the eastern and southern portions of the site and is proposed for large residential lot development. Runoff (Q_5=3.9 cfs and Q_{100}=21.4 cfs) sheet and channels flows to a low point at the western side of the basin at Design Point 1. Dual 24" RCP culverts will route the flow under the new Nature Refuge Way road section and onto Basin C.

Basin A1 (1.83 acres) is an area consisting of the south and east side of the new Nature Refuge Way road and a small area off the road. Runoff (Q_5=2.7 cfs and Q_{100}=6.8 cfs) sheet and channels flows to a low point near the middle of the basin at Design Point 1. Dual 24" RCP culverts will route the flow under the new Nature Refuge Way road section and onto Basin C.

Basin B (1.66 acres) is an area consisting of the north and west side of the new Nature Refuge Way road and a small area off the road. Runoff (Q_5=2.1 cfs and Q_{100}=5.2 cfs) sheet and channels flows to a low point at the western side of the basin at Design Point 2, where it flows onto Basin C.

Basin C (15.36 acres) includes most of the western and northern portions of the site and is proposed for large residential lot development and the proposed Full Spectrum Extended Detention Basin. Runoff (Q_5=4.8 cfs and Q_{100}=24.7 cfs) sheet and channels flows to the detention basin in the southwest corner of the basin at Design Point 1. Outflow from the detention basin flows onto Basin E before flowing into Sand Creek.

Basin D (2.60 acres) is an area consisting of the north side of part of the existing Arroya Lane road and a small area north of the road. Runoff (Q_5=1.1 cfs and Q_{100}=4.7 cfs) sheet and channels flows to the west, where it crosses the new Nature Refuge Way road in proposed dual 24" RCP culverts and flows onto Basin E.

Basin E (1.04 acres) is an area consisting of the north side of part of the existing Arroya Lane road. Runoff (Q_5=1.8 cfs and Q_{100}=4.7 cfs) primarily channel flows to the west, where it enters Sand Creek at Design Point 5. Flows in Basin E are diverted to the Full Sprectrum Extended Detention Basin at point PR7, and this water flows back into Basin E after leaving the detention basin. Flows also enter Basin E from Basin D, the detention basin outfall, Basin F, and Basin OS-5 on their path to Sand Creek. Water quality for Basins D and half of Basin E are provided by the detention basin.

Basin F (0.72 acres) is an area on the western edge of the site that includes some area in large residential lot development and some area around the detention basin. Runoff (Q_5=0.2 cfs and Q_{100}=1.7 cfs) sheet flows to the southwest and onto Basin E.

Basin G (1.16 acres) is an area consisting of the north side of part of the existing Arroya Lane road. Runoff (Q_5=2.0 cfs and Q_{100}=5.1 cfs) primarily channel flows to the east, where it enters Sand Creek at Design Point 6. The WQCV from approximately two thirds of Basin G will be diverted to Sand Filter DP-7 by a 6" culvert crossing Arroya Lane for water quality treatment once the sand filter has been constructed and Arroya Lane has been paved.

Basin H (1.38 acres) is an area consisting of the south side of part of the existing Arroya Lane road. Runoff (Q_5=1.8 cfs and Q_{100}=4.7 cfs) primarily channel flows to the west, where it enters Sand Creek at Design Point 8. The WQCV from approximately two thirds of Basin H will be diverted to Sand Filter DP-8 by a 6” culvert for water quality treatment once the sand filter has been constructed and Arroya Lane has been paved.

Basin I (1.27 acres) is an area consisting of the south side of part of the existing Arroya Lane road. Runoff (Q_5=2.2 cfs and Q_{100}=5.6 cfs) primarily channel flows to the east, where it enters Sand Creek at Design Point 7. The WQCV from approximately two thirds of Basin I will be diverted to Sand Filter DP-7 by a 6” culvert for water quality treatment once the sand filter has been constructed and Arroya Lane has been paved.

At Design Point 3 the combined flow (Q_5=17.0 cfs and Q_{100}=84.1 cfs) of Basins OS-2, OS-3, OS-4, A, A1, B, C, D, and most of E will be captured in a 1.424 acre-foot Extended Detention Basin. Runoff entering the pond on the northeast side will be routed in the natural channel into a 192 cu-ft concrete lined forbay with a 1.5 feet high concrete cutoff wall. A 3 inch notch in the wall drains the flow to a 2’ concrete trickle channel then the runoff is routed to the 2.5’ deep micropool which has a 0.001 ac-ft Initial Surcharge Volume. Runoff entering the pond on the southeast side will be diverted from a swale, through an 18” culvert, and into a 10 cu-ft concrete lined forbay with a 1.0 feet high concrete cutoff wall. A 1 inch notch in the wall drains the flow to a 2’ concrete trickle channel then the runoff is routed to the same micropool. The 49.70 acres tributary to the EDB are 5.69% impervious (including asphalt pavement). Based upon this we need a WQCV of 0.169 ac-ft, an ERUV volume of 0.086 ac-ft and 100-year volume of 1.170 ac-ft for a total volume needed of 1.424 ac-ft. The micropool elevation is at 7247.00 while the ISV elevation is at 7247.33. The WQCV orifice starts at 7247 with 3 1-1/8 inch diameter holes spaced 8.00 inches apart. A 4’x4’ outlet structure is set at 7249.00, which corresponds to the EURV elevation. The 100-year elevation tops out at 7252.15. A 30” RCP outlet will release Q_5=0.1 cfs and Q_{100}=60.4 cfs discharge southwest to a riprap pad and then be routed to Design Point 5. The combined runoff at Design Point 5 is Q_5=21.9 cfs and Q_{100}=98.0.

A portion of the flows in Basins G and I will be diverted to the 0.024 ac-ft Sand Filter DP-7, which is near Design Point 7. The flow will be diverted through 6” culverts, which will limit the flow entering the sand filter. Runoff entering the sand filter will flow down a riprap rundown to the filter sand. After flowing through the filter sand, the runoff either infiltrates into the ground or flows through a 4” perforated pipe to the outlet structure, then through a 12” culvert back to the original swale. Any flow above the WQCV will enter the sand filter and flow directly into the outlet structure. The 2.43 acres tributary to the sand filter are 29.00% impervious (including asphalt pavement). Based upon this we need a WQCV of 0.024 ac-ft. No detention volume is included in the sand filter. The top of the filter sand is at an elevation of 7244.00 feet and the top of the WQCV is at 7245.00 feet. The underdrain pipe is caped with a 0.40” diameter orifice. A 1.5’X1.5’ outlet structure top is set at 7245.00 feet, which is the top of the WQCV. The 12” outlet culvert has several times the capacity of the inlet culvert to allow any extra water volume to flow back into the swale, and eventually Sand Creek.

A portion of the flows in Basin H will be diverted to the 0.013 ac-ft Sand Filter DP-8, which is near Design Point 8. The flow will be diverted through a 6” culvert, which will limit the flow entering the sand filter. Runoff entering the sand filter will flow down a riprap rundown to the filter sand. After flowing through the filter sand, the runoff either infiltrates into the ground or flows through a 4” perforated pipe to the outlet structure, then through a 12” culvert back to the original swale. Any flow above the WQCV will enter the sand filter and flow directly into the outlet structure. The 1.38 acres tributary to the sand filter are 27.00% impervious (including asphalt pavement). Based upon this we need a WQCV of 0.013 ac-ft. No detention volume is included in the sand filter. The top of the filter sand is at an elevation of 7244.25 feet and the top of the WQCV is at 7245.00 feet. The underdrain pipe is caped with a 0.30” diameter orifice. A 1.5’X1.5’ outlet structure top is set at 7245.00 feet, which is the top of the WQCV. The 12” outlet culvert has several times the capacity of the inlet culvert to allow any extra water volume to flow back into the swale, and eventually Sand Creek.

In an effort to protect receiving water and as part of the “four-step process to minimize adverse impacts of urbanization” this site was analyzed in the following manner:

1. Reduce Runoff- Runoff at the site will be collected in natural and grass swales before

being directed into Sand Creek. The low impervious area of the site and the use of pervious swales directly reduces runoff at the site. Additionally, the new improvements and impervious areas on the site will be routed to a proposed private Extended Detention Basin. These items will reduce the volume of runoff using ponding and infiltration.

2. Stabilize Drainageways- All of the proposed drainage channels are either existing natural channels or are grass swales. Additionally, the outflow of the Extended Detention Basin will be protected by riprap in the receiving channel. All of the proposed drainage channels that discharge into Sand Creek are grass swales.
3. Provide Water Quality Capture Volume (WQCV)- The Extended Detention Basin has been sized and designed to sufficiently capture the required WQCV and slowly release it though the three hole outlet, thereby allowing solids and contaminants to settle out.
4. Consider Need for Industrial and Commercial BMPs- As this is a residential development, industrial and commercial BMPs do not apply.

HYDROLOGIC CALCULATIONS

Hydrologic calculations were performed using the El Paso County Storm Drainage Design Criteria Manual - Volumes 1 & 2, latest editions. The Rational Method was used to estimate storm water runoff anticipated from design storms with 5-year and 100-year recurrence intervals. The Urban Drainage Criteria Manual was used to calculate the detention and water quality volume.

HYDRAULIC CALCULATIONS

Hydraulic calculations were estimated using the Manning's Formula and the methods described in the El Paso County Storm Drainage Design Criteria Manual – Volumes 1 & 2, latest editions. The pertinent data sheets are included in the appendix of this report.

A number of existing drainage channels are on the site, and a number of proposed drainage channels have been added along the roads. Preliminary proposed drainage easements for some of the existing drainage channels and cross sections of the proposed channels are shown on the Drainage Maps (see appendix). Actual drainage easements for the existing channels will be determined as part of the lot specific grading plans. Channel flow calculations have been included for both the existing and proposed drainage channels.

Culverts are proposed at the crossing of Sand Creek, for one detention basin inlet, for the detention basin outfall, for the inlets and outfalls of both sand filters, at the intersection of Arroya Lane and Nature Refuge Way, and at a low point on Nature Refuge Way. Design calculations have been included for the proposed culverts.

Box Culvert Bridge at Arroya Lane Crossing Sand Creek

The three 6'x12' box culverts at the Arroya Lane crossing of Sand Creek are classified as a bridge. These culverts have been designed to flow at 66.3% capacity during a 100 year storm event, which results in an internal freeboard of 2.0 feet and an inlet headwater of 10.5 feet.

The Drainage Criteria Manual (Section 6.4.2) requires a culvert classified as a bridge to have a minimum of 2 feet of freeboard (and headwater at least 2 feet below the below the top of the culvert opening). A few possible culvert designs that can provide the required 2 feet of freeboard are:

1. 6' tall x 126' (9-6'x14') wide culvert gives 4' headwater
2. 8' tall x 69' (5-8'x14') wide culvert gives 6' headwater
3. 10' tall x 45' (3-10'x15') wide culvert gives 7.9' headwater
4. 11.2' tall x 36' (3-11.2'x12') wide culvert gives 9.2' headwater

Note: The Sand Creek channel is 45-75 feet wide immediately upstream of the culvert location.

The 6'x126' design is infeasible because it is substantially wider than the Sand Creek channel.

The 8'x69' design would likely require widening of the Sand Creek channel to function properly, which is undesirable. There would also be a series of five large tunnels that would be visible for a considerable distance north and south of the culverts. This design would require over four times more materials/cost to construct than the 3-6'x12' design.

The 10'x45' design would fit within the existing Sand Creek channel and can be accommodated by the proposed Arroya Lane alignment. There would also be a series of three wide and tall tunnels that would be visible for a considerable distance north and south of the culverts. This design would require 3-4 times more materials/cost to construct than the 3-6'x12' design.

The 11.2'x36' design would require raising the proposed Arroya Lane alignment, widening the Sand Creek crossing, lengthening the culverts, and redesigning the culverts based on the new proposed conditions. Due to the large scale of design changes involved, this design was not further evaluated.

The 10'x45' design option is the only alternative currently considered feasible. However, this design has greater negative impacts to aesthetics, environmental disturbance, and cost than the currently proposed culvert. As all of the culvert designs are based on a multi barrel system, they all have the possibility of catching debris on the interior walls regardless of height. Additionally, there are no structures or critical facilities that would be in danger from flooding if debris were to block part of the culverts and backup water upstream of the culverts. As the currently proposed culvert design (3-6'x12') is the preferred option, a deviation request will be submitted with the final plat for the proposed culvert design.

MAINTENANCE

The Full Spectrum Extended Detention Basin, Sand Filter DP-7, Sand Filter DP-8, and the onsite storm drain systems are private and therefore must be maintained by the owner (TimberRidge Metro District). The culverts leading to and from the sand filters are public and will be maintained by the County. These should be checked and possibly cleaned after any significant precipitation event and at least once every three months. The proposed erosion control measures will be repaired and maintained by the property owner or owner's representative as required.

Access to the Full Spectrum Extended Detention Basin is proposed from Nature Refuge Way and/or Arroya Lane. Access to the proposed drainage easements will be from Nature Refuge Way and/or from Arroya Lane via the Extended Detention Basin. Access to the sand filters is proposed from the adjacent future roads.

CONSTRUCTION COST OPINION

Public Reimbursable

1. 12'x6' Box Culverts	306 LF	$ 800	$ 244,800
			Total $ 244,800

Note: The Sand Creek Drainage Basin Planning Study (March 1996), calls out the removal of an existing 60" CMP and the installation of a 6'H x 12'W CBC, 10-Yr capacity at the Arroya Lane crossing of Sand Creek.

Public Non-Reimbursable

1. 6" HDPE	312 LF	$ 65	$ 20,280
2. 12" HDPE	113 LF	$ 73	$ 8,249
3. 18" RCP	50 LF	$ 69	$ 3,450
4. 1'x1' Storm Inlet	2 EA	$ 1,000	$ 2,000
			Total $ 33,979

Private Non Reimbursable

1. 24" RCP	180 LF	$ 50	$ 9,000
2. EDB	1 EA	$ 20,000	$ 20,000
3. Sand Filter	2 EA	$ 15,000	$ 30,000
			Total $ 50,900

DRAINAGE FEES

The existing site is in the Sand Creek Basin. 2018 Drainage fees due prior to final plat recordation are as follows:

FEE TYPE	% IMP.	PARCEL AREA	MOD.	FEE PER IMP. AC.	SUBTOTAL
DRAINAGE FEES:	11% x	35.3 acres x	75% x	$17,197 =	$50,082
BRIDGE FEES:	11% x	35.3 acres x	100% x	$ 5,210 =	$20,230
					TOTAL $70,312

SUMMARY

Development of this site will not adversely affect the surrounding development. Proposed flows, as detailed in this report, will follow the drainage patterns outlined in this report showing how runoff will be safely routed downstream. The Full Spectrum Extended Detention Basin will control flow to historic levels and provide water quality for this site. These water features will need to be periodically maintained by the owner in order to maintain their effectiveness in cleaning the discharge from the site.

PREPARED BY:
TERRA NOVA ENGINEERING, INC.

L Ducett, P.E.
President
Jobs1733.00/drainage/drng report 1733fdr.doc

REFERENCE

"MDDP for the Retreat at TimberRidge" by Classic Consulting Engineers & Surveyors dated 2/22/18

El Paso County Drainage Criteria Manual-Volumes 1 & 2, latest edition

El Paso County Board Resolution No 15-042 (Adoption of Chapter 6 and Section 3.2.1 Chapter 13 of the City of Colorado Springs Drainage Criteria Manual dated May 2014, Hydrology and Full Spectrum Detention)

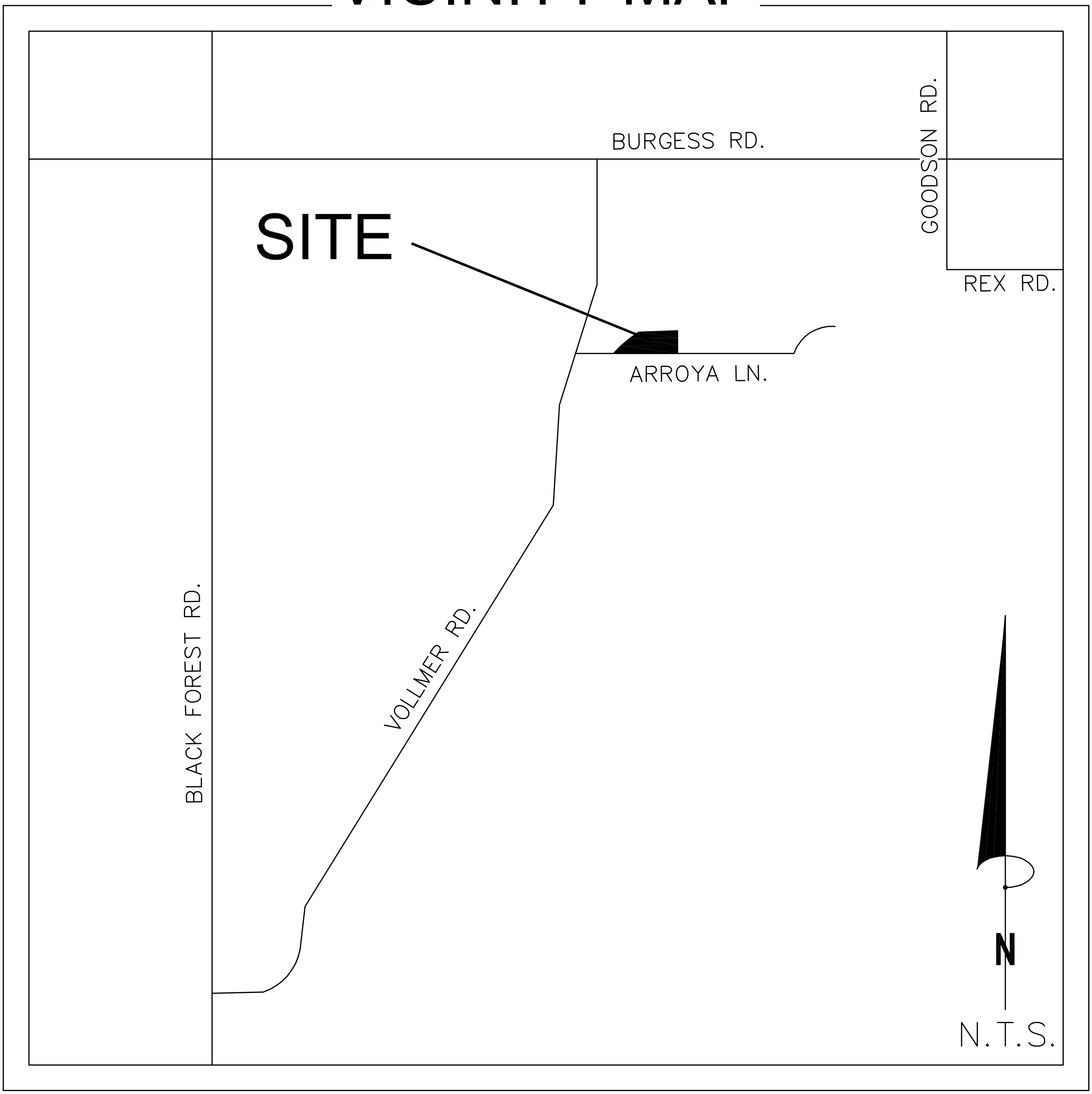
SCS Soils Map for El Paso County

Federal Emergency Management Agency (FEMA) flood maps

"Sand Creek Drainage Basin Planning Study, Preliminary Design Report" by Kiowa Engineering Corporation dated March 1996 (revised)

VICINITY MAP

VICINITY MAP



S.C.S. SOILS MAP

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Area of Interest (AOI) | **Soil Map** | Soil Data Explorer | Download Soils Data | Shopping Cart (Free)

Printable Version | Add to Shopping Cart

Search

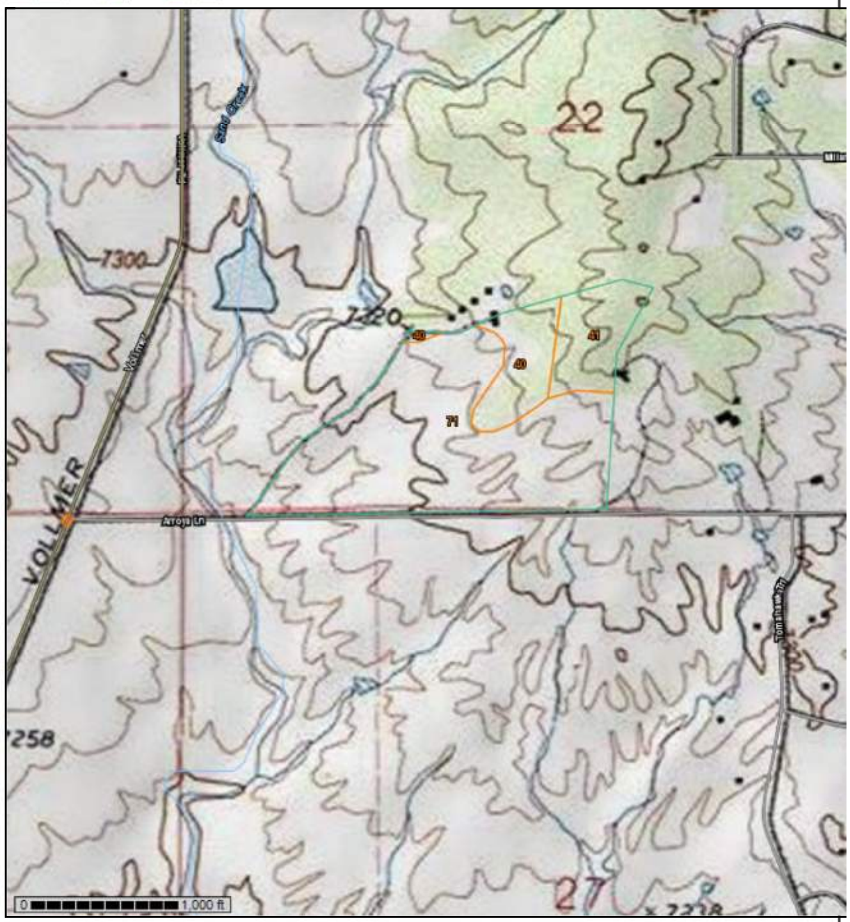
Map Unit Legend

El Paso County Area, Colorado (CO625)

El Paso County Area, Colorado (CO625)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
40	Kettle gravelly loamy sand, 3 to 8 percent slopes	7.9	13.1%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	8.2	13.6%
71	Pring coarse sandy loam, 3 to 8 percent slopes	44.2	73.3%
Totals for Area of Interest		**60.2**	**100.0%**

Soil Map

Scale (not to scale)



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

You have zoomed in beyond the scale at which the soil map for this area is intended to be used. Mappi AOI were mapped at 1:24,000. The design of map units and the level of detail shown in the resulting s

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mappi of contrasting soils that could have been shown at a more detailed scale.

Measure

Segment	Distance (Feet/Miles)	Distance (Meters/Kilometers)
Segment 1	1.02 miles	1.64 kilometers
Total Distance	1.02 miles	1.64 kilometers

FOIA | Accessibility Statement | Privacy Policy | Non-Discrimination Statement | Information Quality | USA.gov | White House

Hydrologic Soil Group: B

FEMA FIRM MAP

NOTES TO USERS

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

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

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

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

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

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

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

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

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

Base Map information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, and Anderson Consulting Engineers, Inc. These data are current as of 2006.

This map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map. The profile baselines depicted on this map represent the hydraulic modeling baselines that match the flood profiles and Floodway Data Tables if applicable, in the FIS report. As a result, the profile baselines may deviate significantly from the new base map channel representation and may appear outside of the floodplain.

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

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

Contact **FEMA Map Service Center** (MSC) via the FEMA Map Information eXchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. The MSC may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

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

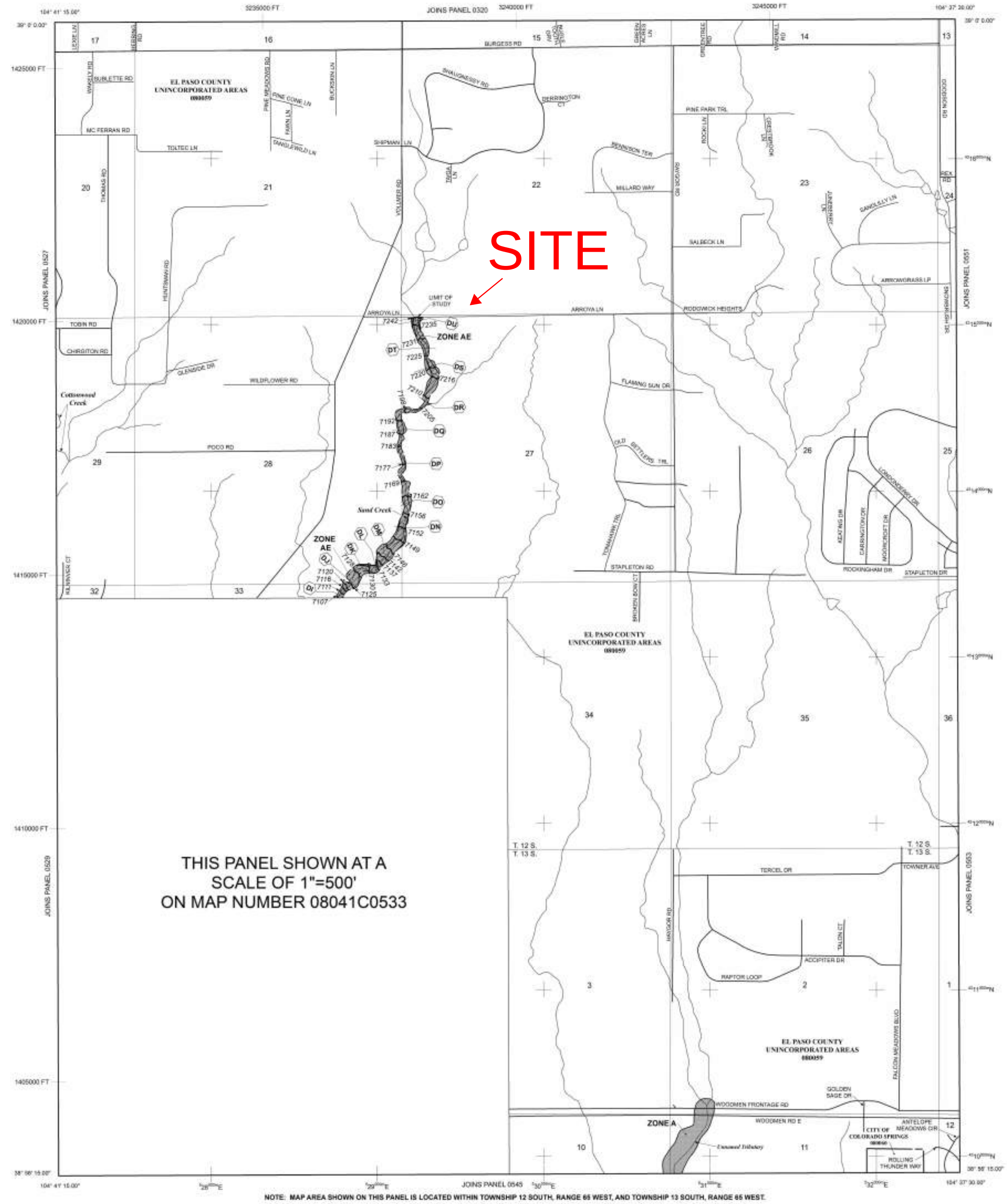
El Paso County Vertical Datum Offset Table

Flooding Source	Vertical Datum Offset (ft)
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION	

Panel Location Map

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

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



NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 12 SOUTH, RANGE 65 WEST, AND TOWNSHIP 13 SOUTH, RANGE 65 WEST.

LEGEND

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

FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

OTHER AREAS

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

MAP SCALE 1" = 1000'

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0535G

FIRM
FLOOD INSURANCE RATE MAP
EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 535 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

MAP NUMBER 08041C0535G

MAP REVISED DECEMBER 7, 2018

Federal Emergency Management Agency

HYDROLOGIC CALCULATIONS

TIMBERRIDGE ESTATES
(Area Runoff Coefficient Summary)

EXISTING CONDITIONS

		STREETS / DEVELOPED			OVERLAND / UNDEVELOPED			WEIGHTED	
BASIN	TOTAL AREA (Acres)	AREA (Acres)	C_5	C_{100}	AREA (Acres)	C_5	C_{100}	C_5	C_{100}
EX-E1	35.30	0.00	0.90	0.96	35.30	0.08	0.35	0.08	0.35
OS-4A	2.98	0.00	0.90	0.96	2.98	0.08	0.35	0.08	0.35
OS-4B	7.76	0.00	0.90	0.96	7.76	0.08	0.35	0.08	0.35
OS-4C	8.17	0.00	0.90	0.96	8.17	0.08	0.35	0.08	0.35
OS-4D	3.39	0.00	0.90	0.96	3.39	0.08	0.35	0.08	0.35

Calculated by: DLF
Date: 8/9/2018
Checked by: ____________

TIMBERRIDGE ESTATES
(Area Runoff Coefficient Summary)

DEVELOPED CONDITIONS

		STREETS / DEVELOPED			*OVERLAND / UNDEVELOPED*			*WEIGHTED*	
BASIN	**TOTAL AREA** *(Acres)*	**AREA** *(Acres)*	**C_5**	**C_{100}**	**AREA** *(Acres)*	**C_5**	**C_{100}**	**C_5**	**C_{100}**
OS-1	7.76	0.00	0.90	0.96	7.76	0.08	0.35	0.08	0.35
OS-2	2.98	0.00	0.90	0.96	2.98	0.08	0.35	0.08	0.35
OS-3	8.17	0.00	0.90	0.96	8.17	0.08	0.35	0.08	0.35
OS-4	3.39	0.00	0.90	0.96	3.39	0.08	0.35	0.08	0.35
OS-5	3.19	0.00	0.90	0.96	3.19	0.08	0.35	0.08	0.35
OS-6	4.89	0.00	0.90	0.96	4.89	0.08	0.35	0.08	0.35
A	12.38	0.51	0.90	0.96	11.87	0.08	0.35	0.11	0.37
A1	1.83	0.73	0.90	0.96	1.10	0.08	0.35	0.41	0.59
B	1.66	0.66	0.90	0.96	0.99	0.08	0.35	0.41	0.59
C	15.36	0.76	0.90	0.96	14.60	0.08	0.35	0.12	0.38
D	2.60	0.26	0.90	0.96	2.34	0.08	0.35	0.16	0.41
E	1.04	0.42	0.90	0.96	0.62	0.08	0.35	0.41	0.59
F	0.72	0.00	0.90	0.96	0.72	0.08	0.35	0.08	0.35
G	1.16	0.46	0.90	0.96	0.70	0.08	0.35	0.41	0.59
H	1.38	0.55	0.90	0.96	0.83	0.08	0.35	0.41	0.59
I	1.27	0.51	0.90	0.96	0.76	0.08	0.35	0.41	0.59

Calculated by: DLF
Date: 8/9/2018
Checked by: ______

TIMBERRIDGE ESTATES
AREA DRAINAGE SUMMARY

EXISTING CONDITIONS

		WEIGHTED		*OVERLAND*				*STREET / CHANNEL FLOW*				*T_t*	*INTENSITY*		*TOTAL FLOWS*	
BASIN	AREA TOTAL *(Acres)*	C_5	C_{100}	C_5	Length *(ft)*	Height *(ft)*	T_C *(min)*	Length *(ft)*	Slope *(%)*	Velocity *(fps)*	T_t *(min)*	TOTAL *(min)*	I_5 *(in/hr)*	I_{100} *(in/hr)*	Q_5 *(c.f.s.)*	Q_{100} *(c.f.s.)*
		* For Calcs See Runoff Summary														
EX-E1	35.30	0.08	0.35	0.08	300	16.0	10.5	2148	5.0%	1.5	23.9	34.3	2.3	3.7	**6.5**	**46.1**
OS-4A	2.98	0.08	0.35	0.08	300	25.0	9.0	390	5.0%	1.5	4.3	13.4	3.6	6.2	**0.9**	**6.5**
OS-4B	7.76	0.08	0.35	0.08	300	20.0	9.7	1220	5.0%	1.5	13.6	23.3	2.8	4.7	**1.8**	**12.7**
OS-4C	8.17	0.08	0.35	0.08	300	20.0	9.7	1150	1.7%	0.9	21.3	31.0	2.4	4.0	**1.6**	**11.4**
OS-4D	3.39	0.08	0.35	0.08	300	20.0	9.7	800	1.7%	0.9	14.8	24.5	2.8	4.5	**0.7**	**5.4**

DEVELOPED CONDITIONS

		WEIGHTED		*OVERLAND*				*STREET / CHANNEL FLOW*				*T_t*	*INTENSITY*		*TOTAL FLOWS*	
BASIN	AREA TOTAL *(Acres)*	C_5	C_{100}	C_5	Length *(ft)*	Height *(ft)*	T_C *(min)*	Length *(ft)*	Slope *(%)*	Velocity *(fps)*	T_t *(min)*	TOTAL *(min)*	I_5 *(in/hr)*	I_{100} *(in/hr)*	Q_5 *(c.f.s.)*	Q_{100} *(c.f.s.)*
		* For Calcs See Runoff Summary														
OS-1	7.76	0.08	0.35	0.09	300	20.0	9.6	1300	5.0%	1.1	19.4	29.0	2.5	4.1	**1.6**	**11.2**
OS-2	2.98	0.08	0.35	0.09	100	25.0	4.0	500	5.0%	1.1	7.5	11.4	3.9	6.7	**0.9**	**7.0**
OS-3	8.17	0.08	0.35	0.09	300	20.0	9.6	1100	5.7%	1.2	15.4	25.0	2.7	4.5	**1.8**	**12.9**
OS-4	3.39	0.08	0.35	0.09	300	20.0	9.6	650	4.9%	1.1	9.8	19.4	3.1	5.2	**0.8**	**6.1**
OS-5	3.19	0.08	0.35	0.09	300	35.0	8.0	1300	5.1%	1.1	19.2	27.2	2.6	4.3	**0.7**	**4.8**
OS-6	4.89	0.08	0.35	0.09	300	15.0	10.6	600	5.1%	1.1	8.9	19.4	3.1	5.2	**1.2**	**8.8**
A	12.38	0.11	0.37	0.09	284	16.0	10.0	1226	4.4%	1.5	13.9	23.9	2.8	4.6	**3.9**	**21.4**
A1	1.83	0.41	0.59	0.09	50	4.0	4.4	844	5.2%	1.6	8.8	13.2	3.7	6.3	**2.7**	**6.8**
B	1.66	0.41	0.59	0.09	129	9.0	6.8	1098	5.1%	1.6	11.6	18.3	3.2	5.3	**2.1**	**5.2**
C	15.36	0.12	0.38	0.09	226	20.0	7.8	1780	4.5%	1.5	20.0	27.8	2.6	4.2	**4.8**	**24.7**
D	2.60	0.16	0.41	0.09	108	6.0	6.8	1448	3.1%	1.2	19.6	26.4	2.7	4.4	**1.1**	**4.7**
E	1.04	0.41	0.59	0.09	30	2.0	3.8	825	4.6%	3.2	4.3	8.1	4.4	7.7	**1.8**	**4.7**
F	0.72	0.08	0.35	0.09	150	10.0	7.3	335	6.0%	1.7	3.3	10.6	4.0	6.9	**0.2**	**1.7**
G	1.16	0.41	0.59	0.09	30	2.0	3.8	934	3.9%	3.0	5.3	9.1	4.2	7.4	**2.0**	**5.1**
H	1.38	0.41	0.59	0.09	58	2.0	6.2	904	5.3%	3.5	4.4	10.6	4.0	6.9	**2.2**	**5.7**
I	1.27	0.41	0.59	0.09	30	2.0	3.8	934	3.9%	3.0	5.3	9.1	4.2	7.4	**2.2**	**5.6**

Calculated by: DLF

Date: 8/9/2018

Checked by: ____________

TIMBERRIDGE ESTATES
PROPOSED SURFACE ROUTING SUMMARY

Design Point(s)	*Contributing Basins*	*Area Ac*	*Flow*	
			Q_5	*Q_{100}*
EX-1	**EX-E1,OS-4A, OS-4B, OS-4C, & OS-4D**	57.60	***11.5***	***82.1***
1	**OS-2, A & A1**	17.18	***6.7***	***24.9***
2	**OS-2, A, A1 & B**	59.26	***9.7***	***40.4***
3	**OS-1, OS-2, A, A1, B, & C**	82.37	***16.1***	***76.4***
4	**D**	2.60	***1.1***	***4.7***
5	**OS-1, OS-2, OS-4, A, A1, B, C, D, E, & F**	90.13	***20.1***	***93.7***
6	**OS-5 & G**	9.21	***2.7***	***9.9***
7	**I**	1.27	***2.2***	***5.6***
8	**H**	1.38	***2.2***	***5.7***
OS-1	**OS-1**	7.76	***1.6***	***11.2***
OS-2	**OS-2**	2.98	***0.9***	***7.0***
OS-3	**OS-3**	8.17	***1.8***	***12.9***
OS-4	**OS-4**	3.39	***0.8***	***6.1***
OS-5	**OS-5**	3.19	***0.7***	***4.8***
OS-6	**OS-6**	4.89	***1.2***	***8.8***

Calculated by: DLF
Date: 8/9/2018
Checked by: ______

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.

HYDRAULIC CALCULATIONS

OPEN CHANNEL FLOW CALCULATION NOTES

1. Point EX3 is the point with the steepest slope along that existing drainage path.
2. Point EX6 is the point with the shallowest slope / widest flow width along that existing drainage path.
3. Point EX11 is the point with the shallowest slope / widest flow width along that existing drainage path.
4. Point EX12 is the point with the steepest slope along that existing drainage path.
5. Point EX13 is the point with the steepest slope along that existing drainage path.

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project:	**Timber Rider Estates**		Location:	Point EX1 - Min 100 Yr Channel Size (Q=1.2 cfs)	
By:	Dane Frank	Date:	5/31/2018		
Chk By:		Date:			version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

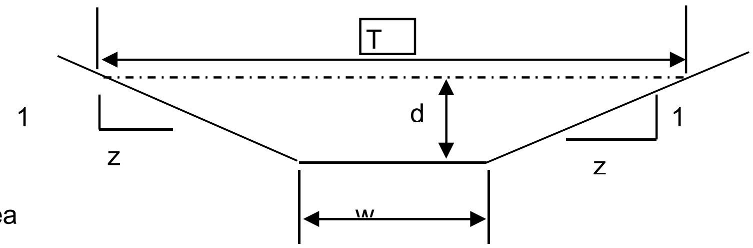
$R = A/P$

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$V = (1.49/n)R_h^{2/3}S^{1/2}$

$Q = V \times A$

INPUT	
z (sideslope)=	11.3
z (sideslope)=	17.5
b (btm width, ft)=	0
d (depth, ft)=	0.22
S (slope, ft/ft)	0.026
n_{low} =	0.03
n_{high} =	0.03

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.22	0.70	6.35	0.11	1.8304196	1.27573	1.83042	1.27573	T =	6.336
								Dm =	0.110

Sc low =	0.0274	Sc high =	0.0274
.7 Sc	1.3 Sc	.7 Sc	1.3 Sc
0.0192	0.0357	0.0192	0.0357

s_c = critical slope ft / ft

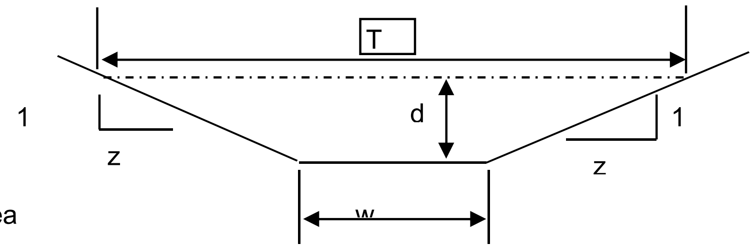
T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project:	**Timber Rider Estates**		Location:	Point EX1 - 100 Yr Flow Plus 1' Depth	
By:	Dane Frank	Date:	10/15/2018		
Chk By:		Date:			version 12-2004



INPUT	
z (sideslope)=	11.3
z (sideslope)=	17.5
b (btm width, ft)=	0
d (depth, ft)=	1.22
S (slope, ft/ft)	0.026
n_{low} =	0.03
n_{high} =	0.03

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient

$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
1.22	21.43	35.22	0.61	5.73500177	122.918	5.735002	122.918	T =	35.136
								Dm =	0.610
				Sc low =	0.0155	Sc high =	0.0155		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0109	0.0202	0.0109	0.0202		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

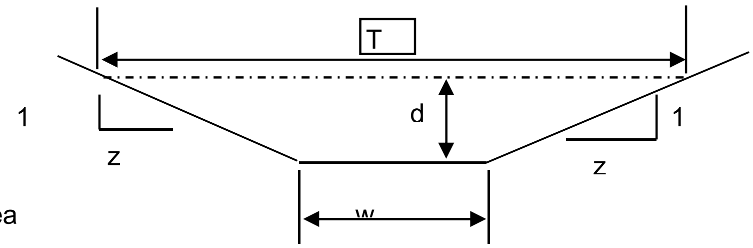
Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point EX2 - Min 100 Yr Channel Size (Q=7.1 cfs)

By: Dane Frank Date: 5/31/2018

Chk By: Date: version 12-2004



Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient

$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

	INPUT
z (sideslope)=	11.5
z (sideslope)=	12
b (btm width, ft)=	8
d (depth, ft)=	0.2
S (slope, ft/ft)	0.056
n_{low} =	0.03
n_{high} =	0.03

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.2	2.07	12.72	0.16	3.49426452	7.23313	3.494265	7.23313	T =	12.7
								Dm =	0.163
				Sc low =	0.0240	Sc high =	0.0240		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0168	0.0312	0.0168	0.0312		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point EX2 - 100 Yr Flow Plus 1' Depth

By: Dane Frank Date: 10/15/2018

Chk By: Date: version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

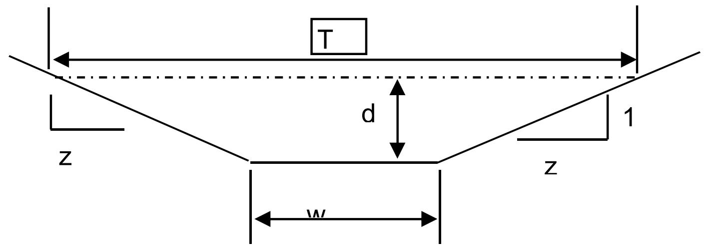
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

INPUT	
z (sideslope)=	11.5
z (sideslope)=	12
b (btm width, ft)=	8
d (depth, ft)=	1.2
S (slope, ft/ft)	0.056
n_{low} =	0.03
n_{high} =	0.03

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
1.2	26.52	36.30	0.73	9.50785218	252.148	9.507852	252.148	T =	36.2
								Dm =	0.733
				Sc low =	0.0146	Sc high =	0.0146		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0102	0.0190	0.0102	0.0190		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

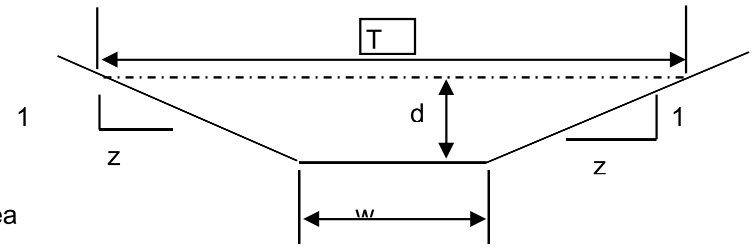
Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point EX3 - Min 100 Yr Channel Size (Q=18.5 cfs)

By: Dane Frank Date: 5/31/2018

Chk By: Date: version 12-2004



Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient

$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

INPUT	
z (sideslope)=	7.2
z (sideslope)=	7.9
b (btm width, ft)=	0
d (depth, ft)=	0.7
S (slope, ft/ft)	0.044
n_{low} =	0.03
n_{high} =	0.03

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.7	3.70	10.66	0.35	5.13016161	18.979	5.130162	18.979	T =	10.57
								Dm =	0.350
				Sc low =	0.0188	Sc high =	0.0188		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0132	0.0245	0.0132	0.0245		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project:	**Timber Rider Estates**		Location:	Point EX3 - 100 Yr Flow Plus 1' Depth
By:	Dane Frank	Date:	10/15/2018	
Chk By:		Date:		version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

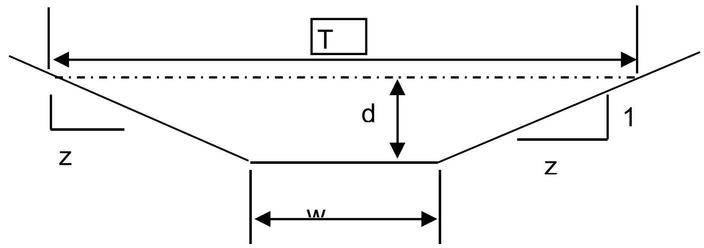
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

	INPUT
z (sideslope)=	7.2
z (sideslope)=	7.9
b (btm width, ft)=	0
d (depth, ft)=	1.7
S (slope, ft/ft)	0.044
n_{low} =	0.03
n_{high} =	0.03

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
1.7	21.82	25.89	0.84	9.26924752	202.25	9.269248	202.25	T =	25.67
								Dm =	0.850
				Sc low =	0.0140	Sc high =	0.0140		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0098	0.0182	0.0098	0.0182		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point EX4 - Min 100 Yr Channel Size (Q=23.9 cfs)

By: Dane Frank Date: 5/31/2018

Chk By: Date:

version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

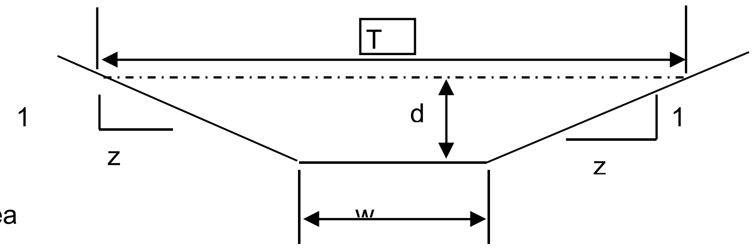
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

INPUT	
z (sideslope)=	7.5
z (sideslope)=	6.5
b (btm width, ft)=	0
d (depth, ft)=	0.77
S (slope, ft/ft)	0.049
n_{low} =	0.03
n_{high} =	0.03

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.77	4.15	10.89	0.38	5.76345528	23.9201	5.763455	23.9201	T =	10.78
								Dm =	0.385

Sc low =	0.0183	Sc high =	0.0183

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

.7 Sc	1.3 Sc	.7 Sc	1.3 Sc
0.0128	0.0237	0.0128	0.0237

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point EX4 - 100 Yr Flow Plus 1' Depth

By: Dane Frank Date: 10/15/2018

Chk By: Date: version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

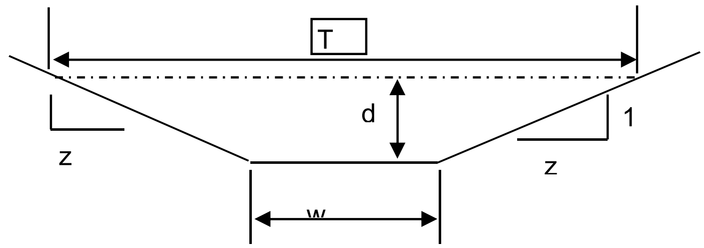
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

INPUT	
z (sideslope)=	7.5
z (sideslope)=	6.5
b (btm width, ft)=	0
d (depth, ft)=	1.77
S (slope, ft/ft)	0.049
n_{low} =	0.03
n_{high} =	0.03

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
1.77	21.93	25.03	0.88	10.0388355	220.155	10.03884	220.155	T =	24.78
								Dm =	0.885
				Sc low =	0.0138	Sc high =	0.0138		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0097	0.0180	0.0097	0.0180		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

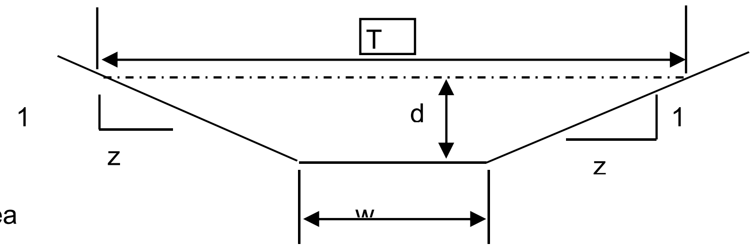
MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point EX5 - Min 100 Yr Channel Size (Q=26.3 cfs)

By: Dane Frank Date: 10/1/2018

Chk By: Date:

version 12-2004



Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient

$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

INPUT	
z (sideslope)=	22
z (sideslope)=	15
b (btm width, ft)=	0
d (depth, ft)=	0.67
S (slope, ft/ft)	0.016
n_{low} =	0.03
n_{high} =	0.03

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.67	8.30	24.83	0.33	3.01902652	25.072	3.019027	25.072	T =	24.79
								Dm =	0.335
				Sc low =	0.0189	Sc high =	0.0189		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0132	0.0246	0.0132	0.0246		

s_c = critical slope ft / ft

T = top width of the stream

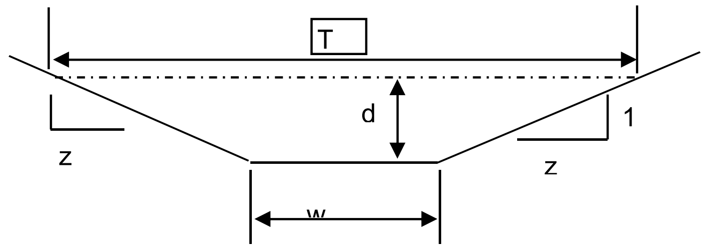
d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project:	**Timber Rider Estates**	Location:	Point EX5 - 100 Yr Flow Plus 1' Depth
By:	Dane Frank	Date:	10/15/2018
Chk By:		Date:	

version 12-2004



Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient

$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

INPUT	
z (sideslope)=	22
z (sideslope)=	15
b (btm width, ft)=	0
d (depth, ft)=	1.67
S (slope, ft/ft)	0.016
n_{low} =	0.03
n_{high} =	0.03

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
1.67	51.59	61.88	0.83	5.55019099	286.36	5.550191	286.36	T =	61.79
								Dm =	0.835
				Sc low =	0.0139	Sc high =	0.0139		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0098	0.0181	0.0098	0.0181		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point EX6 - Min 100 Yr Channel Size (Q=35.5 cfs)

By: Dane Frank Date: 10/1/2018

Chk By: Date:

version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

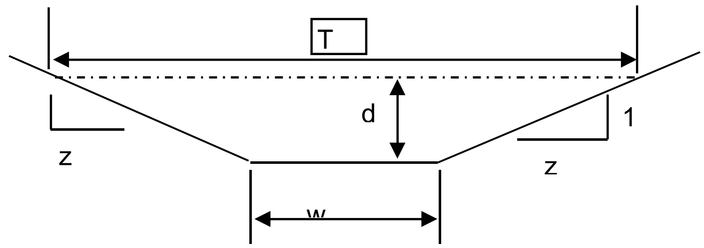
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

INPUT	
z (sideslope)=	16
z (sideslope)=	30
b (btm width, ft)=	0
d (depth, ft)=	0.71
S (slope, ft/ft)	0.016
n_{low} =	0.03
n_{high} =	0.03

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.71	11.59	32.69	0.35	3.13901621	36.3947	3.139016	36.3947	T =	32.66
								Dm =	0.355
				Sc low =	0.0185	Sc high =	0.0185		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0130	0.0241	0.0130	0.0241		

s_c = critical slope ft / ft

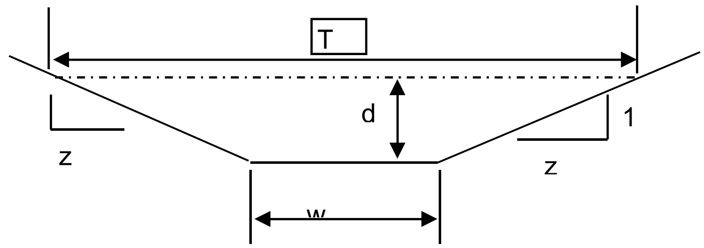
T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point EX6 - 100 Yr Flow Plus 1' Depth
By: Dane Frank Date: 10/15/2018
Chk By: Date: version 12-2004



INPUT	
z (sideslope)=	16
z (sideslope)=	30
b (btm width, ft)=	0
d (depth, ft)=	1.71
S (slope, ft/ft)	0.016
n_{low} =	0.03
n_{high} =	0.03

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

R = A/P
A = cross sectional area
P= wetted perimeter
S = slope of channel
n = Manning's roughness coefficient

$V = (1.49/n)R_h^{2/3}S^{1/2}$
Q = V x A

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
1.71	67.25	78.74	0.85	5.64024701	379.331	5.640247	379.331	T =	78.66
								Dm =	0.855
				Sc low =	0.0138	Sc high =	0.0138		

s_c = critical slope ft / ft
T = top width of the stream
d_m = a/T = mean depth of flow

.7 Sc	1.3 Sc	.7 Sc	1.3 Sc
0.0097	0.0180	0.0097	0.0180

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point EX7 - Min 100 Yr Channel Size (Q=7.6 cfs)

By: Dane Frank Date: 5/31/2018

Chk By: Date: version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

R = A/P

A = cross sectional area

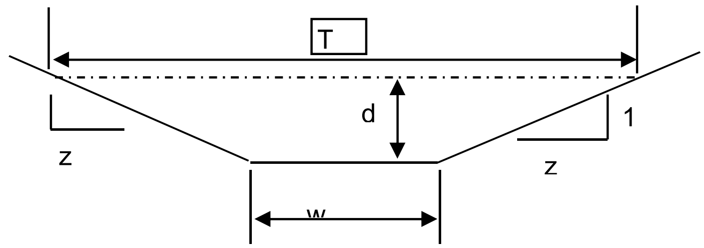
P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient

$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A



INPUT	
z (sideslope)=	6.7
z (sideslope)=	16.8
b (btm width, ft)=	0
d (depth, ft)=	0.4
S (slope, ft/ft)	0.061
n_{low} =	0.03
n_{high} =	0.03

Clear Data Entry Cells

Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Low N Velocity, fps	Low N Flow, cfs	High N Velocity, fps	High N Flow, cfs		
0.4	1.88	9.44	0.20	4.17139395	7.84222	4.171394	7.84222	T =	9.4
								Dm =	0.200
				Sc low =	0.0225	Sc high =	0.0225		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0158	0.0293	0.0158	0.0293		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

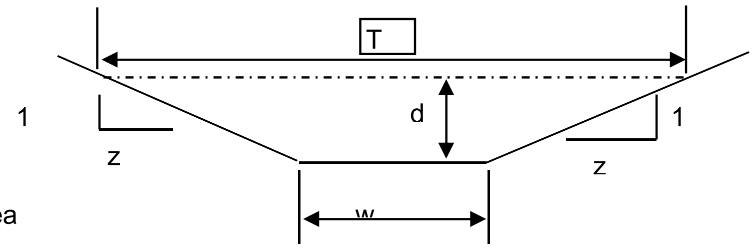
MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point EX7 - 100 Yr Flow Plus 1' Depth

By: Dane Frank Date: 10/15/2018

Chk By: Date:

version 12-2004



	INPUT
z (sideslope)=	6.7
z (sideslope)=	16.8
b (btm width, ft)=	0
d (depth, ft)=	1.4
S (slope, ft/ft)	0.061
n_{low} =	0.03
n_{high} =	0.03

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient

$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
1.4	23.03	33.05	0.70	9.61637458	221.465	9.616375	221.465	T =	32.9
								Dm =	0.700
				Sc low =	0.0148	Sc high =	0.0148		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

.7 Sc	1.3 Sc	.7 Sc	1.3 Sc
0.0104	0.0193	0.0104	0.0193

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project:	**Timber Rider Estates**		Location:	Point EX8 - Min 100 Yr Channel Size (Q=19.8 cfs)
By:	Dane Frank	Date:	5/31/2018	
Chk By:		Date:		version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

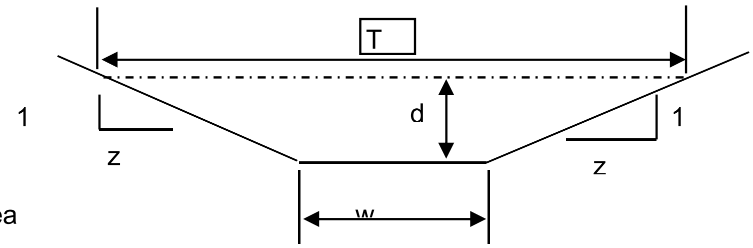
$R = A/P$

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$V = (1.49/n)R_h^{2/3}S^{1/2}$

$Q = V \times A$

INPUT	
z (sideslope)=	7.5
z (sideslope)=	11.5
b (btm width, ft)=	0
d (depth, ft)=	0.7
S (slope, ft/ft)	0.032
n_{low} =	0.03
n_{high} =	0.03

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.7	4.66	13.38	0.35	4.38363847	20.4058	4.383638	20.4058	T =	13.3
								Dm =	0.350
				Sc low =	0.0187	Sc high =	0.0187		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0131	0.0244	0.0131	0.0244		

s_c = critical slope ft / ft

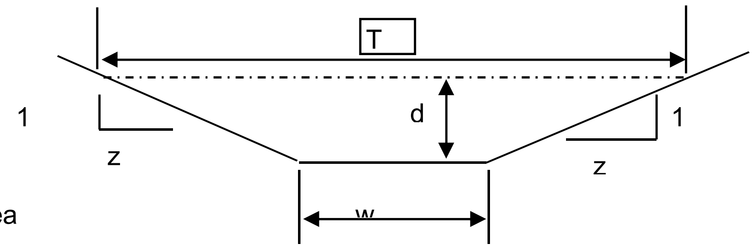
T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project:	**Timber Rider Estates**		Location:	Point EX8 - 100 Yr Flow Plus 1' Depth	
By:	Dane Frank	Date:	10/15/2018		
Chk By:		Date:			version 12-2004



INPUT	
z (sideslope)=	7.5
z (sideslope)=	11.5
b (btm width, ft)=	0
d (depth, ft)=	1.7
S (slope, ft/ft)	0.032
n_{low} =	0.03
n_{high} =	0.03

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient

$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
1.7	27.46	32.49	0.85	7.92041909	217.455	7.920419	217.455	T =	32.3
								Dm =	0.850
				Sc low =	0.0139	Sc high =	0.0139		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0098	0.0181	0.0098	0.0181		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project:	**Timber Rider Estates**		Location:	Point EX9 - Min 100 Yr Channel Size (Q=26.3 cfs)
By:	Dane Frank	Date:	6/6/2018	
Chk By:		Date:		version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

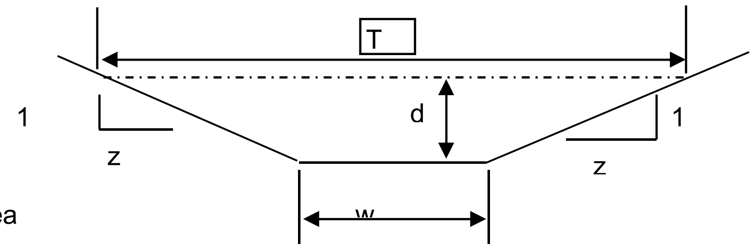
$R = A/P$

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$V = (1.49/n)R_h^{2/3}S^{1/2}$

$Q = V \times A$

INPUT	
z (sideslope)=	4
z (sideslope)=	4
b (btm width, ft)=	0
d (depth, ft)=	1.04
S (slope, ft/ft)	0.039
n_{low} =	0.03
n_{high} =	0.03

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
1.04	4.33	8.58	0.50	6.1988701	26.8188	6.19887	26.8188	T =	8.32
								Dm =	0.520
				Sc low =	0.0170	Sc high =	0.0170		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0119	0.0221	0.0119	0.0221		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

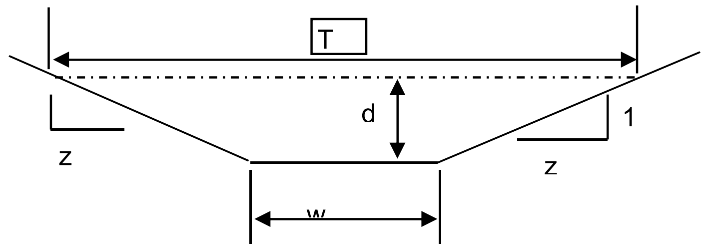
MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point EX9 - 100 Yr Flow Plus 1' Depth

By: Dane Frank Date: 10/15/2018

Chk By: Date:

version 12-2004



Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient

$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

INPUT	
z (sideslope)=	4
z (sideslope)=	4
b (btm width, ft)=	0
d (depth, ft)=	2.04
S (slope, ft/ft)	0.039
n_{low} =	0.03
n_{high} =	0.03

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
2.04	16.65	16.82	0.99	9.71374819	161.699	9.713748	161.699	T =	16.32
								Dm =	1.020
				Sc low =	0.0136	Sc high =	0.0136		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0095	0.0176	0.0095	0.0176		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point EX10 - Min 100 Yr Channel Size (Q=32.0 cfs)

By: Dane Frank Date: 10/1/2018

Chk By: Date: version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

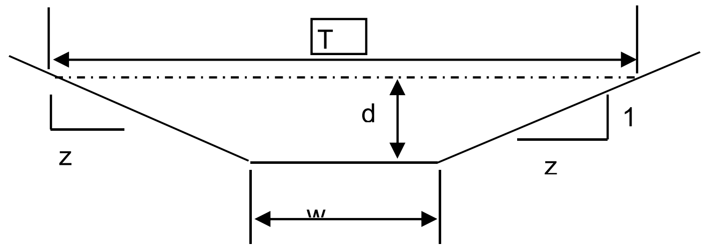
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

INPUT	
z (sideslope)=	5
z (sideslope)=	15
b (btm width, ft)=	125
d (depth, ft)=	0.15
S (slope, ft/ft)	0.018
n_{low} =	0.03
n_{high} =	0.03

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.15	18.98	128.02	0.15	1.8611262	35.3149	1.861126	35.3149	T =	128
								Dm =	0.148
				Sc low =	0.0248	Sc high =	0.0248		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0173	0.0322	0.0173	0.0322		

s_c = critical slope ft / ft

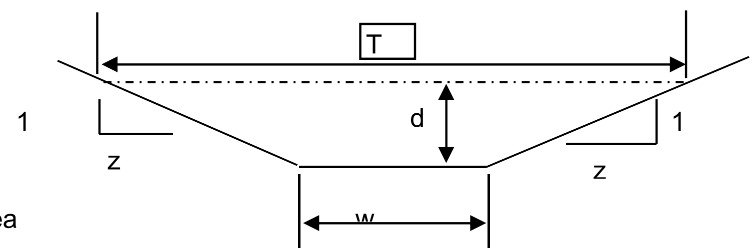
T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project:	**Timber Rider Estates**		Location:	Point EX10 - 100 Yr Flow Plus 1' Depth
By:	Dane Frank	Date:	10/15/2018	
Chk By:		Date:		version 12-2004



Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient

$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

	INPUT
z (sideslope)=	5
z (sideslope)=	15
b (btm width, ft)=	125
d (depth, ft)=	1.15
S (slope, ft/ft)	0.018
n_{low} =	0.03
n_{high} =	0.03

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
1.15	156.98	148.15	1.06	6.90689692	1084.21	6.906897	1084.21	T =	148
								Dm =	1.061
				Sc low =	0.0129	Sc high =	0.0129		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0090	0.0167	0.0090	0.0167		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

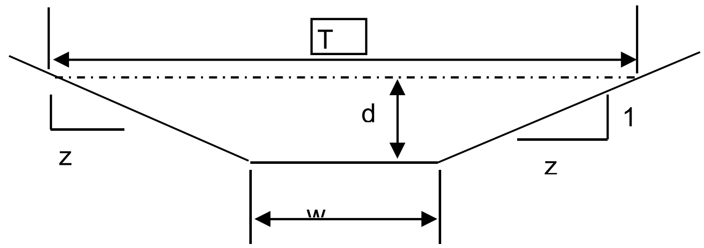
Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point EX11 - Min 100 Yr Channel Size (Q=76.0 cfs)

By: Dane Frank Date: 10/1/2018

Chk By: Date: version 12-2004



	INPUT
z (sideslope)=	27
z (sideslope)=	22
b (btm width, ft)=	130
d (depth, ft)=	0.24
S (slope, ft/ft)	0.018
n_{low} =	0.03
n_{high} =	0.03

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient

$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

Clear Data Entry Cells

Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Low N Velocity, fps	Low N Flow, cfs	High N Velocity, fps	High N Flow, cfs		
0.24	32.61	141.77	0.23	2.49479219	81.3582	2.494792	81.3582	T =	141.76
								Dm =	0.230
				Sc low =	0.0214	Sc high =	0.0214		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0150	0.0278	0.0150	0.0278		

s_c = critical slope ft / ft

T = top width of the stream

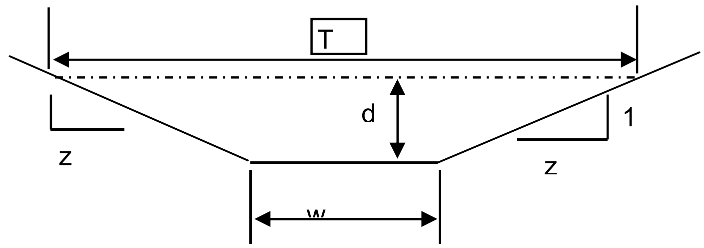
d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project:	**Timber Rider Estates**	Location:	Point EX11 - 100 Yr Flow Plus 1' Depth
By:	Dane Frank	Date:	10/15/2018
Chk By:		Date:	

version 12-2004



INPUT	
z (sideslope)=	27
z (sideslope)=	22
b (btm width, ft)=	130
d (depth, ft)=	1.24
S (slope, ft/ft)	0.018
n_{low} =	0.03
n_{high} =	0.03

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient

$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
1.24	198.87	190.81	1.04	6.831455	1358.58	6.831455	1358.58	T =	190.76
								Dm =	1.043
				Sc low =	0.0129	Sc high =	0.0129		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0090	0.0168	0.0090	0.0168		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

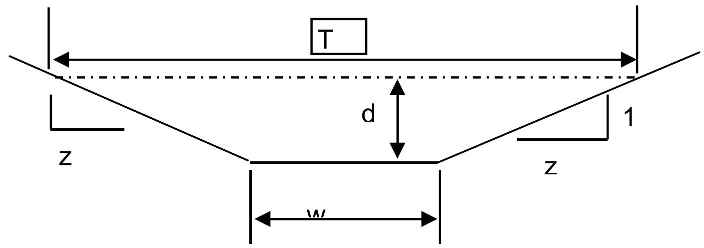
MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point EX12 - Min 100 Yr Channel Size (Q=3.8 cfs)

By: Dane Frank Date: 10/15/2018

Chk By: Date:

version 12-2004



Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient

$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

INPUT	
z (sideslope)=	12
z (sideslope)=	19
b (btm width, ft)=	0
d (depth, ft)=	0.27
S (slope, ft/ft)	0.071
n_{low} =	0.03
n_{high} =	0.03

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.27	1.13	8.39	0.13	3.46806177	3.91874	3.468062	3.91874	T =	8.37
								Dm =	0.135
				Sc low =	0.0256	Sc high =	0.0256		

s_c = critical slope ft / ft

T = top width of the stream

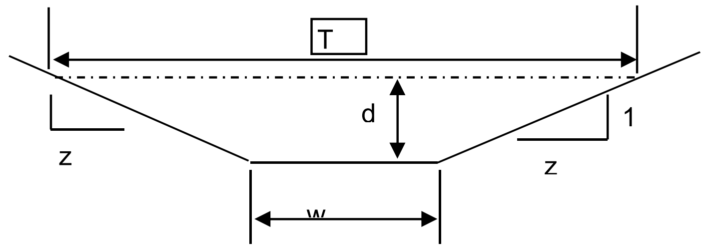
d_m = a/T = mean depth of flow

.7 Sc	1.3 Sc	.7 Sc	1.3 Sc
0.0179	0.0333	0.0179	0.0333

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project:	**Timber Rider Estates**		Location:	Point EX12 - 100 Yr Flow Plus 1' Depth
By:	Dane Frank	Date:	10/15/2018	
Chk By:		Date:		version 12-2004



Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

$R = A/P$

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient

$V = (1.49/n)R_h^{2/3}S^{1/2}$

$Q = V \times A$

INPUT	
z (sideslope)=	12
z (sideslope)=	19
b (btm width, ft)=	0
d (depth, ft)=	1.27
S (slope, ft/ft)	0.071
n_{low} =	0.03
n_{high} =	0.03

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
1.27	25.00	39.46	0.63	9.73649271	243.412	9.736493	243.412	T =	39.37
								Dm =	0.635
				Sc low =	0.0153	Sc high =	0.0153		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0107	0.0199	0.0107	0.0199		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project:	**Timber Rider Estates**	Location:	Point EX13 - Min 100 Yr Channel Size (Q=7.1 cfs)
By:	Dane Frank	Date:	10/15/2018
Chk By:		Date:	

version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

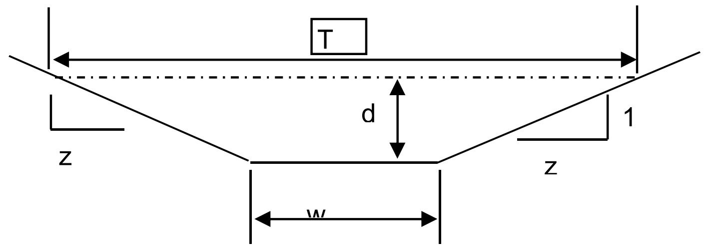
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

INPUT	
z (sideslope)=	19
z (sideslope)=	19
b (btm width, ft)=	0
d (depth, ft)=	0.32
S (slope, ft/ft)	0.069
n_{low} =	0.03
n $_{high}$ =	0.03

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.32	1.95	12.18	0.16	3.83096705	7.45353	3.830967	7.45353	T =	12.16
								Dm =	0.160
				Sc low =	0.0242	Sc high =	0.0242		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0169	0.0314	0.0169	0.0314		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project:	**Timber Rider Estates**	Location:	Point EX13 - 100 Yr Flow Plus 1' Depth
By:	Dane Frank	Date:	10/15/2018
Chk By:		Date:	

version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

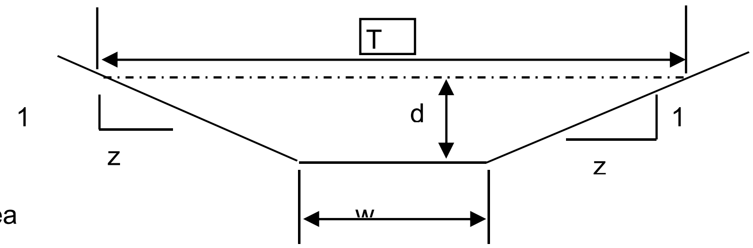
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

INPUT	
z (sideslope)=	19
z (sideslope)=	19
b (btm width, ft)=	0
d (depth, ft)=	1.32
S (slope, ft/ft)	0.069
n_{low} =	0.03
n_{high} =	0.03

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
1.32	33.11	50.23	0.66	9.85397749	326.222	9.853977	326.222	T =	50.16
								Dm =	0.660
				Sc low =	0.0151	Sc high =	0.0151		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0106	0.0196	0.0106	0.0196		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point EX14 - Min 100 Yr Channel Size (Q=26.3 cfs)

By: Dane Frank Date: 10/15/2018

Chk By: Date:

version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

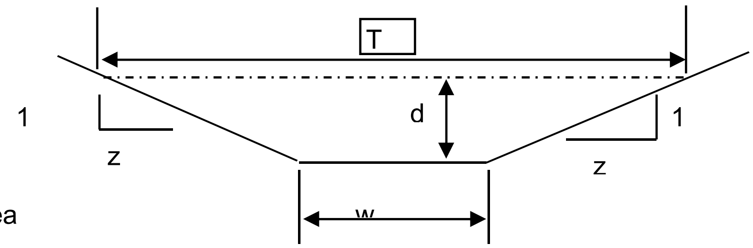
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

INPUT	
z (sideslope)=	19
z (sideslope)=	32
b (btm width, ft)=	100
d (depth, ft)=	0.14
S (slope, ft/ft)	0.021
n_{low} =	0.03
n_{high} =	0.03

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.14	14.50	107.15	0.14	1.89191942	27.4325	1.891919	27.4325	T =	107.14
								Dm =	0.135
				Sc low =	0.0255	Sc high =	0.0255		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0179	0.0332	0.0179	0.0332		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point EX14 - 100 Yr Flow Plus 1' Depth

By: Dane Frank Date: 10/15/2018

Chk By: Date: version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

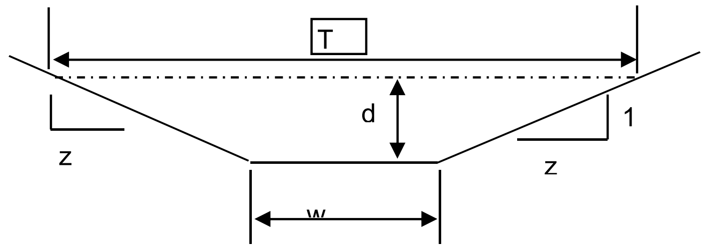
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

INPUT	
z (sideslope)=	19
z (sideslope)=	32
b (btm width, ft)=	100
d (depth, ft)=	1.14
S (slope, ft/ft)	0.021
n_{low} =	0.03
n_{high} =	0.03

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
1.14	147.14	158.19	0.93	6.83981403	1006.41	6.839814	1006.41	T =	158.14
								Dm =	0.930
				Sc low =	0.0134	Sc high =	0.0134		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0094	0.0175	0.0094	0.0175		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

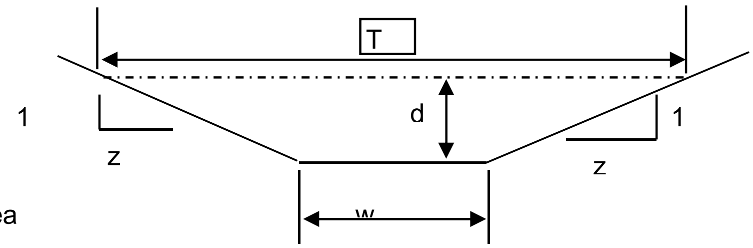
Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project:	**Timber Rider Estates**	Location:	Point PR3 - Min 100 Yr Channel Size (Q=4.7 cfs)
By:	Dane Frank	Date:	5/31/2018
Chk By:		Date:	

version 12-2004

Mannings Formula



$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient

$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

INPUT	
z (sideslope)=	4
z (sideslope)=	4
b (btm width, ft)=	0
d (depth, ft)=	0.55
S (slope, ft/ft)	0.038
n_{low} =	0.03
n_{high} =	0.03

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.55	1.21	4.54	0.27	4.00143446	4.84174	4.001434	4.84174	T =	4.4
								Dm =	0.275
				Sc low =	0.0210	Sc high =	0.0210		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

.7 Sc	1.3 Sc	.7 Sc	1.3 Sc
0.0147	0.0273	0.0147	0.0273

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

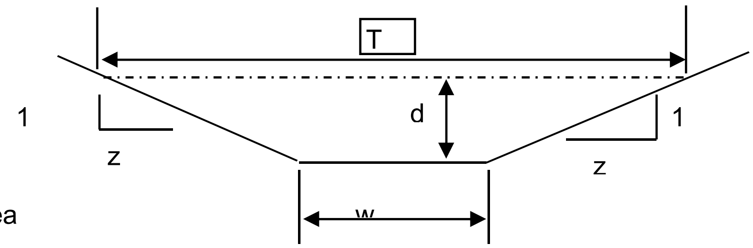
Project: **Timber Rider Estates** Location: Point PR4 - Min 100 Yr Channel Size (Q=3.2 cfs)

By: Dane Frank Date: 5/31/2018

Chk By: Date:

version 12-2004

Mannings Formula



$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient

$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

INPUT	
z (sideslope)=	4.5
z (sideslope)=	3.6
b (btm width, ft)=	0
d (depth, ft)=	0.43
S (slope, ft/ft)	0.063
n_{low} =	0.03
n_{high} =	0.03

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.43	0.75	3.59	0.21	4.37360021	3.27515	4.3736	3.27515	T =	3.483
								Dm =	0.215
				Sc low =	0.0228	Sc high =	0.0228		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

.7 Sc	1.3 Sc	.7 Sc	1.3 Sc
0.0159	0.0296	0.0159	0.0296

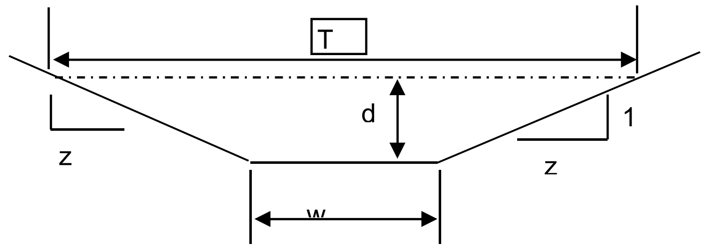
Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point PR5 - Min 100 Yr Channel Size (Q=0.9 cfs)

By: Dane Frank Date: 5/31/2018

Chk By: Date: version 12-2004



INPUT	
z (sideslope)=	3.8
z (sideslope)=	3.8
b (btm width, ft)=	0
d (depth, ft)=	0.37
S (slope, ft/ft)	0.013
n_{low} =	0.03
n_{high} =	0.03

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient

$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

Clear Data Entry Cells

Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Low N Velocity, fps	Low N Flow, cfs	High N Velocity, fps	High N Flow, cfs		
0.37	0.52	2.91	0.18	1.7930763	0.93279	1.793076	0.93279	T =	2.812
								Dm =	0.185
				Sc low =	0.0240	Sc high =	0.0240		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0168	0.0313	0.0168	0.0313		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project:	**Timber Rider Estates**		Location:	Point PR6 - Min 100 Yr Channel Size (Q=3.6 cfs)
By:	Dane Frank	Date:	5/31/2018	
Chk By:		Date:		version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

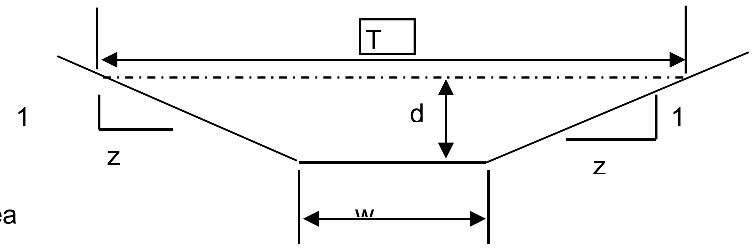
$R = A/P$

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$V = (1.49/n)R_h^{2/3}S^{1/2}$

$Q = V \times A$

INPUT	
z (sideslope)=	4
z (sideslope)=	3.5
b (btm width, ft)=	0
d (depth, ft)=	0.62
S (slope, ft/ft)	0.013
n_{low} =	0.03
n_{high} =	0.03

Clear Data Entry Cells

Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Low N Velocity, fps	Low N Flow, cfs	High N Velocity, fps	High N Flow, cfs		
0.62	1.44	4.81	0.30	2.52798622	3.64409	2.527986	3.64409	T =	4.65
								Dm =	0.310
				Sc low =	0.0203	Sc high =	0.0203		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0142	0.0264	0.0142	0.0264		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point PR7 - Min 100 Yr Channel Size (Q=8.2 cfs)

By: Dane Frank Date: 5/31/2018

Chk By: Date:

version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

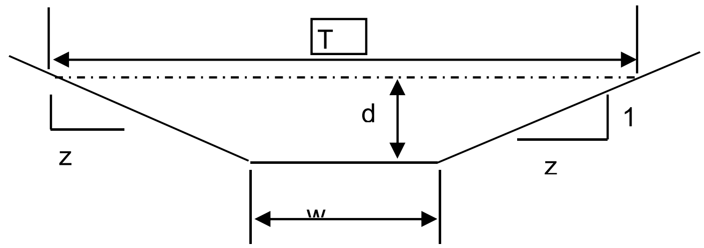
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

INPUT	
z (sideslope)=	4
z (sideslope)=	3
b (btm width, ft)=	0
d (depth, ft)=	0.67
S (slope, ft/ft)	0.052
n_{low} =	0.03
n_{high} =	0.03

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.67	1.57	4.88	0.32	5.30489075	8.33478	5.304891	8.33478	T =	4.69
								Dm =	0.335
				Sc low =	0.0199	Sc high =	0.0199		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0139	0.0259	0.0139	0.0259		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point PR8 - Min 100 Yr Channel Size (Q=66.0 cfs)

By: Dane Frank Date: 5/31/2018

Chk By: Date: version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

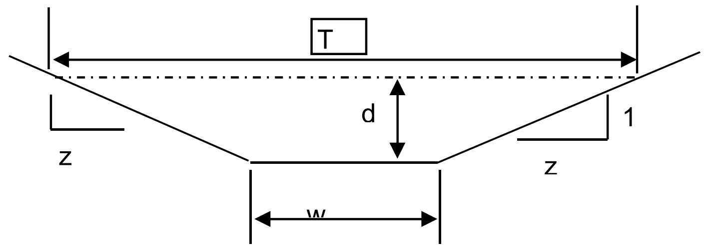
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

INPUT	
z (sideslope)=	4
z (sideslope)=	4
b (btm width, ft)=	0
d (depth, ft)=	1.4
S (slope, ft/ft)	0.05
n_{low} =	0.03
n_{high} =	0.03

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
1.4	7.84	11.54	0.68	8.55721943	67.0886	8.557219	67.0886	T =	11.2
								Dm =	0.700
				Sc low =	0.0154	Sc high =	0.0154		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0108	0.0200	0.0108	0.0200		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point PR9 - Min 100 Yr Channel Size (Q=5.7 cfs)

By: Dane Frank Date: 5/31/2018

Chk By: Date: version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

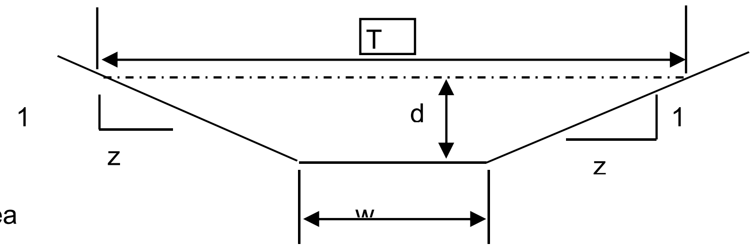
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

INPUT	
z (sideslope)=	4
z (sideslope)=	4
b (btm width, ft)=	0
d (depth, ft)=	0.54
S (slope, ft/ft)	0.06
n_{low} =	0.03
n_{high} =	0.03

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.54	1.17	4.45	0.26	4.96691411	5.79341	4.966914	5.79341	T =	4.32
								Dm =	0.270
				Sc low =	0.0211	Sc high =	0.0211		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0148	0.0274	0.0148	0.0274		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point PR10 - Min 100 Yr Channel Size (Q=10.5 cfs)

By: Dane Frank Date: 5/31/2018

Chk By: Date: version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

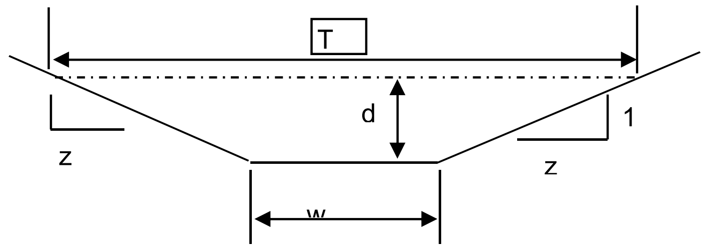
R = A/P

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$V = (1.49/n)R_h^{2/3}S^{1/2}$

Q = V x A

INPUT	
z (sideslope)=	3.5
z (sideslope)=	4
b (btm width, ft)=	0
d (depth, ft)=	0.7
S (slope, ft/ft)	0.059
n_{low} =	0.03
n_{high} =	0.03

Clear Data Entry Cells

				Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.7	1.84	5.43	0.34	5.83940175	10.7299	5.839402	10.7299	T =	5.25
								Dm =	0.350
				Sc low =	0.0195	Sc high =	0.0195		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0136	0.0253	0.0136	0.0253		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

Created by: Mike O'Shea

MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **Timber Rider Estates** Location: Point PR11 - Min 100 Yr Channel Size (Q=5.6 cfs)

By: Dane Frank Date: 5/31/2018

Chk By: Date: version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

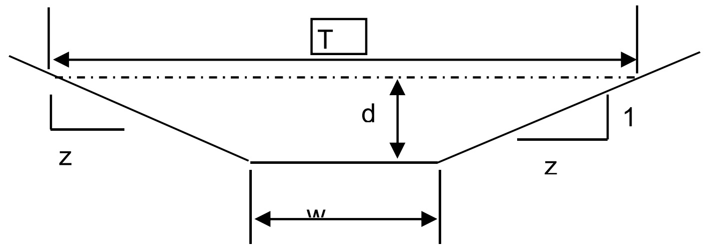
$R = A/P$

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$V = (1.49/n)R_h^{2/3}S^{1/2}$

$Q = V \times A$

INPUT	
z (sideslope)=	3.5
z (sideslope)=	4
b (btm width, ft)=	0
d (depth, ft)=	0.53
S (slope, ft/ft)	0.078
n_{low} =	0.03
n_{high} =	0.03

Clear Data Entry Cells

Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Low N Velocity, fps	Low N Flow, cfs	High N Velocity, fps	High N Flow, cfs		
0.53	1.05	4.11	0.26	5.57747344	5.87517	5.577473	5.87517	T =	3.975
								Dm =	0.265
				Sc low =	0.0214	Sc high =	0.0214		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0150	0.0278	0.0150	0.0278		

s_c = critical slope ft / ft

T = top width of the stream

d_m = a/T = mean depth of flow

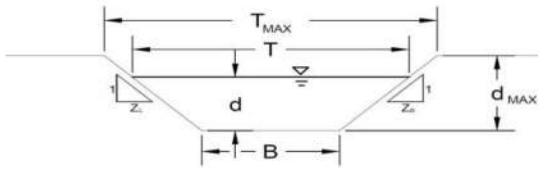
Created by: Mike O'Shea

Version 4.05 Released March 2017

AREA INLET IN A SWALE

Timberridge Estates

EDB South Inlet ST Inlet



This worksheet uses the NRCS vegetal retardance method to determine Manning's n.

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

NRCS Vegetal Retardance (A, B, C, D, or E)	A, B, C, D or E		
Manning's n (Leave cell D16 blank to manually enter an n value)	n =	0.030	
Channel Invert Slope	S_O =	0.0520	ft/ft
Bottom Width	B =	0.00	ft
Left Side Slope	Z1 =	4.00	ft/ft
Right Side Slope	Z2 =	3.00	ft/ft

Check one of the following soil types:

Soil Type:	Max. Velocity (V_{MAX})	Max Froude No. (F_{MAX})
Non-Cohesive	5.0 fps	0.60
Cohesive	7.0 fps	0.80
Paved	N/A	N/A

Choose One:
- Non-Cohesive
- Cohesive
- Paved

		Minor Storm	Major Storm	
Max. Allowable Top Width of Channel for Minor & Major Storm	T_{MAX} =	**24.00**	**24.00**	**feet**
Max. Allowable Water Depth in Channel for Minor & Major Storm	d_{MAX} =	**2.00**	**2.00**	**feet**

Allowable Channel Capacity Based On Channel Geometry		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**154.4**	**154.4**	**cfs**
MAJOR STORM Allowable Capacity is based on Depth Criterion	d_{allow} =	**2.00**	**2.00**	**ft**

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow	Q_o =	**3.1**	**8.2**	**cfs**
Water Depth	d =	**0.46**	**0.67**	**feet**

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

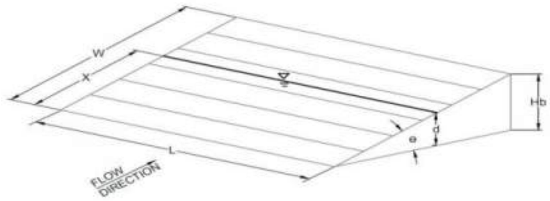
AREA INLET IN A SWALE

Timberridge Estates

EDB South Inlet ST Inlet

Inlet Design Information (Input)

Type of Inlet	CDOT Type C	Inlet Type =	CDOT Type C	
Angle of Inclined Grate (must be <= 30 degrees)		θ =	0.00	degrees
Width of Grate		W =	3.00	feet
Length of Grate		L =	3.00	feet
Open Area Ratio		A_{RATIO} =	0.70	
Height of Inclined Grate		H_B =	0.00	feet
Clogging Factor		C_f =	0.50	
Grate Discharge Coefficient		C_d =	0.96	
Orifice Coefficient		C_o =	0.64	
Weir Coefficient		C_w =	2.05	

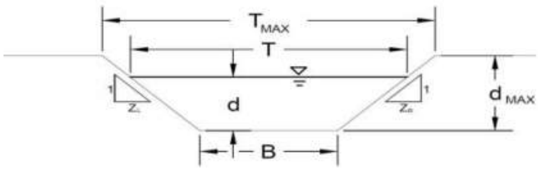


		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	0.46	0.67	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**5.8**	**10.0**	**cfs**
	Bypassed Flow, Q_b =	**0.0**	**0.0**	**cfs**
	Capture Percentage = Q_a/Q_o = C%	**100**	**100**	**%**

Warning 03: Velocity exceeds USDCM Volume I recommendation.
Warning 04: Froude No. exceeds USDCM Volume I recommendation.

AREA INLET IN A SWALE

Timberridge Estates
SF DP8 Inlet ST Inlet



This worksheet uses the NRCS vegetal retardance method to determine Manning's n.

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

NRCS Vegetal Retardance (A, B, C, D, or E)	A, B, C, D or E		
Manning's n (Leave cell D16 blank to manually enter an n value)	n =	0.030	
Channel Invert Slope	S_O =	0.0600	ft/ft
Bottom Width	B =	0.00	ft
Left Side Slope	Z1 =	4.00	ft/ft
Right Side Slope	Z2 =	4.00	ft/ft

Check one of the following soil types:

Soil Type:	Max. Velocity (V_{MAX})	Max Froude No. (F_{MAX})
Non-Cohesive	5.0 fps	0.60
Cohesive	7.0 fps	0.80
Paved	N/A	N/A

Choose One:
- Non-Cohesive
- Cohesive
- Paved

		Minor Storm	Major Storm	
Max. Allowable Top Width of Channel for Minor & Major Storm	T_{MAX} =	**4.30**	**4.30**	**feet**
Max. Allowable Water Depth in Channel for Minor & Major Storm	d_{MAX} =	**0.27**	**0.27**	**feet**

Allowable Channel Capacity Based On Channel Geometry

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**0.9**	**0.9**	**cfs**
MAJOR STORM Allowable Capacity is based on Depth Criterion	d_{allow} =	**0.27**	**0.27**	**ft**

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow	Q_o =	**0.1**	**0.1**	**cfs**
Water Depth	d =	**0.12**	**0.12**	**feet**

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Version 4.05 Released March 2017

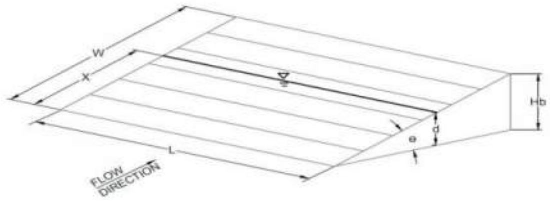
AREA INLET IN A SWALE

Timberridge Estates

SF DP8 Inlet ST Inlet

Inlet Design Information (Input)

Type of Inlet: User-Defined — Inlet Type = User-Defined



Angle of Inclined Grate (must be <= 30 degrees)	θ =	0.00	degrees
Width of Grate	W =	1.00	feet
Length of Grate	L =	1.00	feet
Open Area Ratio	A_{RATIO} =	0.70	
Height of Inclined Grate	H_B =	0.00	feet
Clogging Factor	C_f =	0.50	
Grate Discharge Coefficient	C_d =	N/A	
Orifice Coefficient	C_o =	0.64	
Weir Coefficient	C_w =	2.05	

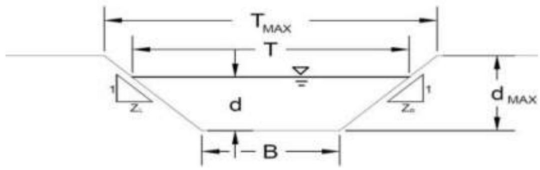
		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	0.12	0.12	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**0.2**	**0.2**	**cfs**
	Bypassed Flow, Q_b =	**0.0**	**0.0**	**cfs**
	Capture Percentage = Q_a/Q_o = C%	**100**	**100**	**%**

Warning 04: Froude No. exceeds USDCM Volume I recommendation.

AREA INLET IN A SWALE

Timberridge Estates

SF DP7 Inlet (north)



This worksheet uses the NRCS vegetal retardance method to determine Manning's n.

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

NRCS Vegetal Retardance (A, B, C, D, or E)	A, B, C, D or E		
Manning's n (Leave cell D16 blank to manually enter an n value)	n =	0.030	
Channel Invert Slope	S_O =	0.0200	ft/ft
Bottom Width	B =	0.00	ft
Left Side Slope	Z1 =	3.00	ft/ft
Right Side Slope	Z2 =	3.00	ft/ft

Check one of the following soil types:

Soil Type:	Max. Velocity (V_{MAX})	Max Froude No. (F_{MAX})
Non-Cohesive	5.0 fps	0.60
Cohesive	7.0 fps	0.80
Paved	N/A	N/A

Choose One:
- Non-Cohesive
- Cohesive
- Paved

		Minor Storm	Major Storm	
Max. Allowable Top Width of Channel for Minor & Major Storm	T_{MAX} =	30.00	30.00	feet
Max. Allowable Water Depth in Channel for Minor & Major Storm	d_{MAX} =	4.00	4.00	feet

Allowable Channel Capacity Based On Channel Geometry		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	516.7	516.7	cfs
MAJOR STORM Allowable Capacity is based on Depth Criterion	d_{allow} =	4.00	4.00	ft

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow	Q_o =	0.2	0.2	cfs
Water Depth	d =	0.21	0.21	feet

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Version 4.05 Released March 2017

AREA INLET IN A SWALE

Timberridge Estates

SF DP7 Inlet (north)

Inlet Design Information (Input)

Type of Inlet	User-Defined	Inlet Type =	User-Defined
Angle of Inclined Grate (must be <= 30 degrees)	θ =	0.00	degrees
Width of Grate	W =	1.00	feet
Length of Grate	L =	1.00	feet
Open Area Ratio	A_{RATIO} =	0.70	
Height of Inclined Grate	H_B =	0.00	feet
Clogging Factor	C_f =	0.50	
Grate Discharge Coefficient	C_d =	N/A	
Orifice Coefficient	C_o =	0.64	
Weir Coefficient	C_w =	2.05	

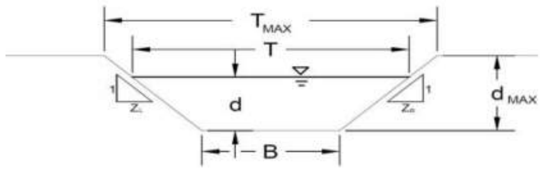
		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	0.21	0.21	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**0.6**	**0.6**	**cfs**
	Bypassed Flow, Q_b =	**0.0**	**0.0**	**cfs**
	Capture Percentage = Q_a/Q_o = C%	**100**	**100**	**%**

Warning 04: Froude No. exceeds USDCM Volume I recommendation.

AREA INLET IN A SWALE

Timberridge Estates

SF DP7 Inlet (south)



This worksheet uses the NRCS vegetal retardance method to determine Manning's n.

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

NRCS Vegetal Retardance (A, B, C, D, or E)	A, B, C, D or E		
Manning's n (Leave cell D16 blank to manually enter an n value)	n =	0.030	
Channel Invert Slope	S_O =	0.0200	ft/ft
Bottom Width	B =	0.00	ft
Left Side Slope	Z1 =	3.00	ft/ft
Right Side Slope	Z2 =	3.00	ft/ft

Check one of the following soil types:

Soil Type:	Max. Velocity (V_{MAX})	Max Froude No. (F_{MAX})
Non-Cohesive	5.0 fps	0.60
Cohesive	7.0 fps	0.80
Paved	N/A	N/A

Choose One:
- (•) **Non-Cohesive**
- ( ) **Cohesive**
- ( ) **Paved**

		Minor Storm	Major Storm	
Max. Allowable Top Width of Channel for Minor & Major Storm	T_{MAX} =	**30.00**	**30.00**	**feet**
Max. Allowable Water Depth in Channel for Minor & Major Storm	d_{MAX} =	**3.00**	**3.00**	**feet**

Allowable Channel Capacity Based On Channel Geometry

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**239.9**	**239.9**	**cfs**
MAJOR STORM Allowable Capacity is based on Depth Criterion	d_{allow} =	**3.00**	**3.00**	**ft**

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow	Q_o =	**0.1**	**0.1**	**cfs**
Water Depth	d =	**0.16**	**0.16**	**feet**

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'
Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Version 4.05 Released March 2017

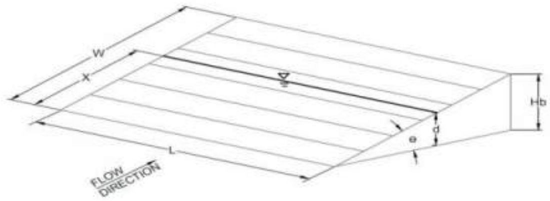
AREA INLET IN A SWALE

Timberridge Estates

SF DP7 Inlet (south)

Inlet Design Information (Input)

Type of Inlet	User-Defined	Inlet Type =	User-Defined	
Angle of Inclined Grate (must be <= 30 degrees)		θ =	0.00	degrees
Width of Grate		W =	1.00	feet
Length of Grate		L =	1.00	feet
Open Area Ratio		A_{RATIO} =	0.70	
Height of Inclined Grate		H_B =	0.00	feet
Clogging Factor		C_f =	0.50	
Grate Discharge Coefficient		C_d =	N/A	
Orifice Coefficient		C_o =	0.64	
Weir Coefficient		C_w =	2.05	

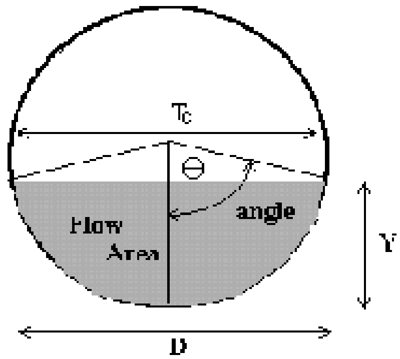


		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	0.16	0.16	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**0.4**	**0.4**	**cfs**
	Bypassed Flow, Q_b =	**0.0**	**0.0**	**cfs**
	Capture Percentage = Q_a/Q_o = C%	**100**	**100**	**%**

Warning 04: Froude No. exceeds USDCM Volume I recommendation.

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

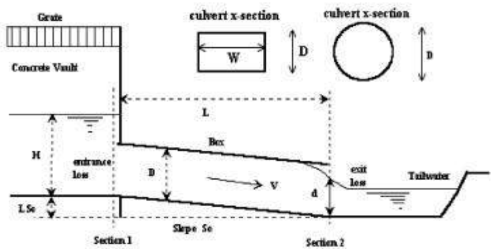
Project: **TIMBERRIDGE ESTATES**
Pipe ID: **Design Point 1 (35.5 cfs) - Dual 24" RCP Culverts**



Design Information (Input)			
Pipe Invert Slope	So =	0.0100	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	24.00	inches
Design discharge	**Q =**	**17.75**	**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 =	22.68	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.91	radians
Flow area	An =	2.22	sq ft
Top width	Tn =	1.89	ft
Wetted perimeter	Pn =	3.82	ft
Flow depth	Yn =	1.33	ft
Flow velocity	Vn =	7.99	fps
Discharge	Qn =	17.75	cfs
Percent Full Flow	Flow =	78.3%	of full flow
Normal Depth Froude Number	Fr_n =	1.30	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	2.12	radians
Critical flow area	Ac =	2.56	sq ft
Critical top width	Tc =	1.71	ft
Critical flow depth	Yc =	1.52	ft
Critical flow velocity	Vc =	6.94	fps
Critical Depth Froude Number	Fr_c =	1.00	

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

Project: Timberridge Estates
Basin ID: Design Point 1 (35.5 cfs) - Dual 24" RCP Culverts
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/ 90-15 Deg. Headwall	
	Number of Barrels	No =	2	
	Inlet Elevation at Culvert Invert	Inlet Elev =	7270.37	ft. elev.
	Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.)	Outlet Elev =	7269.7	ft. elev.
	Culvert Length in Feet	L =	80	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 =	0.84
Sum of All Loss Coefficients	K_s =	2.04
Orifice Inlet Condition Coefficient	C_d =	0.95
Minimum Energy Condition Coefficient	KE_{low} =	-0.0342

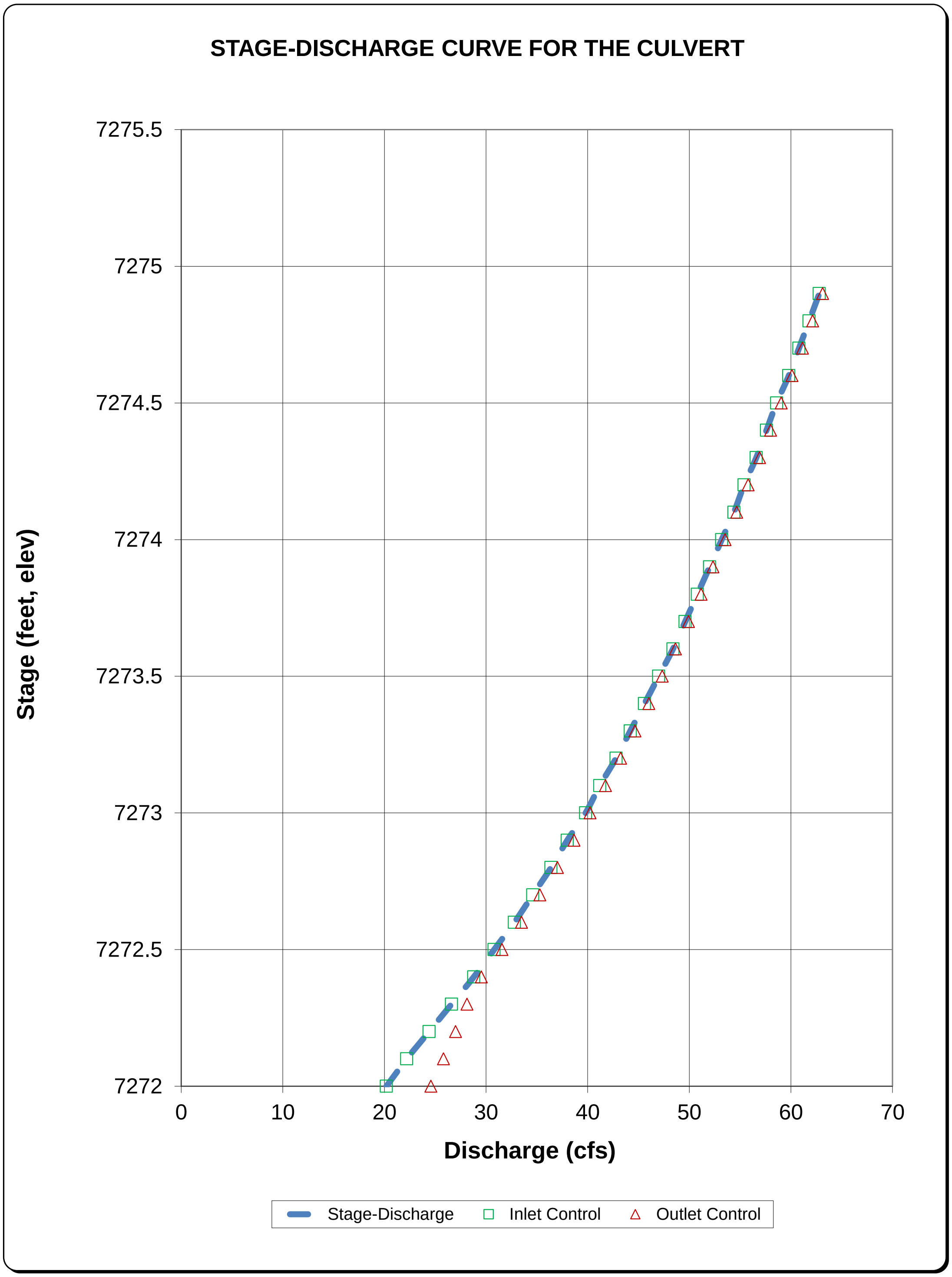
Calculations of Culvert Capacity (output):

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
7272.00		20.20	24.58	**20.20**	Regression Eqn.	INLET
7272.10		22.20	25.81	**22.20**	Regression Eqn.	INLET
7272.20		24.40	27.00	**24.40**	Regression Eqn.	INLET
7272.30		26.60	28.13	**26.60**	Regression Eqn.	INLET
7272.40		28.80	29.54	**28.80**	Regression Eqn.	INLET
7272.50		30.80	31.58	**30.80**	Regression Eqn.	INLET
7272.60		32.80	33.49	**32.80**	Regression Eqn.	INLET
7272.70		34.60	35.30	**34.60**	Regression Eqn.	INLET
7272.80		36.40	37.03	**36.40**	Regression Eqn.	INLET
7272.90		38.00	38.67	**38.00**	Regression Eqn.	INLET
7273.00		39.80	40.24	**39.80**	Regression Eqn.	INLET
7273.10		41.20	41.76	**41.20**	Regression Eqn.	INLET
7273.20		42.80	43.24	**42.80**	Regression Eqn.	INLET
7273.30		44.20	44.65	**44.20**	Regression Eqn.	INLET
7273.40		45.60	46.02	**45.60**	Regression Eqn.	INLET
7273.50		47.00	47.35	**47.00**	Regression Eqn.	INLET
7273.60		48.40	48.65	**48.40**	Regression Eqn.	INLET
7273.70		49.60	49.93	**49.60**	Regression Eqn.	INLET
7273.80		50.80	51.16	**50.80**	Regression Eqn.	INLET
7273.90		52.00	52.35	**52.00**	Regression Eqn.	INLET
7274.00		53.20	53.54	**53.20**	Regression Eqn.	INLET
7274.10		54.40	54.68	**54.40**	Regression Eqn.	INLET
7274.20		55.40	55.80	**55.40**	Regression Eqn.	INLET
7274.30		56.60	56.92	**56.60**	Regression Eqn.	INLET
7274.40		57.60	58.00	**57.60**	Regression Eqn.	INLET
7274.50		58.60	59.05	**58.60**	Regression Eqn.	INLET
7274.60		59.80	60.11	**59.80**	Regression Eqn.	INLET
7274.70		60.80	61.14	**60.80**	Regression Eqn.	INLET
7274.80		61.80	62.15	**61.80**	Regression Eqn.	INLET
7274.90		62.80	63.14	**62.80**	Regression Eqn.	INLET

Processing Time: 00.87 Seconds

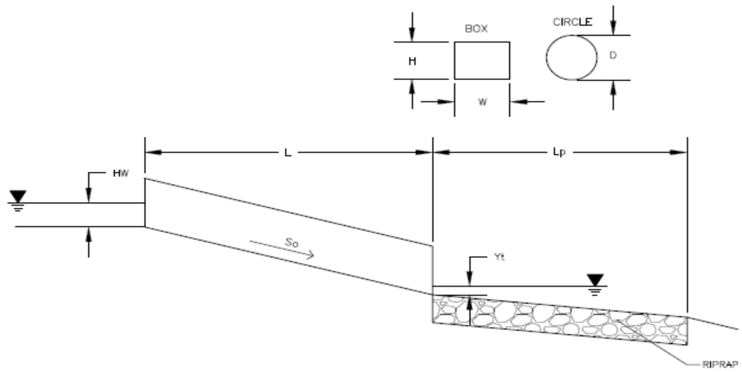
CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Timberridge Estates
Basin ID: Design Point 1 (35.5 cfs) - Dual 24" RCP Culverts



Determination of Culvert Headwater and Outlet Protection

Project: Timberridge Estates
Basin ID: Design Point 1 (35.5 cfs) - Dual 24" RCP Culverts



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

Supercritical Flow! Using Da to calculate protection type.

Design Information (Input):

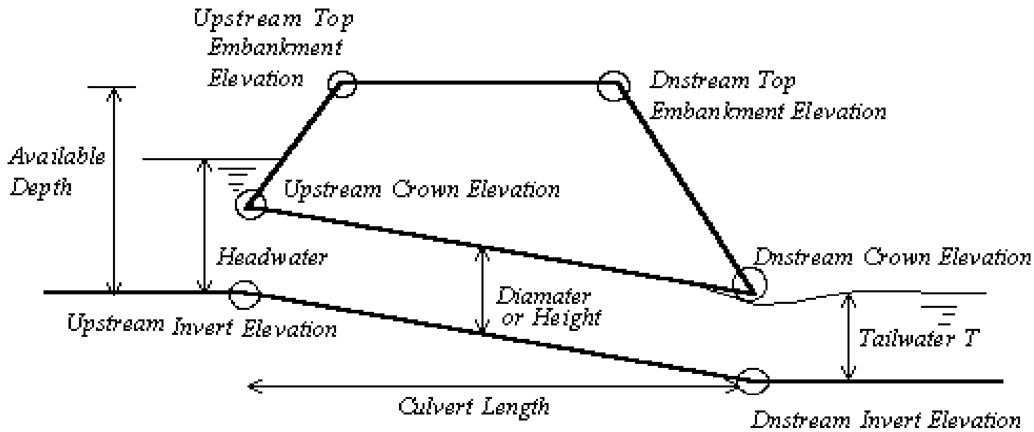
Design Discharge	Q =	17.75	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	24	inches
Inlet Edge Type (Choose from pull-down list)		Grooved End Projection	
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	Height (Rise) =		ft
Barrel Width (Span) in Feet	Width (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	No =	2	
Inlet Elevation	Elev IN =	7270.37	ft
Outlet Elevation **OR** Slope	Elev OUT =	7269.7	ft
Culvert Length	L =	80	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 =	5	ft/s

Required Protection (Output):

Tailwater Surface Height	Y_t =	0.80	ft
Flow Area at Max Channel Velocity	A_t =	1.77	ft^2
Culvert Cross Sectional Area Available	A =	3.14	ft^2
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	0.99	
Sum of All Losses Coefficients	k_s =	2.19	ft
Culvert Normal Depth	Y_n =	0.91	ft
Culvert Critical Depth	Y_c =	1.06	ft
Tailwater Depth for Design	d =	1.53	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	1.46	ft
Expansion Factor	1/(2*tan(Θ)) =	6.70	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	1.57	$ft^{0.5}/s$
Froude Number	Fr =	1.34	**Supercritical!**
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	0.55	
Inlet Control Headwater	HW_I =	1.52	ft
Outlet Control Headwater	HW_O =	1.13	ft
Design Headwater Elevation	**HW =**	**7,271.89**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**0.76**	
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**

Vertical Profile for the Culvert

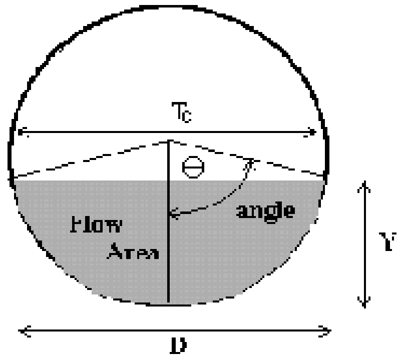
Project = **Timberridge Estates**
Box ID = **Design Point 1 (35.5 cfs) - Dual 24" RCP Culverts**



Culvert Information (Input)			
Barrel Diameter or Height	D or H =	24.00	inches
Barrel Length	L =	80.00	ft
Barrel Invert Slope	So =	0.0084	ft/ft
Downstream Invert Elevation	EDI =	7269.70	ft
Downstream Top Embankment Elevation	EDT =	7272.70	ft
Upstream Top Embankment Elevation	EUT =	7273.40	ft
Design Headwater Depth (not elev.)	Hw =	1.53	ft
Tailwater Depth (not elev.)	Yt =	0.56	ft
Culvert Hydraulics (Calculated)			
Available Headwater Depth	HW-a =	3.03	ft
Design Hw/D ratio	Hw/D =	0.77	
Culvert Vertical Profile			
Upstream Invert Elevation	EUI =	7270.37	ft
Upstream Crown Elevation	EUC =	7272.37	ft
Upstream Soil Cover Depth	Upsoil =	1.03	ft
Downstream Invert Elevation	EDI =	7269.70	ft
Downstream Crown Elevation	EDC =	7271.70	ft
Downstream Soil Cover Depth	Dnsoil =	1.00	ft

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

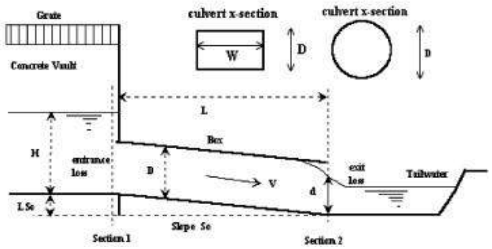
Project: **TIMBERRIDGE ESTATES**
Pipe ID: **Design Point 4 (4.7 cfs) - 24" RCP**



Design Information (Input)			
Pipe Invert Slope	So =	0.0100	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	24.00	inches
Design discharge	**Q =**	**4.70**	**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 =	22.68	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.18	radians
Flow area	An =	0.83	sq ft
Top width	Tn =	1.85	ft
Wetted perimeter	Pn =	2.36	ft
Flow depth	Yn =	0.62	ft
Flow velocity	Vn =	5.69	fps
Discharge	Qn =	4.70	cfs
Percent Full Flow	Flow =	20.7%	of full flow
Normal Depth Froude Number	Fr_n =	1.50	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	1.33	radians
Critical flow area	Ac =	1.10	sq ft
Critical top width	Tc =	1.94	ft
Critical flow depth	Yc =	0.76	ft
Critical flow velocity	Vc =	4.27	fps
Critical Depth Froude Number	Fr_c =	1.00	

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

Project: Timberridge Estates
Basin ID: Design Point 4 (4.7 cfs) - 24" RCP
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/ 90-15 Deg. Headwall	
	Number of Barrels	No =	1	
	Inlet Elevation at Culvert Invert	Inlet Elev =	7272	ft. elev.
	Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.)	Outlet Elev =	7271.39	ft. elev.
	Culvert Length in Feet	L =	61	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 =	0.75
Sum of All Loss Coefficients	K_s =	1.95
Orifice Inlet Condition Coefficient	C_d =	0.95
Minimum Energy Condition Coefficient	KE_{low} =	-0.0342

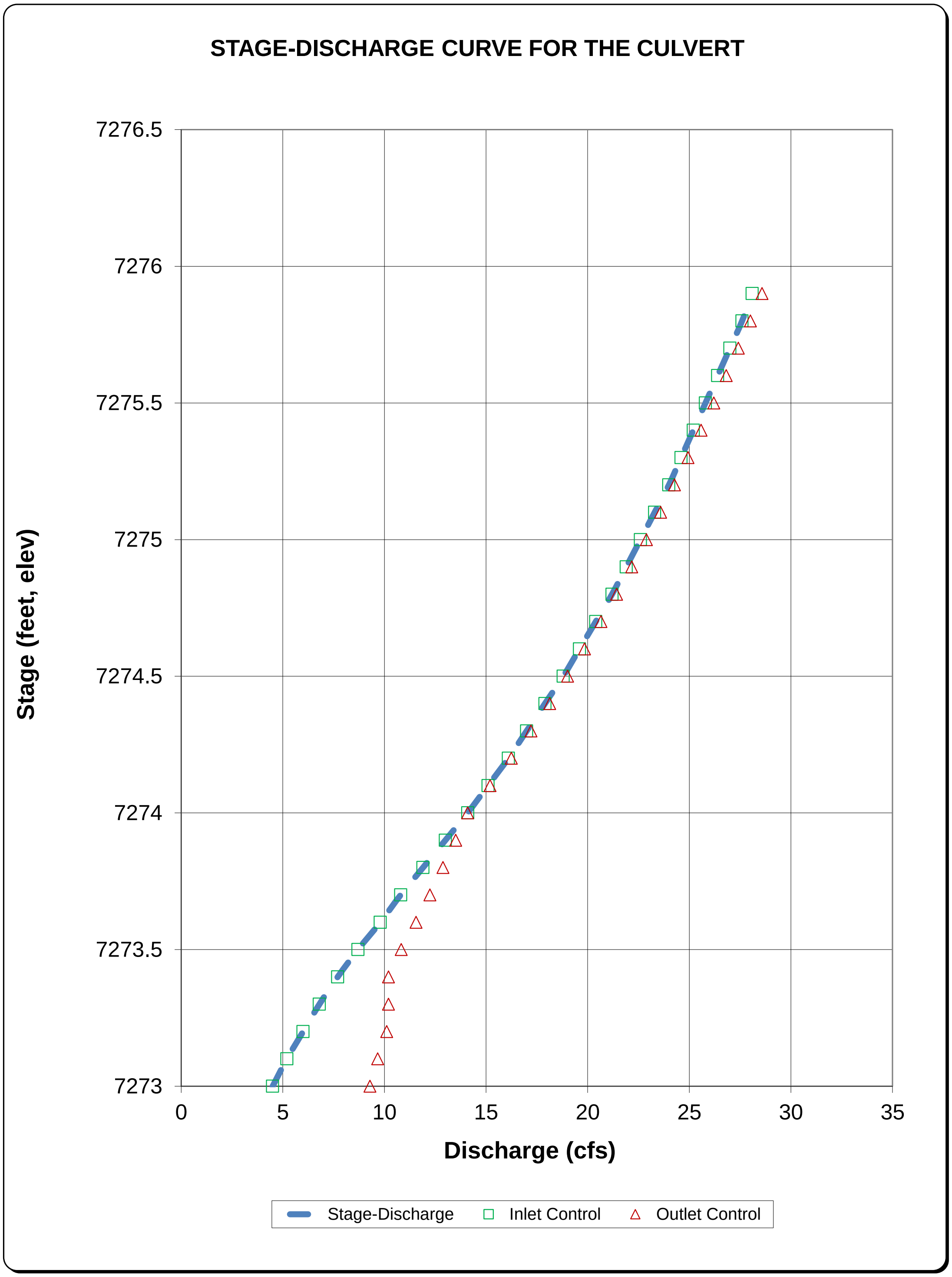
Calculations of Culvert Capacity (output):

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
7273.00		4.50	9.29	**4.50**	Min. Energy. Eqn.	INLET
7273.10		5.20	9.67	**5.20**	Regression Eqn.	INLET
7273.20		6.00	10.11	**6.00**	Regression Eqn.	INLET
7273.30		6.80	10.20	**6.80**	Regression Eqn.	INLET
7273.40		7.70	10.20	**7.70**	Regression Eqn.	INLET
7273.50		8.70	10.82	**8.70**	Regression Eqn.	INLET
7273.60		9.80	11.56	**9.80**	Regression Eqn.	INLET
7273.70		10.80	12.24	**10.80**	Regression Eqn.	INLET
7273.80		11.90	12.88	**11.90**	Regression Eqn.	INLET
7273.90		13.00	13.51	**13.00**	Regression Eqn.	INLET
7274.00		14.10	14.09	**14.09**	Regression Eqn.	OUTLET
7274.10		15.10	15.20	**15.10**	Regression Eqn.	INLET
7274.20		16.10	16.24	**16.10**	Regression Eqn.	INLET
7274.30		17.00	17.22	**17.00**	Regression Eqn.	INLET
7274.40		17.90	18.13	**17.90**	Regression Eqn.	INLET
7274.50		18.80	19.01	**18.80**	Regression Eqn.	INLET
7274.60		19.60	19.85	**19.60**	Regression Eqn.	INLET
7274.70		20.40	20.65	**20.40**	Regression Eqn.	INLET
7274.80		21.20	21.42	**21.20**	Regression Eqn.	INLET
7274.90		21.90	22.17	**21.90**	Regression Eqn.	INLET
7275.00		22.60	22.89	**22.60**	Regression Eqn.	INLET
7275.10		23.30	23.60	**23.30**	Regression Eqn.	INLET
7275.20		24.00	24.27	**24.00**	Regression Eqn.	INLET
7275.30		24.60	24.94	**24.60**	Regression Eqn.	INLET
7275.40		25.20	25.59	**25.20**	Regression Eqn.	INLET
7275.50		25.80	26.21	**25.80**	Regression Eqn.	INLET
7275.60		26.40	26.82	**26.40**	Regression Eqn.	INLET
7275.70		27.00	27.42	**27.00**	Regression Eqn.	INLET
7275.80		27.60	28.01	**27.60**	Regression Eqn.	INLET
7275.90		28.10	28.58	**28.10**	Regression Eqn.	INLET

Processing Time: 00.64 Seconds

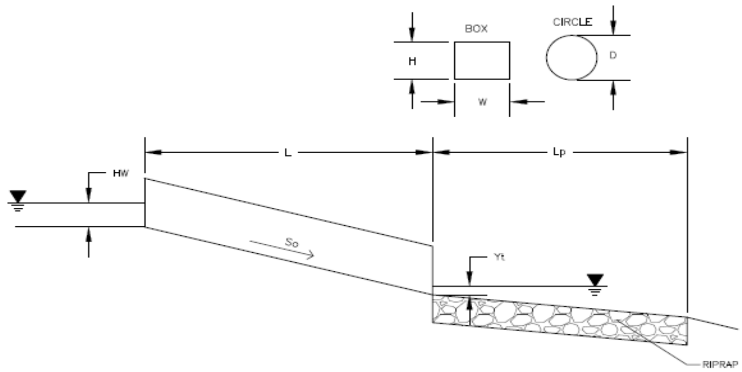
CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Timberridge Estates
Basin ID: Design Point 4 (4.7 cfs) - 24" RCP



Determination of Culvert Headwater and Outlet Protection

Project: Timberridge Estates
Basin ID: Design Point 4 (4.7 cfs) - 24" RCP



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

Supercritical Flow! Using Da to calculate protection type.

Design Information (Input):

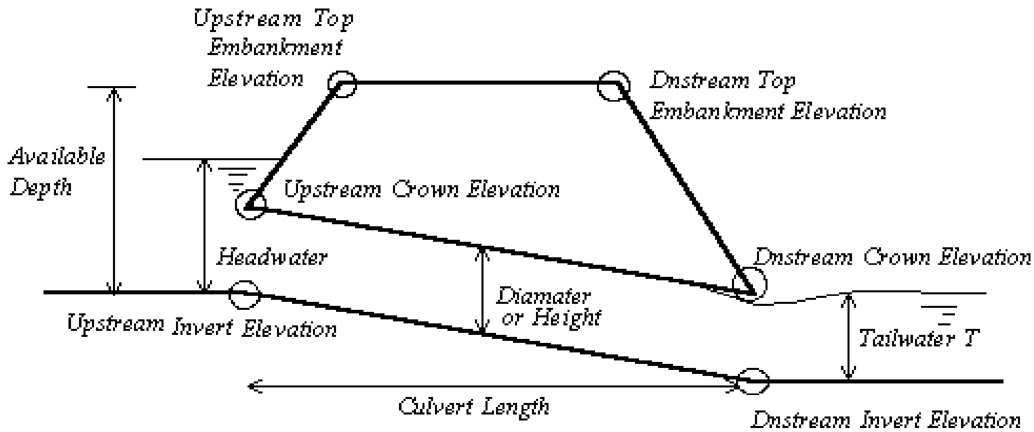
Design Discharge	Q =	4.7	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	24	inches
Inlet Edge Type (Choose from pull-down list)	Grooved End Projection		
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	Height (Rise) =		ft
Barrel Width (Span) in Feet	Width (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	No =	1	
Inlet Elevation	Elev IN =	7272	ft
Outlet Elevation **OR** Slope	Elev OUT =	7271.39	ft
Culvert Length	L =	61	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 =	5	ft/s

Required Protection (Output):

Tailwater Surface Height	Y_t =	0.80	ft
Flow Area at Max Channel Velocity	A_t =	0.94	ft^2
Culvert Cross Sectional Area Available	A =	3.14	ft^2
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	0.75	
Sum of All Losses Coefficients	k_s =	1.95	ft
Culvert Normal Depth	Y_n =	0.62	ft
Culvert Critical Depth	Y_c =	0.76	ft
Tailwater Depth for Design	d =	1.38	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	1.31	ft
Expansion Factor	1/(2*tan(Θ)) =	6.70	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	0.83	$ft^{0.5}/s$
Froude Number	Fr =	1.50	**Supercritical!**
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	0.61	
Inlet Control Headwater	HW_I =	1.05	ft
Outlet Control Headwater	HW_O =	0.84	
Design Headwater Elevation	**HW =**	**7,273.05**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**0.52**	
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 =**	**6**	**ft**
Width of Protection	**T =**	**3**	**ft**

Vertical Profile for the Culvert

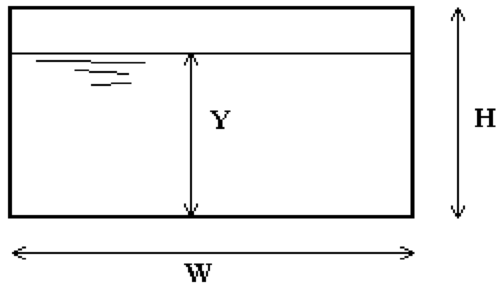
Project = Timberridge Estates
Box ID = Design Point 4 (4.7 cfs) - 24" RCP



Culvert Information (Input)			
Barrel Diameter or Height	D or H =	24.00	inches
Barrel Length	L =	61.00	ft
Barrel Invert Slope	So =	0.0100	ft/ft
Downstream Invert Elevation	EDI =	7271.39	ft
Downstream Top Embankment Elevation	EDT =	7275.00	ft
Upstream Top Embankment Elevation	EUT =	7275.00	ft
Design Headwater Depth (not elev.)	Hw =	1.05	ft
Tailwater Depth (not elev.)	Yt =	0.61	ft
Culvert Hydraulics (Calculated)			
Available Headwater Depth	HW-a =	3.00	ft
Design Hw/D ratio	Hw/D =	0.53	
Culvert Vertical Profile			
Upstream Invert Elevation	EUI =	7272.00	ft
Upstream Crown Elevation	EUC =	7274.00	ft
Upstream Soil Cover Depth	Upsoil =	1.00	ft
Downstream Invert Elevation	EDI =	7271.39	ft
Downstream Crown Elevation	EDC =	7273.39	ft
Downstream Soil Cover Depth	Dnsoil =	1.61	ft

BOX CONDUIT FLOW (Normal & Critical Depth Computation)

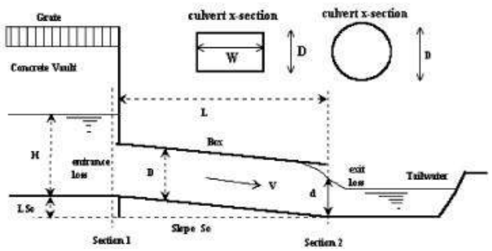
Project: **Timberridge Estates**
Box ID: **Arroya Lane Crossing Sand Creek (2,607 cfs) - 3-6'x12' Conc Box Culverts**



Design Information (Input)			
Box conduit invert slope	So =	0.0100	ft/ft
Box Manning's n-value	n =	0.0130	
Box Width	W =	12.00	ft
Box Height	H =	6.00	ft
Design discharge	**Q =**	**869.00**	**cfs**
Full-flow capacity (Calculated)			
Full-flow area	Af =	72.00	sq ft
Full-flow wetted perimeter	Pf =	36.00	ft
Full-flow capacity	Qf =	1309.97	cfs
Calculations of Normal Flow Condition			
Normal flow depth (<H)	Yn =	3.66	ft
Flow area	An =	43.87	sq ft
Wetted perimeter	Pn =	19.31	ft
Flow velocity	Vn =	19.81	fps
Discharge	Qn =	869.00	cfs
Percent Full	Flow =	66.3%	of full flow
Normal Depth Froude Number	Fr_n =	1.83	supercritical
Calculation of Critical Flow Condition			
Critical flow depth	Yc =	5.46	ft
Critical flow area	Ac =	65.53	sq ft
Critical flow velocity	Vc =	13.26	fps
Critical Depth Froude Number	Fr_c =	1.00	

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

Project: Timberridge Estates
Basin ID: Arroya Lane Crossing Sand Creek (2,607 cfs) - 3-6'x12' Conc Box Culverts
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) =	6.00	ft.
	Barrel Width (Span) in Feet	Width (Span) =	12.00	ft.
	Inlet Edge Type (choose from pull-down list)		Square Edge w/ 90-15 Deg. Headwall	
	Number of Barrels	No =	3	
	Inlet Elevation at Culvert Invert	Inlet Elev =	7233	ft. elev.
	Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.)	Outlet Elev =	7232	ft. elev.
	Culvert Length in Feet	L =	100	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 =	0.29
Sum of All Loss Coefficients	K_s =	1.79
Orifice Inlet Condition Coefficient	C_d =	0.82
Minimum Energy Condition Coefficient	KE_{low} =	0.4004

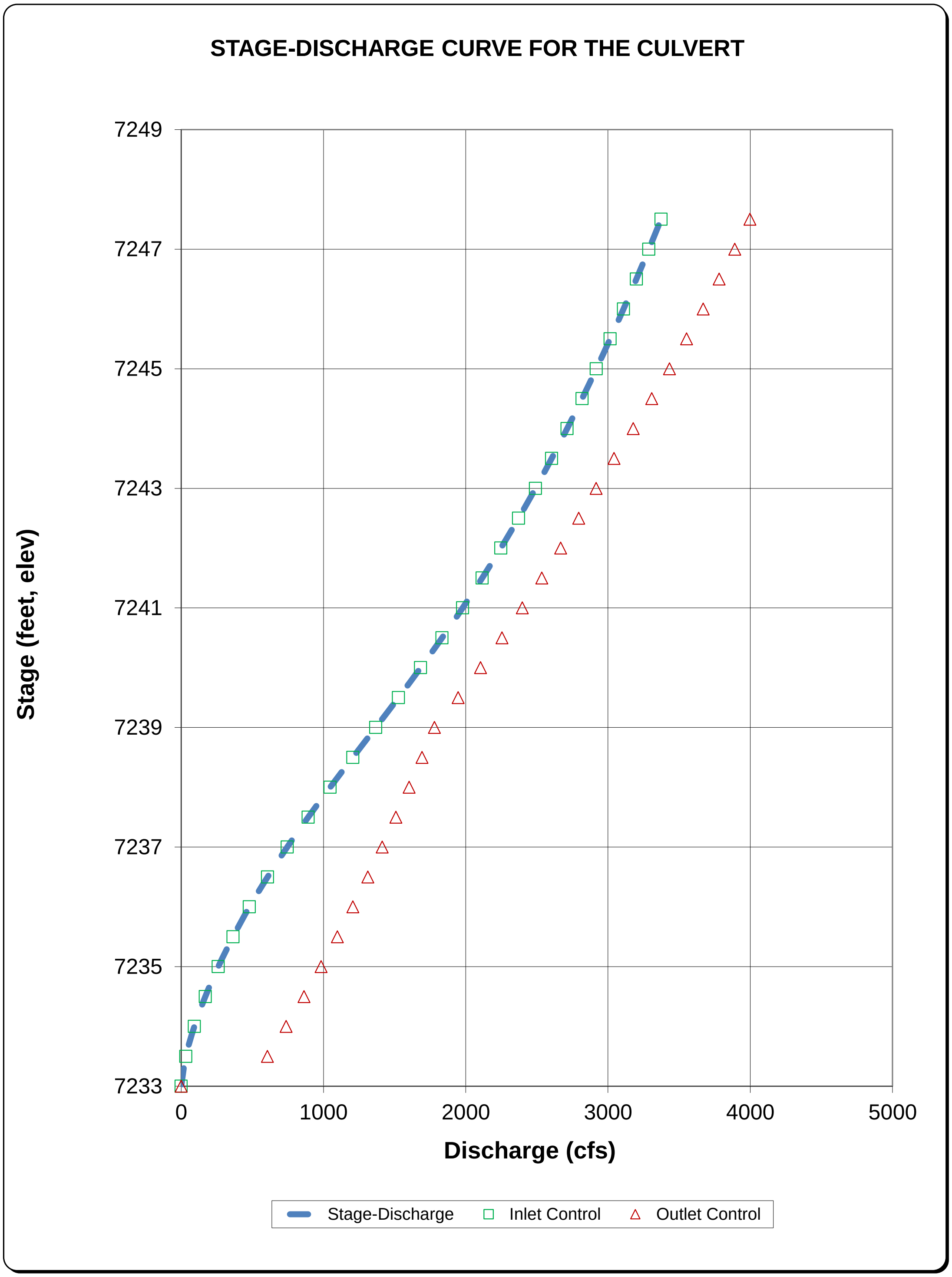
Calculations of Culvert Capacity (output):

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
7233.00		0.00	0.00	**0.00**	No Flow (WS < inlet)	N/A
7233.50		32.70	605.74	**32.70**	Min. Energy. Eqn.	INLET
7234.00		92.40	737.63	**92.40**	Min. Energy. Eqn.	INLET
7234.50		169.50	863.44	**169.50**	Min. Energy. Eqn.	INLET
7235.00		260.70	983.37	**260.70**	Min. Energy. Eqn.	INLET
7235.50		364.50	1,097.81	**364.50**	Min. Energy. Eqn.	INLET
7236.00		479.10	1,207.17	**479.10**	Min. Energy. Eqn.	INLET
7236.50		607.50	1,312.01	**607.50**	Regression Eqn.	INLET
7237.00		745.50	1,412.54	**745.50**	Regression Eqn.	INLET
7237.50		892.80	1,509.35	**892.80**	Regression Eqn.	INLET
7238.00		1,047.30	1,602.63	**1,047.30**	Regression Eqn.	INLET
7238.50		1,206.60	1,692.77	**1,206.60**	Regression Eqn.	INLET
7239.00		1,367.70	1,780.18	**1,367.70**	Regression Eqn.	INLET
7239.50		1,527.30	1,947.14	**1,527.30**	Regression Eqn.	INLET
7240.00		1,683.30	2,104.90	**1,683.30**	Regression Eqn.	INLET
7240.50		1,833.90	2,255.01	**1,833.90**	Regression Eqn.	INLET
7241.00		1,978.20	2,398.26	**1,978.20**	Regression Eqn.	INLET
7241.50		2,115.60	2,535.44	**2,115.60**	Regression Eqn.	INLET
7242.00		2,246.70	2,667.52	**2,246.70**	Regression Eqn.	INLET
7242.50		2,371.50	2,794.51	**2,371.50**	Regression Eqn.	INLET
7243.00		2,490.60	2,917.38	**2,490.60**	Regression Eqn.	INLET
7243.50		2,604.30	3,042.41	**2,604.30**	Regression Eqn.	INLET
7244.00		2,713.20	3,177.82	**2,713.20**	Regression Eqn.	INLET
7244.50		2,817.90	3,307.55	**2,817.90**	Regression Eqn.	INLET
7245.00		2,918.40	3,432.39	**2,918.40**	Regression Eqn.	INLET
7245.50		3,015.30	3,552.91	**3,015.30**	Regression Eqn.	INLET
7246.00		3,109.20	3,669.31	**3,109.20**	Regression Eqn.	INLET
7246.50		3,199.80	3,782.19	**3,199.80**	Regression Eqn.	INLET
7247.00		3,287.70	3,891.93	**3,287.70**	Regression Eqn.	INLET
7247.50		3,373.20	3,998.54	**3,373.20**	Regression Eqn.	INLET

Processing Time: 00.70 Seconds

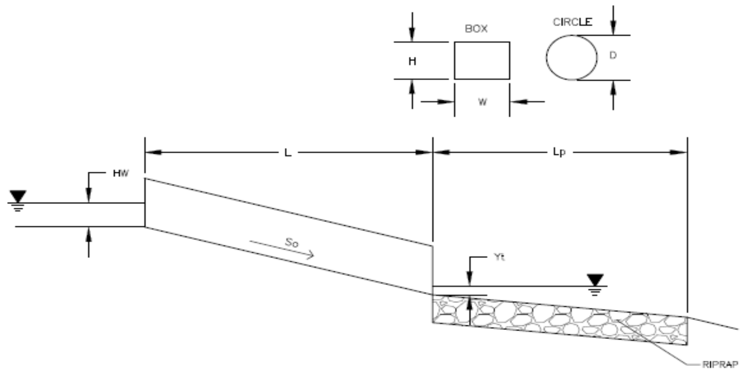
CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Timberridge Estates
Basin ID: Arroya Lane Crossing Sand Creek (2,607 cfs) - 3-6'x12' Conc Box Culverts



Determination of Culvert Headwater and Outlet Protection

Project: **Timberridge Estates**
Basin ID: **Arroya Lane Crossing Sand Creek (2,607 cfs) - 3-6'x12' Conc Box Culverts**



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

Supercritical Flow! Using Ha to calculate protection type.

Design Information (Input):

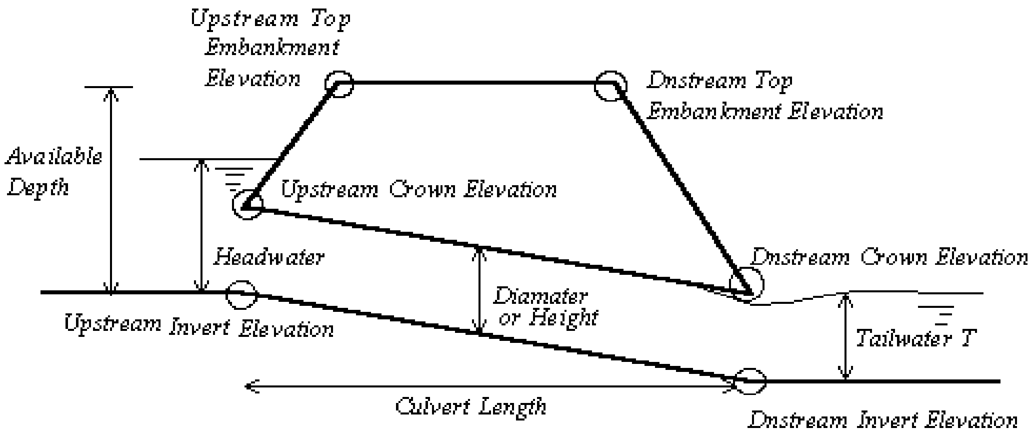
Design Discharge	Q =	2607	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =		inches
Inlet Edge Type (Choose from pull-down list)			
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	Height (Rise) =	6	ft
Barrel Width (Span) in Feet	Width (Span) =	12	ft
Inlet Edge Type (Choose from pull-down list)	Square Edge w/ 90-15 Deg. Headwall		
Number of Barrels	No =	3	
Inlet Elevation	Elev IN =	7233	ft
Outlet Elevation **OR** Slope	Elev OUT =	7232	ft
Culvert Length	L =	100	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 =	5	ft/s

Required Protection (Output):

Tailwater Surface Height	Y_t =	2.40	ft
Flow Area at Max Channel Velocity	A_t =	173.80	ft^2
Culvert Cross Sectional Area Available	A =	72.00	ft^2
Entrance Loss Coefficient	k_e =	0.50	
Friction Loss Coefficient	k_f =	0.29	
Sum of All Losses Coefficients	k_s =	1.79	ft
Culvert Normal Depth	Y_n =	3.66	ft
Culvert Critical Depth	Y_c =	5.46	ft
Tailwater Depth for Design	d =	5.73	ft
Adjusted Diameter **OR** Adjusted Rise	H_a =	4.83	ft
Expansion Factor	1/(2*tan(Θ)) =	2.85	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/WH^1.5 =	4.93	$ft^{0.5}/s$
Froude Number	Fr =	1.83	**Supercritical!**
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/H =	0.50	
Inlet Control Headwater	HW_I =	10.51	ft
Outlet Control Headwater	HW_O =	8.77	
Design Headwater Elevation	**HW =**	**7,243.51**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/H =**	**1.75**	**HW/H > 1.5!**
Minimum Theoretical Riprap Size	d_{50} =	11	in
Nominal Riprap Size	d_{50} =	12	in
UDFCD Riprap Type	**Type =**	**M**	
Length of Protection	**L_p =**	**60**	**ft**
Width of Protection	**T =**	**34**	**ft**

Vertical Profile for the Culvert

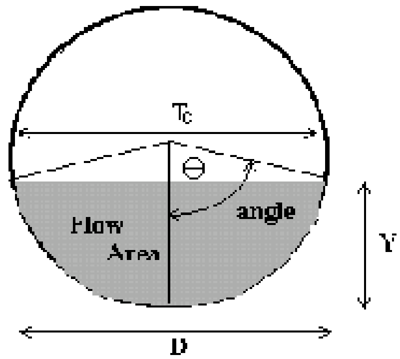
Project = **Timberridge Estates**
Box ID = **Arroya Lane Crossing Sand Creek (2,607 cfs) - 3-6'x12' Conc Box Culverts**



Culvert Information (Input)			
Barrel Diameter or Height	D or H =	72.00	inches
Barrel Length	L =	100.00	ft
Barrel Invert Slope	So =	0.0100	ft/ft
Downstream Invert Elevation	EDI =	7232.00	ft
Downstream Top Embankment Elevation	EDT =	7244.00	ft
Upstream Top Embankment Elevation	EUT =	7244.00	ft
Design Headwater Depth (not elev.)	Hw =	8.70	ft
Tailwater Depth (not elev.)	Yt =	5.73	ft
Culvert Hydraulics (Calculated)			
Available Headwater Depth	HW-a =	11.00	ft
Design Hw/D ratio	Hw/D =	1.45	
Culvert Vertical Profile			
Upstream Invert Elevation	EUI =	7233.00	ft
Upstream Crown Elevation	EUC =	7239.00	ft
Upstream Soil Cover Depth	Upsoil =	5.00	ft
Downstream Invert Elevation	EDI =	7232.00	ft
Downstream Crown Elevation	EDC =	7238.00	ft
Downstream Soil Cover Depth	Dnsoil =	6.00	ft

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

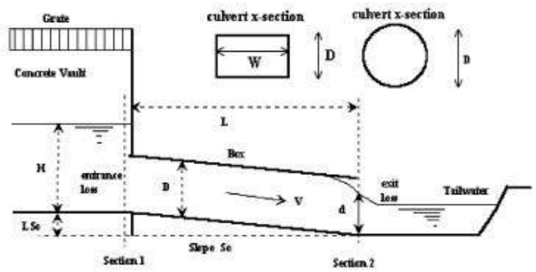
Project: **Timberridge Estates**
Pipe ID: **EDB South Inlet (8.2 cfs) - 18" RCP**



Design Information (Input)			
Pipe Invert Slope	So =	0.0500	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	18.00	inches
Design discharge	**Q =**	**8.20**	**cfs**
Full-flow Capacity (Calculated)			
Full-flow area	Af =	1.77	sq ft
Full-flow wetted perimeter	Pf =	4.71	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	23.55	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.38	radians
Flow area	An =	0.68	sq ft
Top width	Tn =	1.47	ft
Wetted perimeter	Pn =	2.08	ft
Flow depth	Yn =	0.61	ft
Flow velocity	Vn =	12.13	fps
Discharge	Qn =	8.20	cfs
Percent Full Flow	Flow =	34.8%	of full flow
Normal Depth Froude Number	Fr_n =	3.16	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	2.07	radians
Critical flow area	Ac =	1.40	sq ft
Critical top width	Tc =	1.32	ft
Critical flow depth	Yc =	1.11	ft
Critical flow velocity	Vc =	5.85	fps
Critical Depth Froude Number	Fr_c =	1.00	

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

Project: **Timberridge Estates**
Basin ID: **EDB South Inlet (8.2 cfs) - 18" RCP**
Status:



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D =	18	inches
	Inlet Edge Type (choose from pull-down list)		Grooved End with Headwall	
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 =	7252.5	ft. elev.
	Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.)	Outlet Elev =	7250	ft. elev.
	Culvert Length in Feet	L =	50	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 =	0.91
Sum of All Loss Coefficients	K_s =	2.11
Orifice Inlet Condition Coefficient	C_d =	0.99
Minimum Energy Condition Coefficient	KE_{low} =	-0.1741

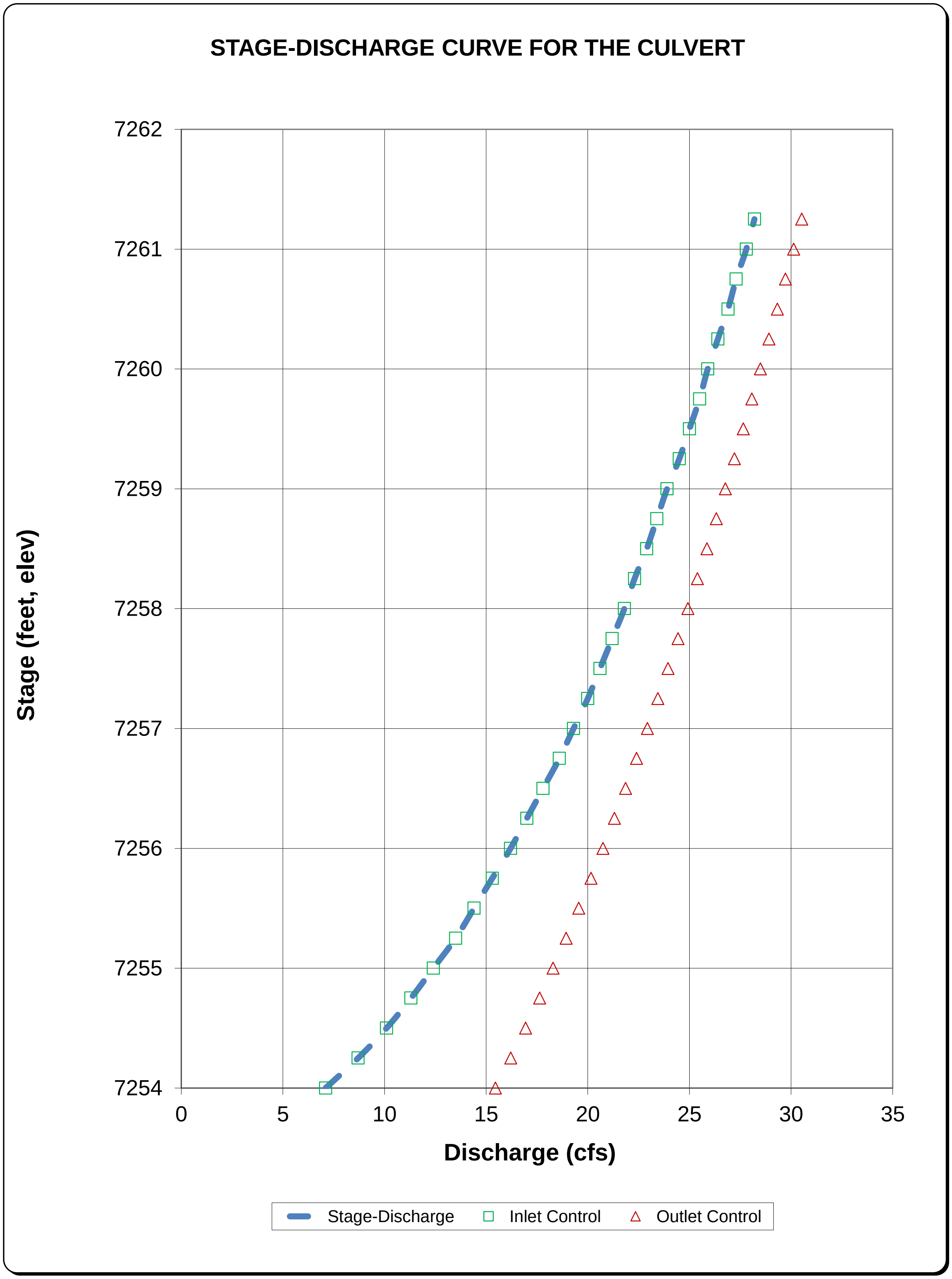
Calculations of Culvert Capacity (output):

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
7254.00		7.10	15.46	**7.10**	Regression Eqn.	INLET
7254.25		8.70	16.21	**8.70**	Regression Eqn.	INLET
7254.50		10.10	16.94	**10.10**	Regression Eqn.	INLET
7254.75		11.30	17.63	**11.30**	Regression Eqn.	INLET
7255.00		12.40	18.29	**12.40**	Regression Eqn.	INLET
7255.25		13.50	18.93	**13.50**	Regression Eqn.	INLET
7255.50		14.40	19.55	**14.40**	Regression Eqn.	INLET
7255.75		15.30	20.15	**15.30**	Regression Eqn.	INLET
7256.00		16.20	20.74	**16.20**	Regression Eqn.	INLET
7256.25		17.00	21.30	**17.00**	Regression Eqn.	INLET
7256.50		17.80	21.86	**17.80**	Regression Eqn.	INLET
7256.75		18.60	22.40	**18.60**	Regression Eqn.	INLET
7257.00		19.30	22.92	**19.30**	Regression Eqn.	INLET
7257.25		20.00	23.44	**20.00**	Orifice Eqn.	INLET
7257.50		20.60	23.95	**20.60**	Orifice Eqn.	INLET
7257.75		21.20	24.44	**21.20**	Orifice Eqn.	INLET
7258.00		21.80	24.92	**21.80**	Orifice Eqn.	INLET
7258.25		22.30	25.39	**22.30**	Orifice Eqn.	INLET
7258.50		22.90	25.86	**22.90**	Orifice Eqn.	INLET
7258.75		23.40	26.32	**23.40**	Orifice Eqn.	INLET
7259.00		23.90	26.77	**23.90**	Orifice Eqn.	INLET
7259.25		24.50	27.21	**24.50**	Orifice Eqn.	INLET
7259.50		25.00	27.65	**25.00**	Orifice Eqn.	INLET
7259.75		25.50	28.07	**25.50**	Orifice Eqn.	INLET
7260.00		25.90	28.49	**25.90**	Orifice Eqn.	INLET
7260.25		26.40	28.91	**26.40**	Orifice Eqn.	INLET
7260.50		26.90	29.33	**26.90**	Orifice Eqn.	INLET
7260.75		27.30	29.72	**27.30**	Orifice Eqn.	INLET
7261.00		27.80	30.12	**27.80**	Orifice Eqn.	INLET
7261.25		28.20	30.52	**28.20**	Orifice Eqn.	INLET

Processing Time: 00.84 Seconds

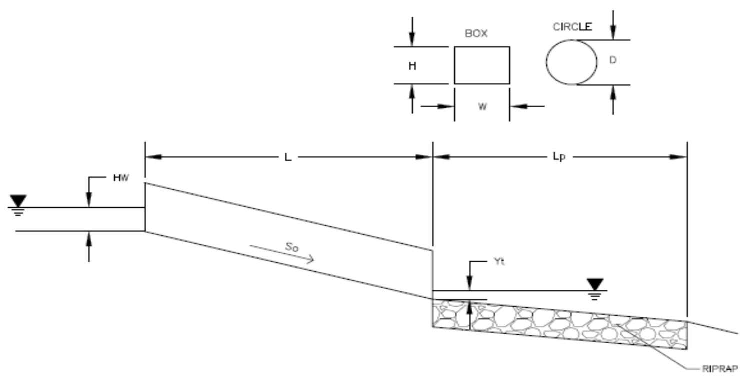
CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Timberridge Estates
Basin ID: EDB South Inlet (8.2 cfs) - 18" RCP



Determination of Culvert Headwater and Outlet Protection

Project: Timberridge Estates
Basin ID: EDB South Inlet (8.2 cfs) - 18" RCP



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

Supercritical Flow! Using Da to calculate protection type.

Design Information (Input):

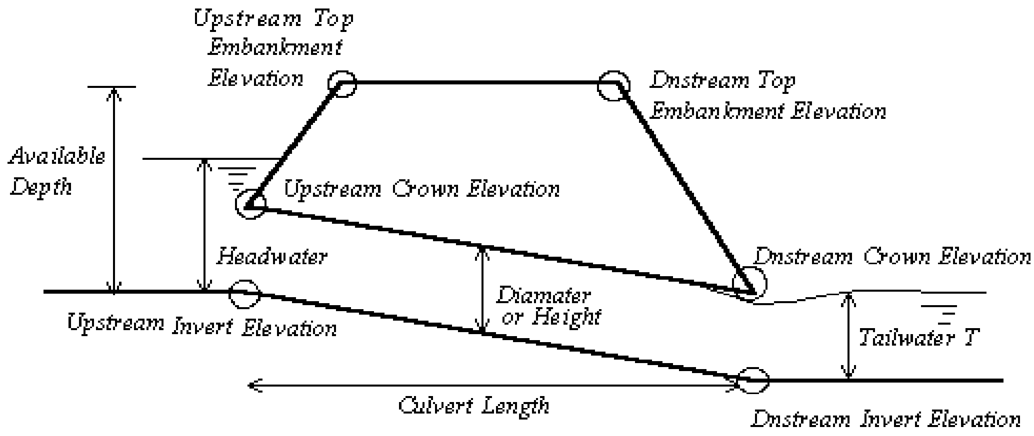
	Design Discharge	Q =	8.2	cfs
Circular Culvert:				
	Barrel Diameter in Inches	D =	18	inches
	Inlet Edge Type (Choose from pull-down list)	Grooved End with Headwall		
Box Culvert:			**OR**	
	Barrel Height (Rise) in Feet	Height (Rise) =		ft
	Barrel Width (Span) in Feet	Width (Span) =		ft
	Inlet Edge Type (Choose from pull-down list)			
	Number of Barrels	No =	1	
	Inlet Elevation	Elev IN =	7252.5	ft
	Outlet Elevation **OR** Slope	Elev OUT =	7250	ft
	Culvert Length	L =	50	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 =	7254	ft
	Max Allowable Channel Velocity	V =	5	ft/s

Required Protection (Output):

Tailwater Surface Height	Y_t =	4.00	ft
Flow Area at Max Channel Velocity	A_t =	1.64	ft^2
Culvert Cross Sectional Area Available	A =	1.77	ft^2
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	0.91	
Sum of All Losses Coefficients	k_s =	2.11	ft
Culvert Normal Depth	Y_n =	0.61	ft
Culvert Critical Depth	Y_c =	1.11	ft
Tailwater Depth for Design	d =	1.30	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	1.06	ft
Expansion Factor	1/(2*tan(Θ)) =	6.70	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	2.98	$ft^{0.5}/s$
Froude Number	Fr =	3.16	**Supercritical!**
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	3.79	
Inlet Control Headwater	HW_I =	1.67	ft
Outlet Control Headwater	HW_O =	-0.49	
Design Headwater Elevation	**HW =**	**7,254.17**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**1.11**	
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 **=**	**5**	**ft**
Width of Protection	**T =**	**3**	**ft**

Vertical Profile for the Culvert

Project = Timberridge Estates
Box ID = EDB South Inlet (8.2 cfs) - 18" RCP



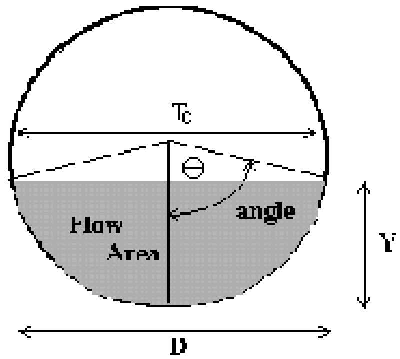
Culvert Information (Input)			
Barrel Diameter or Height	D or H =	18.00	inches
Barrel Length	L =	50.00	ft
Barrel Invert Slope	So =	0.0500	ft/ft
Downstream Invert Elevation	EDI =	7250.00	ft
Downstream Top Embankment Elevation	EDT =	7254.50	ft
Upstream Top Embankment Elevation	EUT =	7257.00	ft
Design Headwater Depth (not elev.)	Hw =	1.67	ft
Tailwater Depth (not elev.)	Yt =	1.30	ft

Culvert Hydraulics (Calculated)			
Available Headwater Depth	HW-a =	4.50	ft
Design Hw/D ratio	Hw/D =	1.11	
Culvert Vertical Profile			
Upstream Invert Elevation	EUI =	7252.50	ft
Upstream Crown Elevation	EUC =	7254.00	ft
Upstream Soil Cover Depth	Upsoil =	3.00	ft
Downstream Invert Elevation	EDI =	7250.00	ft
Downstream Crown Elevation	EDC =	7251.50	ft
Downstream Soil Cover Depth	Dnsoil =	3.00	ft

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

Project: **TIMBERRIDGE ESTATES**

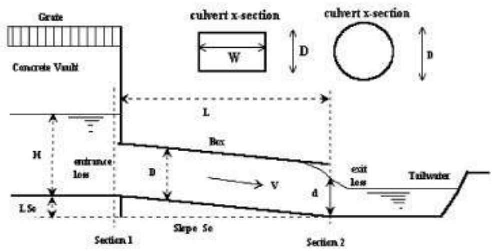
Pipe ID: **Detention Basin Outlet (50.1 cfs) - 30" RCP**



Design Information (Input)			
Pipe Invert Slope	So =	0.0180	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	30.00	inches
Design discharge	**Q =**	**50.10**	**cfs**
Full-flow Capacity (Calculated)			
Full-flow area	Af =	4.91	sq ft
Full-flow wetted perimeter	Pf =	7.85	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	55.18	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	2.09	radians
Flow area	An =	3.93	sq ft
Top width	Tn =	2.17	ft
Wetted perimeter	Pn =	5.22	ft
Flow depth	Yn =	1.87	ft
Flow velocity	Vn =	12.73	fps
Discharge	Qn =	50.10	cfs
Percent Full Flow	Flow =	90.8%	of full flow
Normal Depth Froude Number	Fr_n =	1.67	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	2.57	radians
Critical flow area	Ac =	4.73	sq ft
Critical top width	Tc =	1.35	ft
Critical flow depth	Yc =	2.30	ft
Critical flow velocity	Vc =	10.60	fps
Critical Depth Froude Number	Fr_c =	1.00	

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

Project: Timberridge Estates
Basin ID: Detention Basin Outlet (50.1 cfs) - 30" RCP
Status:



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D =	30	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/ 90-15 Deg. Headwall	
	Number of Barrels	No =	1	
	Inlet Elevation at Culvert Invert	Inlet Elev =	7246.5	ft. elev.
	Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.)	Outlet Elev =	7243.9	ft. elev.
	Culvert Length in Feet	L =	145	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 =	1.33
Sum of All Loss Coefficients	K_s =	2.53
Orifice Inlet Condition Coefficient	C_d =	0.95
Minimum Energy Condition Coefficient	KE_{low} =	-0.0628

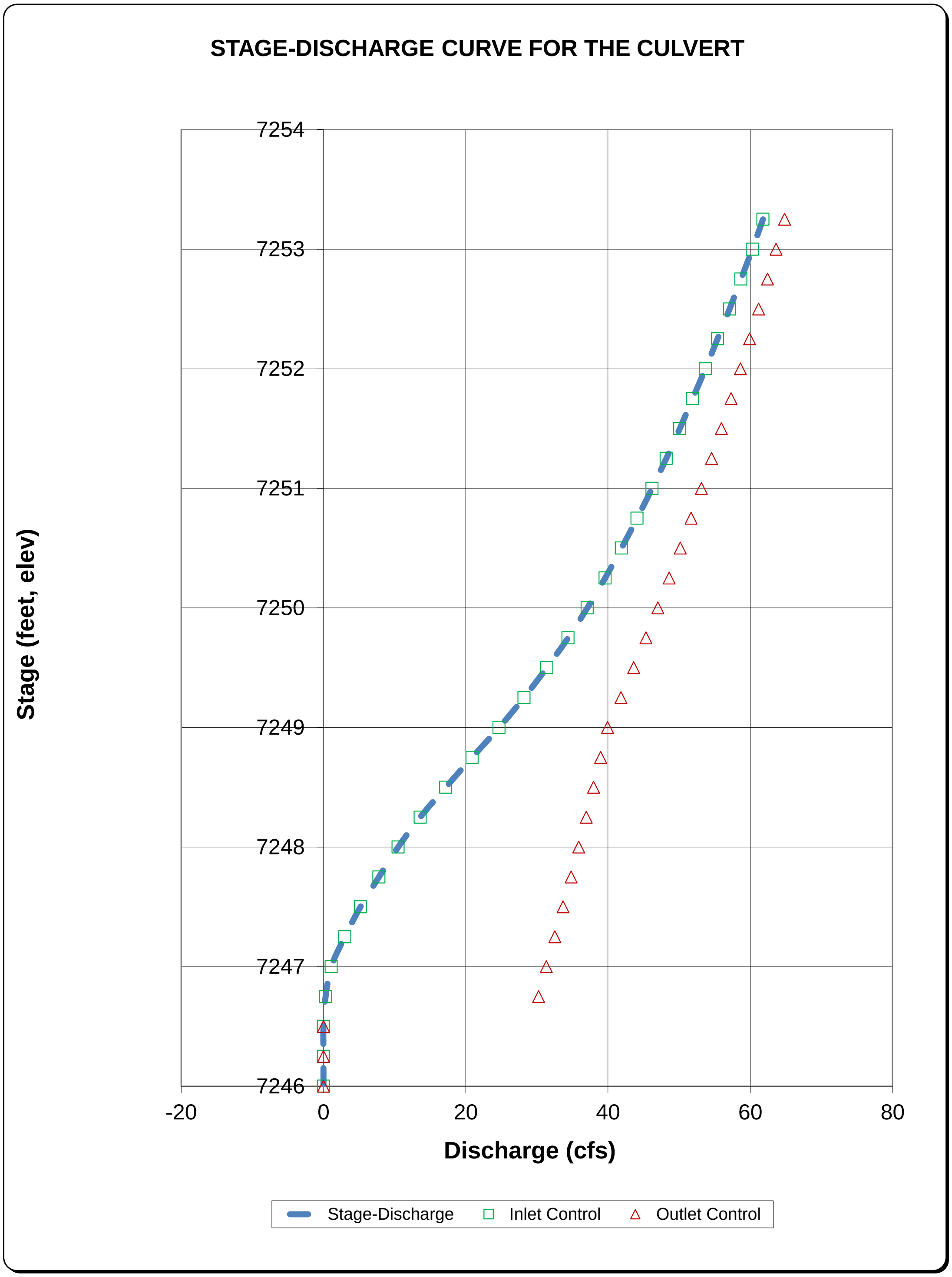
Calculations of Culvert Capacity (output):

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
7246.00		0.00	0.00	**0.00**	No Flow (WS < inlet)	N/A
7246.25		0.00	0.00	**0.00**	No Flow (WS < inlet)	N/A
7246.50		0.00	0.00	**0.00**	No Flow (WS < inlet)	N/A
7246.75		0.30	30.24	**0.30**	Min. Energy. Eqn.	INLET
7247.00		1.10	31.33	**1.10**	Min. Energy. Eqn.	INLET
7247.25		3.00	32.54	**3.00**	Min. Energy. Eqn.	INLET
7247.50		5.20	33.70	**5.20**	Min. Energy. Eqn.	INLET
7247.75		7.80	34.82	**7.80**	Min. Energy. Eqn.	INLET
7248.00		10.50	35.89	**10.50**	Regression Eqn.	INLET
7248.25		13.60	36.96	**13.60**	Regression Eqn.	INLET
7248.50		17.20	37.98	**17.20**	Regression Eqn.	INLET
7248.75		20.90	38.97	**20.90**	Regression Eqn.	INLET
7249.00		24.70	39.96	**24.70**	Regression Eqn.	INLET
7249.25		28.20	41.83	**28.20**	Regression Eqn.	INLET
7249.50		31.40	43.61	**31.40**	Regression Eqn.	INLET
7249.75		34.40	45.34	**34.40**	Regression Eqn.	INLET
7250.00		37.10	47.02	**37.10**	Regression Eqn.	INLET
7250.25		39.60	48.61	**39.60**	Regression Eqn.	INLET
7250.50		41.90	50.17	**41.90**	Regression Eqn.	INLET
7250.75		44.10	51.68	**44.10**	Regression Eqn.	INLET
7251.00		46.20	53.14	**46.20**	Regression Eqn.	INLET
7251.25		48.20	54.57	**48.20**	Regression Eqn.	INLET
7251.50		50.10	55.94	**50.10**	Regression Eqn.	INLET
7251.75		51.90	57.31	**51.90**	Regression Eqn.	INLET
7252.00		53.70	58.63	**53.70**	Regression Eqn.	INLET
7252.25		55.40	59.92	**55.40**	Regression Eqn.	INLET
7252.50		57.10	61.19	**57.10**	Regression Eqn.	INLET
7252.75		58.70	62.42	**58.70**	Regression Eqn.	INLET
7253.00		60.30	63.63	**60.30**	Regression Eqn.	INLET
7253.25		61.80	64.84	**61.80**	Regression Eqn.	INLET

Processing Time: 00.71 Seconds

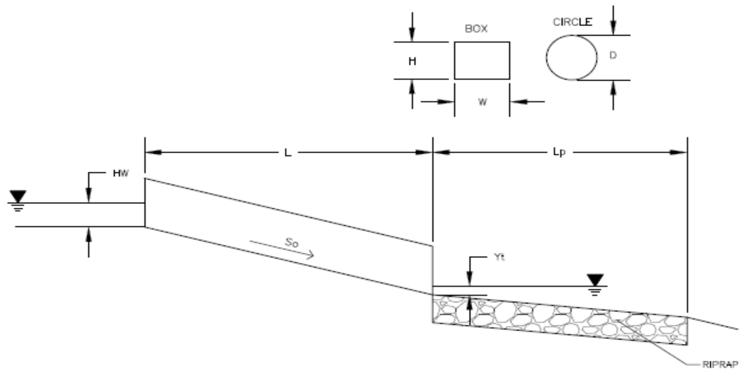
CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: **Timberridge Estates**
Basin ID: **Detention Basin Outlet (50.1 cfs) - 30" RCP**



Determination of Culvert Headwater and Outlet Protection

Project: **Timberridge Estates**
Basin ID: **Detention Basin Outlet (50.1 cfs) - 30" RCP**



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

Supercritical Flow! Using Da to calculate protection type.

Design Information (Input):

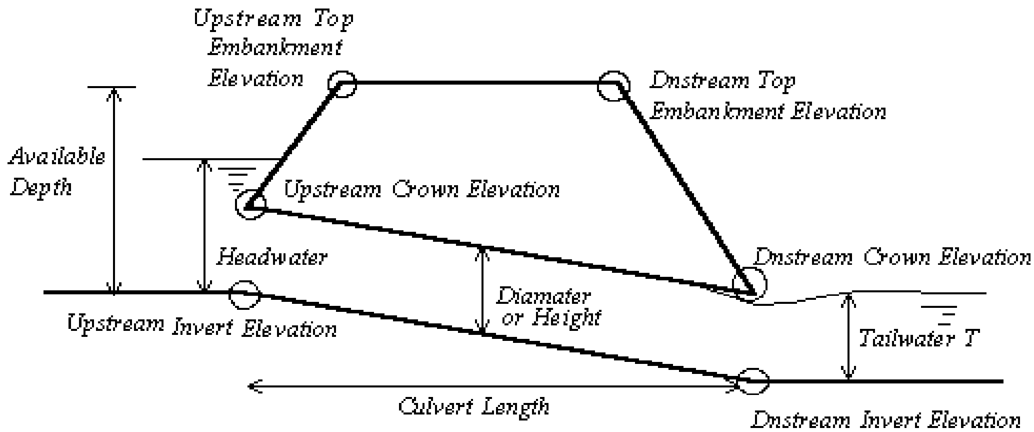
Design Discharge	Q =	50.1	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	30	inches
Inlet Edge Type (Choose from pull-down list)	Grooved End Projection		
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	Height (Rise) =		ft
Barrel Width (Span) in Feet	Width (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	No =	1	
Inlet Elevation	Elev IN =	7246.5	ft
Outlet Elevation **OR** Slope	Elev OUT =	7243.9	ft
Culvert Length	L =	145	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 =	5	ft/s

Required Protection (Output):

Tailwater Surface Height	Y_t =	1.00	ft
Flow Area at Max Channel Velocity	A_t =	10.02	ft^2
Culvert Cross Sectional Area Available	A =	4.91	ft^2
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	1.33	
Sum of All Losses Coefficients	k_s =	2.53	ft
Culvert Normal Depth	Y_n =	1.87	ft
Culvert Critical Depth	Y_c =	2.30	ft
Tailwater Depth for Design	d =	2.40	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	2.19	ft
Expansion Factor	1/(2*tan(Θ)) =	2.93	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	5.07	$ft^{0.5}/s$
Froude Number	Fr =	1.66	**Supercritical!**
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	0.46	
Inlet Control Headwater	HW_I =	5.01	ft
Outlet Control Headwater	HW_O =	3.89	
Design Headwater Elevation	**HW =**	**7,251.51**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**2.00**	**HW/D > 1.5!**
Minimum Theoretical Riprap Size	d_{50} =	11	in
Nominal Riprap Size	d_{50} =	12	in
UDFCD Riprap Type	**Type =**	**M**	
Length of Protection	**L_p =**	**23**	**ft**
Width of Protection	**T =**	**11**	**ft**

Vertical Profile for the Culvert

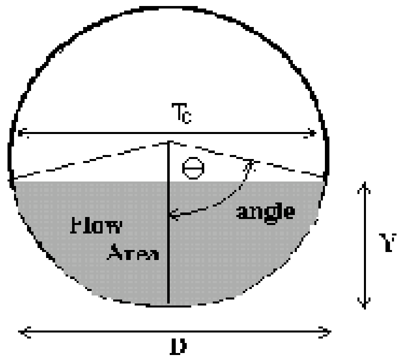
Project = **Timberridge Estates**
Box ID = **Detention Basin Outlet (50.1 cfs) - 30" RCP**



Culvert Information (Input)			
Barrel Diameter or Height	D or H =	30.00	inches
Barrel Length	L =	145.00	ft
Barrel Invert Slope	So =	0.0180	ft/ft
Downstream Invert Elevation	EDI =	7243.90	ft
Downstream Top Embankment Elevation	EDT =	7244.00	ft
Upstream Top Embankment Elevation	EUT =	7252.30	ft
Design Headwater Depth (not elev.)	Hw =	5.01	ft
Tailwater Depth (not elev.)	Yt =	0.46	ft
Culvert Hydraulics (Calculated)			
Available Headwater Depth	HW-a =	5.79	ft
Design Hw/D ratio	Hw/D =	2.00	
Culvert Vertical Profile			
Upstream Invert Elevation	EUI =	7246.51	ft
Upstream Crown Elevation	EUC =	7249.01	ft
Upstream Soil Cover Depth	Upsoil =	3.29	ft
Downstream Invert Elevation	EDI =	7243.90	ft
Downstream Crown Elevation	EDC =	7246.40	ft
Downstream Soil Cover Depth	Dnsoil =	-2.40	ft

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

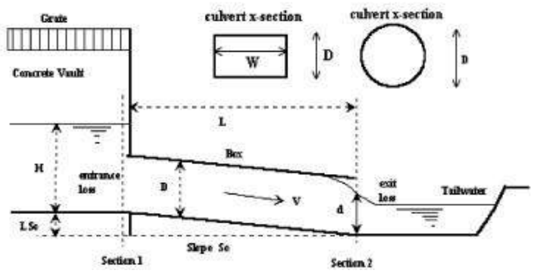
Project: **Timberridge Estates**
Pipe ID: **SF DP7 North Inlet (0.3 cfs) - 6" HDPE**



Design Information (Input)			
Pipe Invert Slope	So =	0.0130	ft/ft
Pipe Manning's n-value	n =	0.0120	
Pipe Diameter	D =	6.00	inches
Design discharge	**Q =**	**0.30**	**cfs**
Full-flow Capacity (Calculated)			
Full-flow area	Af =	0.20	sq ft
Full-flow wetted perimeter	Pf =	1.57	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	0.69	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	1.49	radians
Flow area	An =	0.09	sq ft
Top width	Tn =	0.50	ft
Wetted perimeter	Pn =	0.74	ft
Flow depth	Yn =	0.23	ft
Flow velocity	Vn =	3.41	fps
Discharge	Qn =	0.30	cfs
Percent Full Flow	Flow =	43.5%	of full flow
Normal Depth Froude Number	Fr_n =	1.43	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	1.68	radians
Critical flow area	Ac =	0.11	sq ft
Critical top width	Tc =	0.50	ft
Critical flow depth	Yc =	0.28	ft
Critical flow velocity	Vc =	2.69	fps
Critical Depth Froude Number	Fr_c =	1.00	

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

Project: **Timberridge Estates**
Basin ID: **SF DP7 North Inlet (0.3 cfs) - 6" HDPE**
Status:



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D =	6	inches
	Inlet Edge Type (choose from pull-down list)		Grooved End with Headwall	
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 =	7248	ft. elev.
	Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.)	Outlet Elev =	7245	ft. elev.
	Culvert Length in Feet	L =	222	ft.
	Manning's Roughness	n =	0.012	
	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 =	14.83
Sum of All Loss Coefficients	K_s =	16.03
Orifice Inlet Condition Coefficient	C_d =	1.04
Minimum Energy Condition Coefficient	KE_{low} =	-0.7045

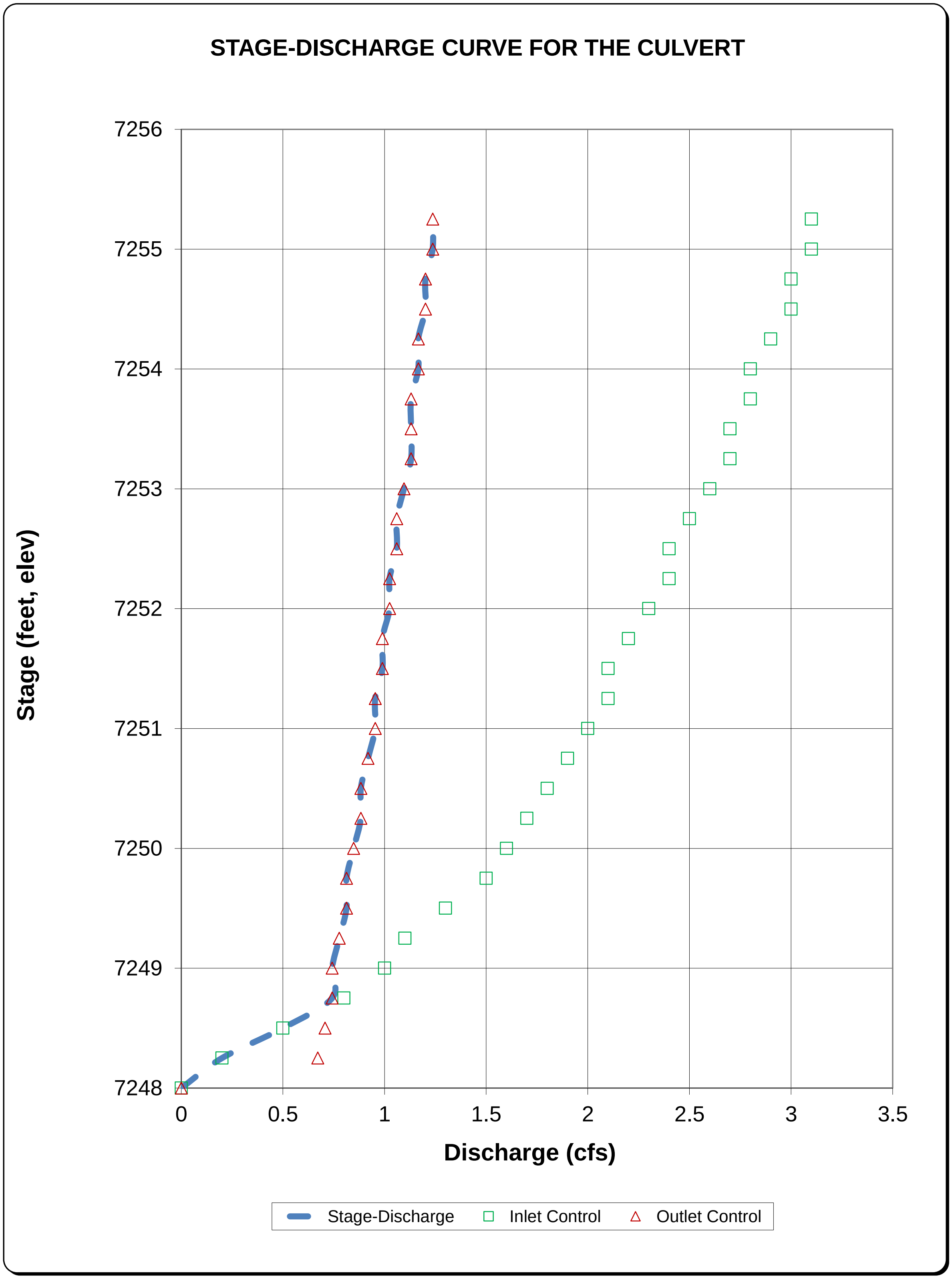
Calculations of Culvert Capacity (output):

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
7248.00		0.00	0.00	**0.00**	No Flow (WS < inlet)	N/A
7248.25		0.20	0.67	**0.20**	Min. Energy. Eqn.	INLET
7248.50		0.50	0.71	**0.50**	Regression Eqn.	INLET
7248.75		0.80	0.74	**0.74**	Regression Eqn.	OUTLET
7249.00		1.00	0.74	**0.74**	Regression Eqn.	OUTLET
7249.25		1.10	0.78	**0.78**	Regression Eqn.	OUTLET
7249.50		1.30	0.81	**0.81**	Regression Eqn.	OUTLET
7249.75		1.50	0.81	**0.81**	Orifice Eqn.	OUTLET
7250.00		1.60	0.85	**0.85**	Orifice Eqn.	OUTLET
7250.25		1.70	0.88	**0.88**	Orifice Eqn.	OUTLET
7250.50		1.80	0.88	**0.88**	Orifice Eqn.	OUTLET
7250.75		1.90	0.92	**0.92**	Orifice Eqn.	OUTLET
7251.00		2.00	0.95	**0.95**	Orifice Eqn.	OUTLET
7251.25		2.10	0.95	**0.95**	Orifice Eqn.	OUTLET
7251.50		2.10	0.99	**0.99**	Orifice Eqn.	OUTLET
7251.75		2.20	0.99	**0.99**	Orifice Eqn.	OUTLET
7252.00		2.30	1.02	**1.02**	Orifice Eqn.	OUTLET
7252.25		2.40	1.02	**1.02**	Orifice Eqn.	OUTLET
7252.50		2.40	1.06	**1.06**	Orifice Eqn.	OUTLET
7252.75		2.50	1.06	**1.06**	Orifice Eqn.	OUTLET
7253.00		2.60	1.10	**1.10**	Orifice Eqn.	OUTLET
7253.25		2.70	1.13	**1.13**	Orifice Eqn.	OUTLET
7253.50		2.70	1.13	**1.13**	Orifice Eqn.	OUTLET
7253.75		2.80	1.13	**1.13**	Orifice Eqn.	OUTLET
7254.00		2.80	1.17	**1.17**	Orifice Eqn.	OUTLET
7254.25		2.90	1.17	**1.17**	Orifice Eqn.	OUTLET
7254.50		3.00	1.20	**1.20**	Orifice Eqn.	OUTLET
7254.75		3.00	1.20	**1.20**	Orifice Eqn.	OUTLET
7255.00		3.10	1.24	**1.24**	Orifice Eqn.	OUTLET
7255.25		3.10	1.24	**1.24**	Orifice Eqn.	OUTLET

Processing Time: 34.38 Seconds

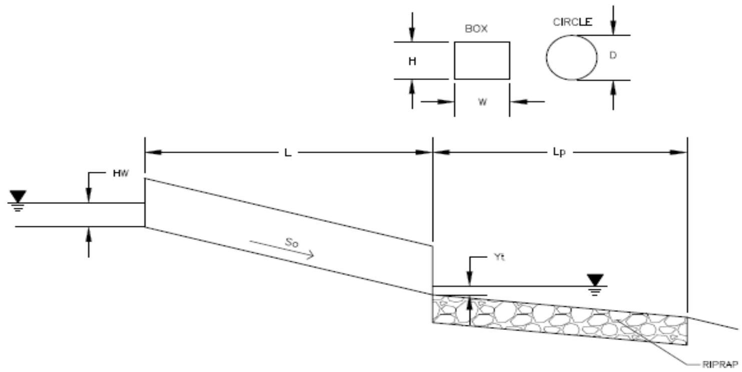
CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Timberridge Estates
Basin ID: SF DP7 North Inlet (0.3 cfs) - 6" HDPE



Determination of Culvert Headwater and Outlet Protection

Project: Timberridge Estates
Basin ID: SF DP7 North Inlet (0.3 cfs) - 6" HDPE



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

Supercritical Flow! Using Da to calculate protection type.

Design Information (Input):

Design Discharge	Q =	0.3	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	6	inches
Inlet Edge Type (Choose from pull-down list)	Grooved End with Headwall		
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 =	7248	ft
Outlet Elevation **OR** Slope	Elev OUT =	7245	ft
Culvert Length	L =	222	ft
Manning's Roughness	n =	0.012	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	Elev Y_t =	7245	ft
Max Allowable Channel Velocity	V =	5	ft/s

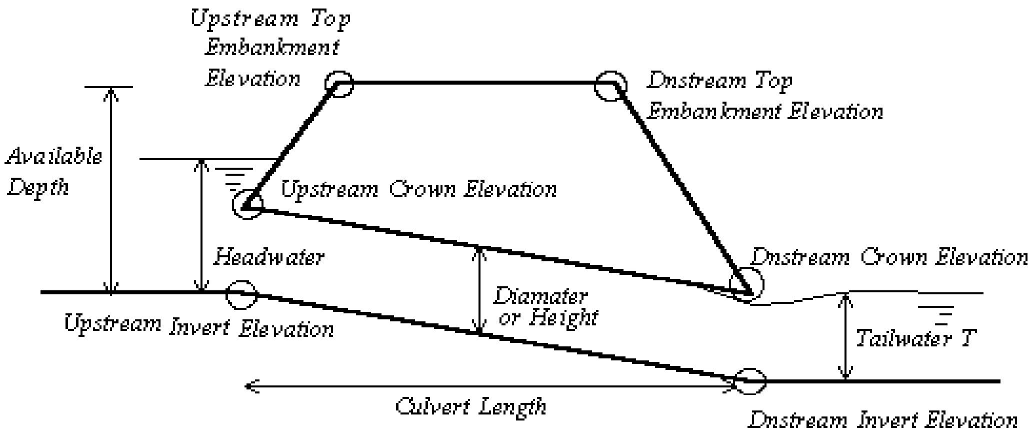
Tailwater ELEVATION is less than outlet elevation, using 0.4 x RISE as Yt

Required Protection (Output):

Tailwater Surface Height	Y_t =	0.20	ft
Flow Area at Max Channel Velocity	A_t =	0.06	ft^2
Culvert Cross Sectional Area Available	A =	0.20	ft^2
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	14.83	
Sum of All Losses Coefficients	k_s =	16.03	ft
Culvert Normal Depth	Y_n =	0.23	ft
Culvert Critical Depth	Y_c =	0.28	ft
Tailwater Depth for Design	d =	0.39	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	0.36	ft
Expansion Factor	1/(2*tan(Θ)) =	6.70	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	1.70	$ft^{0.5}/s$
Froude Number	Fr =	1.46	Supercritical!
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	0.55	
Inlet Control Headwater	HW_I =	0.39	ft
Outlet Control Headwater	HW_O =	-2.03	
Design Headwater Elevation	**HW =**	**7,248.39**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**0.79**	
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 **=**	**2**	**ft**
Width of Protection	**T =**	**1**	**ft**

Vertical Profile for the Culvert

Project = **Timberridge Estates**
Box ID = **SF DP7 North Inlet (0.3 cfs) - 6" HDPE**

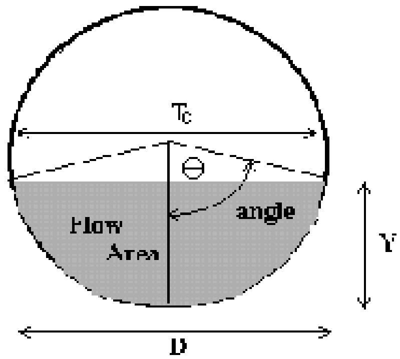


Culvert Information (Input)			
Barrel Diameter or Height	D or H =	6.00	inches
Barrel Length	L =	222.00	ft
Barrel Invert Slope	So =	0.0130	ft/ft
Downstream Invert Elevation	EDI =	7245.00	ft
Downstream Top Embankment Elevation	EDT =	7246.00	ft
Upstream Top Embankment Elevation	EUT =	7252.00	ft
Design Headwater Depth (not elev.)	Hw =	0.39	ft
Tailwater Depth (not elev.)	Yt =	0.39	ft

Culvert Hydraulics (Calculated)			
Available Headwater Depth	HW-a =	4.11	ft
Design Hw/D ratio	Hw/D =	0.78	
Culvert Vertical Profile			
Upstream Invert Elevation	EUI =	7247.89	ft
Upstream Crown Elevation	EUC =	7248.39	ft
Upstream Soil Cover Depth	Upsoil =	3.61	ft
Downstream Invert Elevation	EDI =	7245.00	ft
Downstream Crown Elevation	EDC =	7245.50	ft
Downstream Soil Cover Depth	Dnsoil =	0.50	ft

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

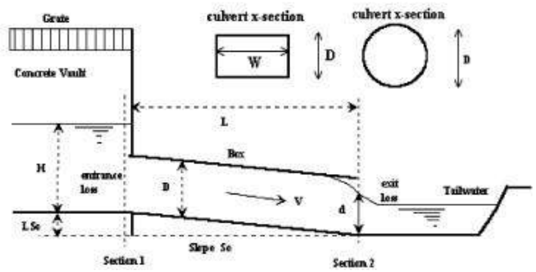
Project: Timberridge Estates
Pipe ID: SF DP7 North Outlet (0.3 cfs) - 12" HDPE



Design Information (Input)			
Pipe Invert Slope	So =	0.0220	ft/ft
Pipe Manning's n-value	n =	0.0120	
Pipe Diameter	D =	12.00	inches
Design discharge	**Q =**	**0.30**	**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 =	5.74	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	0.81	radians
Flow area	An =	0.08	sq ft
Top width	Tn =	0.72	ft
Wetted perimeter	Pn =	0.81	ft
Flow depth	Yn =	0.16	ft
Flow velocity	Vn =	3.86	fps
Discharge	Qn =	0.30	cfs
Percent Full Flow	Flow =	5.2%	of full flow
Normal Depth Froude Number	Fr_n =	2.08	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	0.99	radians
Critical flow area	Ac =	0.13	sq ft
Critical top width	Tc =	0.84	ft
Critical flow depth	Yc =	0.23	ft
Critical flow velocity	Vc =	2.26	fps
Critical Depth Froude Number	Fr_c =	1.00	

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

Project: Timberridge Estates
Basin ID: SF DP7 North Outlet (0.3 cfs) - 12" HDPE
Status:



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D =	12	inches
	Inlet Edge Type (choose from pull-down list)		Grooved End with Headwall	
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 =	7241.5	ft. elev.
	Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.)	Outlet Elev =	7240	ft. elev.
	Culvert Length in Feet	L =	67	ft.
	Manning's Roughness	n =	0.012	
	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 =	1.78
Sum of All Loss Coefficients	K_s =	2.98
Orifice Inlet Condition Coefficient	C_d =	0.99
Minimum Energy Condition Coefficient	KE_{low} =	-0.0898

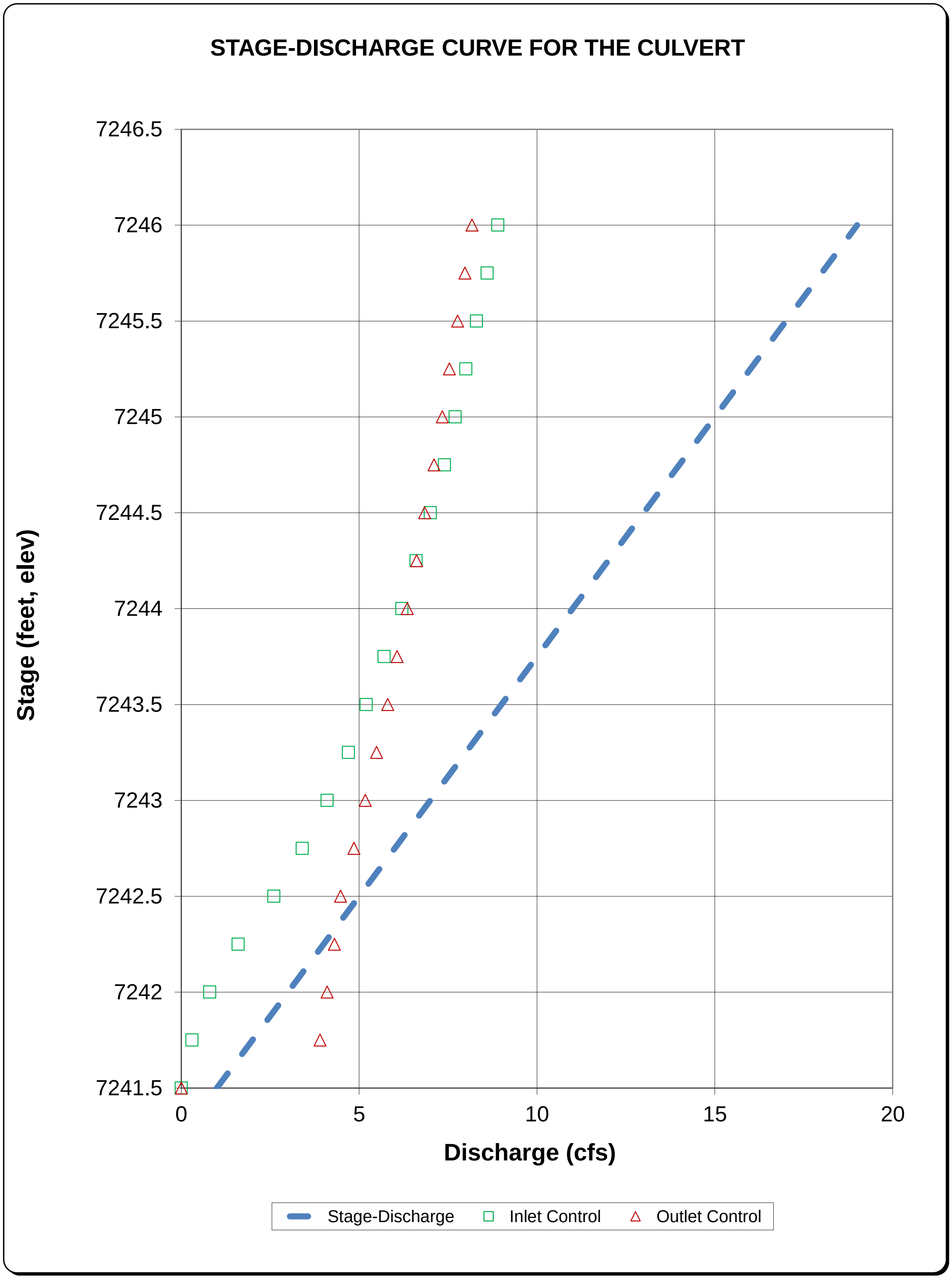
Calculations of Culvert Capacity (output):

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
7241.50		0.00	0.00	**0.00**	No Flow (WS < inlet)	N/A
7241.75		0.30	3.90	**0.30**	Min. Energy. Eqn.	INLET
7242.00		0.80	4.10	**0.80**	Min. Energy. Eqn.	INLET
7242.25		1.60	4.30	**1.60**	Regression Eqn.	INLET
7242.50		2.60	4.48	**2.60**	Regression Eqn.	INLET
7242.75		3.40	4.85	**3.40**	Regression Eqn.	INLET
7243.00		4.10	5.17	**4.10**	Regression Eqn.	INLET
7243.25		4.70	5.49	**4.70**	Regression Eqn.	INLET
7243.50		5.20	5.80	**5.20**	Regression Eqn.	INLET
7243.75		5.70	6.06	**5.70**	Regression Eqn.	INLET
7244.00		6.20	6.35	**6.20**	Regression Eqn.	INLET
7244.25		6.60	6.61	**6.60**	Regression Eqn.	INLET
7244.50		7.00	6.84	**6.84**	Regression Eqn.	OUTLET
7244.75		7.40	7.10	**7.10**	Orifice Eqn.	OUTLET
7245.00		7.70	7.33	**7.33**	Orifice Eqn.	OUTLET
7245.25		8.00	7.54	**7.54**	Orifice Eqn.	OUTLET
7245.50		8.30	7.77	**7.77**	Orifice Eqn.	OUTLET
7245.75		8.60	7.97	**7.97**	Orifice Eqn.	OUTLET
7246.00		8.90	8.17	**8.17**	Orifice Eqn.	OUTLET
					Invalid Entry	
					Invalid Entry	
					Invalid Entry	
					Invalid Entry	
					Invalid Entry	
					Invalid Entry	
					Invalid Entry	
					Invalid Entry	
					Invalid Entry	
					Invalid Entry	
					Invalid Entry	

Processing Time: 18.77 Seconds

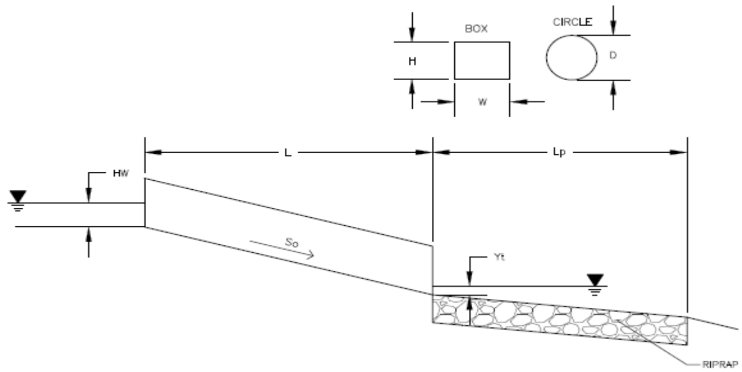
CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Timberridge Estates
Basin ID: SF DP7 North Outlet (0.3 cfs) - 12" HDPE



Determination of Culvert Headwater and Outlet Protection

Project: Timberridge Estates
Basin ID: SF DP7 North Outlet (0.3 cfs) - 12" HDPE



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

Supercritical Flow! Using Da to calculate protection type.

Design Information (Input):

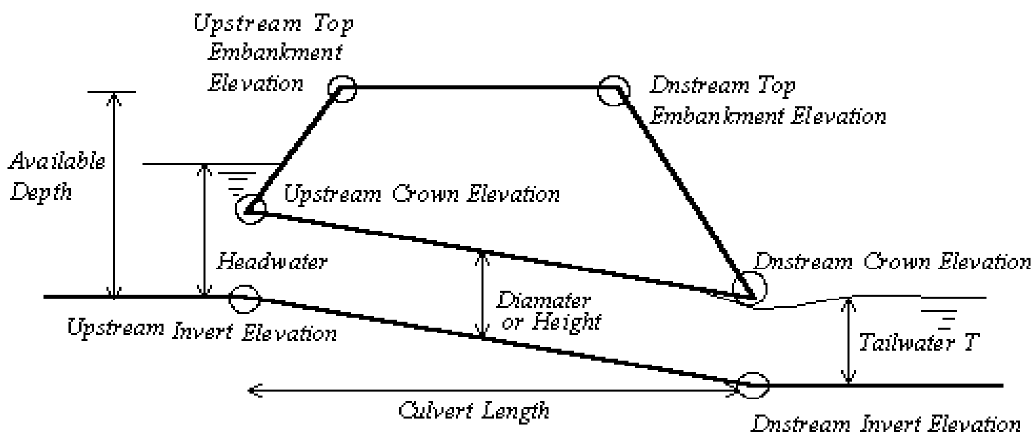
	Design Discharge	Q =	0.3	cfs
Circular Culvert:				
	Barrel Diameter in Inches	D =	12	inches
	Inlet Edge Type (Choose from pull-down list)	Grooved End with Headwall		
Box Culvert:			**OR**	
	Barrel Height (Rise) in Feet	Height (Rise) =		ft
	Barrel Width (Span) in Feet	Width (Span) =		ft
	Inlet Edge Type (Choose from pull-down list)			
	Number of Barrels	No =	1	
	Inlet Elevation	Elev IN =	7241.5	ft
	Outlet Elevation **OR** Slope	Elev OUT =	7240	ft
	Culvert Length	L =	67	ft
	Manning's Roughness	n =	0.012	
	Bend Loss Coefficient	k_b =	0	
	Exit Loss Coefficient	k_x =	1	
	Tailwater Surface Elevation	Elev Y_t =		ft
	Max Allowable Channel Velocity	V =	5	ft/s

Required Protection (Output):

Tailwater Surface Height	Y_t =	0.40	ft
Flow Area at Max Channel Velocity	A_t =	0.06	ft^2
Culvert Cross Sectional Area Available	A =	0.79	ft^2
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	1.78	
Sum of All Losses Coefficients	k_s =	2.98	ft
Culvert Normal Depth	Y_n =	0.15	ft
Culvert Critical Depth	Y_c =	0.23	ft
Tailwater Depth for Design	d =	0.61	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	0.58	ft
Expansion Factor	1/(2*tan(Θ)) =	6.70	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	0.30	$ft^{0.5}/s$
Froude Number	Fr =	2.09	**Supercritical!**
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	0.69	
Inlet Control Headwater	HW_I =	0.30	ft
Outlet Control Headwater	HW_O =	-0.88	
Design Headwater Elevation	**HW =**	**7,241.80**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**0.30**	
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 =**	**2**	**ft**

Vertical Profile for the Culvert

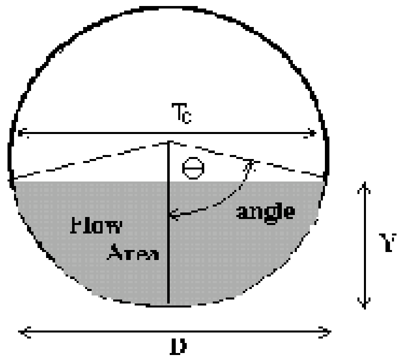
Project = **Timberridge Estates**
Box ID = **SF DP7 North Outlet (0.3 cfs) - 12" HDPE**



Culvert Information (Input)			
Barrel Diameter or Height	D or H =	12.00	inches
Barrel Length	L =	67.00	ft
Barrel Invert Slope	So =	0.0220	ft/ft
Downstream Invert Elevation	EDI =	7240.00	ft
Downstream Top Embankment Elevation	EDT =	7248.00	ft
Upstream Top Embankment Elevation	EUT =	7246.00	ft
Design Headwater Depth (not elev.)	Hw =	0.30	ft
Tailwater Depth (not elev.)	Yt =	0.61	ft
Culvert Hydraulics (Calculated)			
Available Headwater Depth	HW-a =	4.53	ft
Design Hw/D ratio	Hw/D =	0.30	
Culvert Vertical Profile			
Upstream Invert Elevation	EUI =	7241.47	ft
Upstream Crown Elevation	EUC =	7242.47	ft
Upstream Soil Cover Depth	Upsoil =	3.53	ft
Downstream Invert Elevation	EDI =	7240.00	ft
Downstream Crown Elevation	EDC =	7241.00	ft
Downstream Soil Cover Depth	Dnsoil =	7.00	ft

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

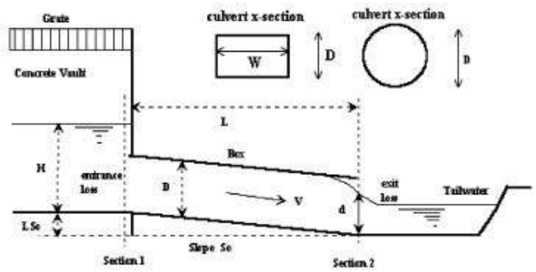
Project: **Timberridge Estates**
Pipe ID: **SF DP8 Inlet (0.1 cfs) - 6" HDPE**



Design Information (Input)			
Pipe Invert Slope	So =	0.0300	ft/ft
Pipe Manning's n-value	n =	0.0120	
Pipe Diameter	D =	6.00	inches
Design discharge	**Q =**	**0.10**	**cfs**
Full-flow Capacity (Calculated)			
Full-flow area	Af =	0.20	sq ft
Full-flow wetted perimeter	Pf =	1.57	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	1.06	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	0.95	radians
Flow area	An =	0.03	sq ft
Top width	Tn =	0.41	ft
Wetted perimeter	Pn =	0.47	ft
Flow depth	Yn =	0.10	ft
Flow velocity	Vn =	3.38	fps
Discharge	Qn =	0.10	cfs
Percent Full Flow	Flow =	9.4%	of full flow
Normal Depth Froude Number	Fr_n =	2.21	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	1.19	radians
Critical flow area	Ac =	0.05	sq ft
Critical top width	Tc =	0.46	ft
Critical flow depth	Yc =	0.16	ft
Critical flow velocity	Vc =	1.91	fps
Critical Depth Froude Number	Fr_c =	1.00	

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

Project: Timberridge Estates
Basin ID: SF DP8 Inlet (0.1 cfs) - 6" HDPE
Status:



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D =	6	inches
	Inlet Edge Type (choose from pull-down list)		Grooved End with Headwall	
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 =	7246.5	ft. elev.
	Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.)	Outlet Elev =	7245	ft. elev.
	Culvert Length in Feet	L =	82	ft.
	Manning's Roughness	n =	0.012	
	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 =	5.48
Sum of All Loss Coefficients	K_s =	6.68
Orifice Inlet Condition Coefficient	C_d =	1.04
Minimum Energy Condition Coefficient	KE_{low} =	-0.7045

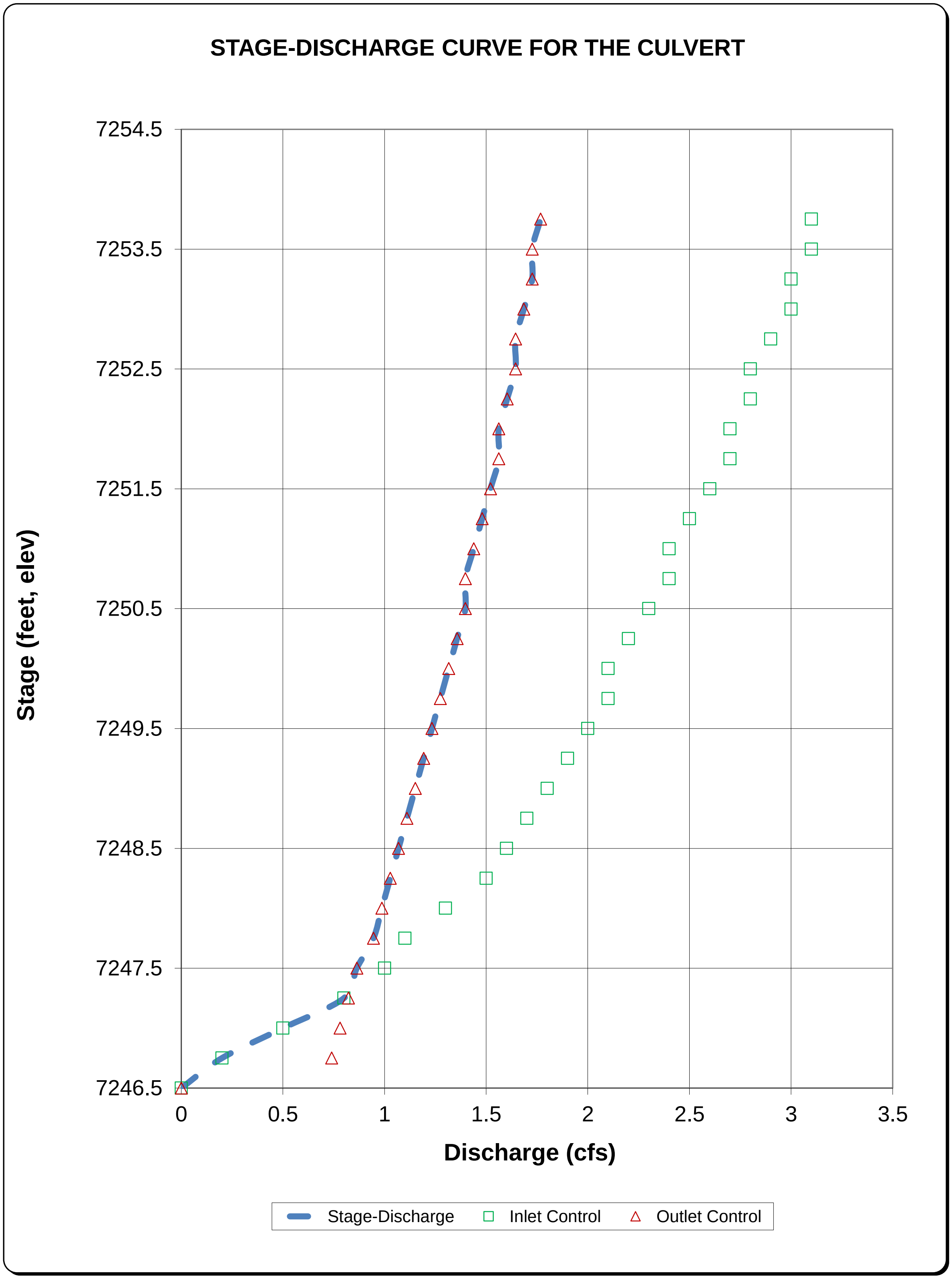
Calculations of Culvert Capacity (output):

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
7246.50		0.00	0.00	**0.00**	No Flow (WS < inlet)	N/A
7246.75		0.20	0.74	**0.20**	Min. Energy. Eqn.	INLET
7247.00		0.50	0.78	**0.50**	Regression Eqn.	INLET
7247.25		0.80	0.82	**0.80**	Regression Eqn.	INLET
7247.50		1.00	0.86	**0.86**	Regression Eqn.	OUTLET
7247.75		1.10	0.95	**0.95**	Regression Eqn.	OUTLET
7248.00		1.30	0.99	**0.99**	Regression Eqn.	OUTLET
7248.25		1.50	1.03	**1.03**	Orifice Eqn.	OUTLET
7248.50		1.60	1.07	**1.07**	Orifice Eqn.	OUTLET
7248.75		1.70	1.11	**1.11**	Orifice Eqn.	OUTLET
7249.00		1.80	1.15	**1.15**	Orifice Eqn.	OUTLET
7249.25		1.90	1.19	**1.19**	Orifice Eqn.	OUTLET
7249.50		2.00	1.23	**1.23**	Orifice Eqn.	OUTLET
7249.75		2.10	1.27	**1.27**	Orifice Eqn.	OUTLET
7250.00		2.10	1.32	**1.32**	Orifice Eqn.	OUTLET
7250.25		2.20	1.36	**1.36**	Orifice Eqn.	OUTLET
7250.50		2.30	1.40	**1.40**	Orifice Eqn.	OUTLET
7250.75		2.40	1.40	**1.40**	Orifice Eqn.	OUTLET
7251.00		2.40	1.44	**1.44**	Orifice Eqn.	OUTLET
7251.25		2.50	1.48	**1.48**	Orifice Eqn.	OUTLET
7251.50		2.60	1.52	**1.52**	Orifice Eqn.	OUTLET
7251.75		2.70	1.56	**1.56**	Orifice Eqn.	OUTLET
7252.00		2.70	1.56	**1.56**	Orifice Eqn.	OUTLET
7252.25		2.80	1.60	**1.60**	Orifice Eqn.	OUTLET
7252.50		2.80	1.64	**1.64**	Orifice Eqn.	OUTLET
7252.75		2.90	1.64	**1.64**	Orifice Eqn.	OUTLET
7253.00		3.00	1.69	**1.69**	Orifice Eqn.	OUTLET
7253.25		3.00	1.73	**1.73**	Orifice Eqn.	OUTLET
7253.50		3.10	1.73	**1.73**	Orifice Eqn.	OUTLET
7253.75		3.10	1.77	**1.77**	Orifice Eqn.	OUTLET

Processing Time: 17.79 Seconds

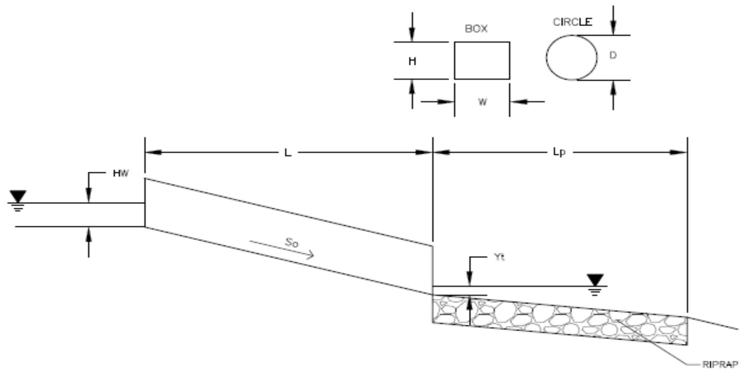
CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Timberridge Estates
Basin ID: SF DP8 Inlet (0.1 cfs) - 6" HDPE



Determination of Culvert Headwater and Outlet Protection

Project: Timberridge Estates
Basin ID: SF DP8 Inlet (0.1 cfs) - 6" HDPE



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

Supercritical Flow! Using Da to calculate protection type.

Design Information (Input):

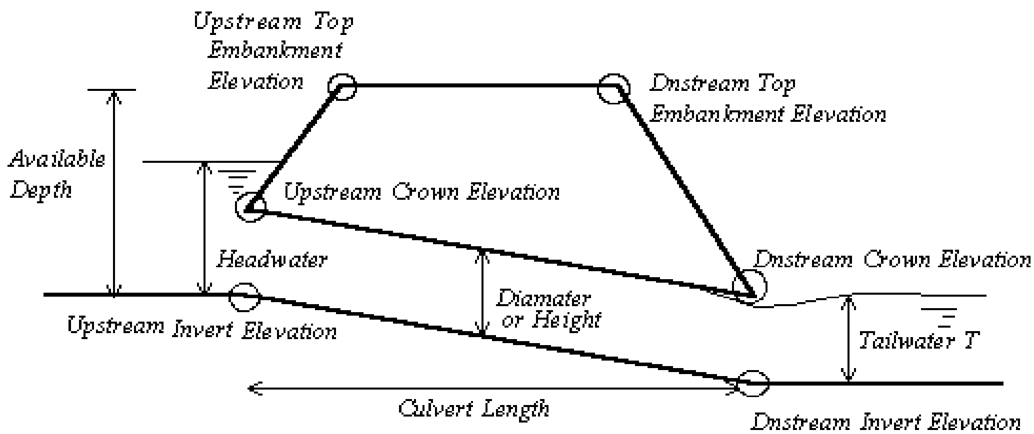
	Design Discharge	Q =	0.2	cfs
Circular Culvert:				
	Barrel Diameter in Inches	D =	6	inches
	Inlet Edge Type (Choose from pull-down list)	Grooved End with Headwall		
Box Culvert:			**OR**	
	Barrel Height (Rise) in Feet	Height (Rise) =		ft
	Barrel Width (Span) in Feet	Width (Span) =		ft
	Inlet Edge Type (Choose from pull-down list)			
	Number of Barrels	No =	1	
	Inlet Elevation	Elev IN =	7246.5	ft
	Outlet Elevation **OR** Slope	Elev OUT =	7245	ft
	Culvert Length	L =	82	ft
	Manning's Roughness	n =	0.012	
	Bend Loss Coefficient	k_b =	0	
	Exit Loss Coefficient	k_x =	1	
	Tailwater Surface Elevation	Elev Y_t =		ft
	Max Allowable Channel Velocity	V =	5	ft/s

Required Protection (Output):

Tailwater Surface Height	Y_t =	0.20	ft
Flow Area at Max Channel Velocity	A_t =	0.04	ft^2
Culvert Cross Sectional Area Available	A =	0.20	ft^2
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	5.48	
Sum of All Losses Coefficients	k_s =	6.68	ft
Culvert Normal Depth	Y_n =	0.17	ft
Culvert Critical Depth	Y_c =	0.22	ft
Tailwater Depth for Design	d =	0.36	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	0.33	ft
Expansion Factor	1/(2*tan(Θ)) =	6.70	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	1.13	$ft^{0.5}/s$
Froude Number	Fr =	1.74	**Supercritical!**
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	0.60	
Inlet Control Headwater	HW_I =	0.31	ft
Outlet Control Headwater	HW_O =	-1.03	
Design Headwater Elevation	**HW =**	**7,246.81**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**0.62**	
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 =**	**2**	**ft**
Width of Protection	**T =**	**1**	**ft**

Vertical Profile for the Culvert

Project = Timberridge Estates
Box ID = SF DP8 Inlet (0.1 cfs) - 6" HDPE

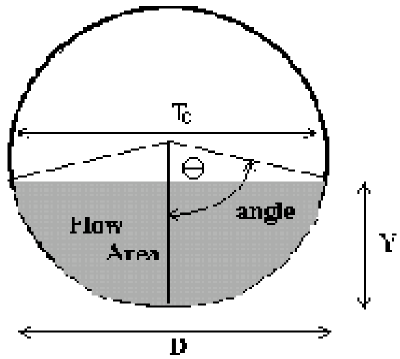


Culvert Information (Input)			
Barrel Diameter or Height	D or H =	6.00	inches
Barrel Length	L =	82.00	ft
Barrel Invert Slope	So =	0.0180	ft/ft
Downstream Invert Elevation	EDI =	7245.00	ft
Downstream Top Embankment Elevation	EDT =	7250.00	ft
Upstream Top Embankment Elevation	EUT =	7252.00	ft
Design Headwater Depth (not elev.)	Hw =	0.31	ft
Tailwater Depth (not elev.)	Yt =	0.36	ft

Culvert Hydraulics (Calculated)			
Available Headwater Depth	HW-a =	5.52	ft
Design Hw/D ratio	Hw/D =	0.62	
Culvert Vertical Profile			
Upstream Invert Elevation	EUI =	7246.48	ft
Upstream Crown Elevation	EUC =	7246.98	ft
Upstream Soil Cover Depth	Upsoil =	5.02	ft
Downstream Invert Elevation	EDI =	7245.00	ft
Downstream Crown Elevation	EDC =	7245.50	ft
Downstream Soil Cover Depth	Dnsoil =	4.50	ft

CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

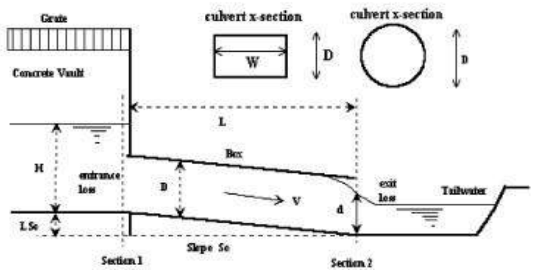
Project: **Timberridge Estates**
Pipe ID: **SF DP8 Outlet (0.1 cfs) - 12" HDPE**



Design Information (Input)			
Pipe Invert Slope	So =	0.0330	ft/ft
Pipe Manning's n-value	n =	0.0120	
Pipe Diameter	D =	12.00	inches
Design discharge	**Q =**	**0.10**	**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 =	7.03	cfs
Calculation of Normal Flow Condition			
Half Central Angle (0<Theta<3.14)	Theta =	0.59	radians
Flow area	An =	0.03	sq ft
Top width	Tn =	0.55	ft
Wetted perimeter	Pn =	0.59	ft
Flow depth	Yn =	0.08	ft
Flow velocity	Vn =	3.20	fps
Discharge	Qn =	0.10	cfs
Percent Full Flow	Flow =	1.4%	of full flow
Normal Depth Froude Number	Fr_n =	2.37	supercritical
Calculation of Critical Flow Condition			
Half Central Angle (0<Theta-c<3.14)	Theta-c =	0.73	radians
Critical flow area	Ac =	0.06	sq ft
Critical top width	Tc =	0.67	ft
Critical flow depth	Yc =	0.13	ft
Critical flow velocity	Vc =	1.69	fps
Critical Depth Froude Number	Fr_c =	1.00	

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

Project: **Timberridge Estates**
Basin ID: **SF DP8 Outlet (0.1 cfs) - 12" HDPE**
Status:



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D =	12	inches
	Inlet Edge Type (choose from pull-down list)		Grooved End with Headwall	
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 =	7241.5	ft. elev.
	Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.)	Outlet Elev =	7240	ft. elev.
	Culvert Length in Feet	L =	46	ft.
	Manning's Roughness	n =	0.012	
	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 =	1.22
Sum of All Loss Coefficients	K_s =	2.42
Orifice Inlet Condition Coefficient	C_d =	0.99
Minimum Energy Condition Coefficient	KE_{low} =	-0.3158

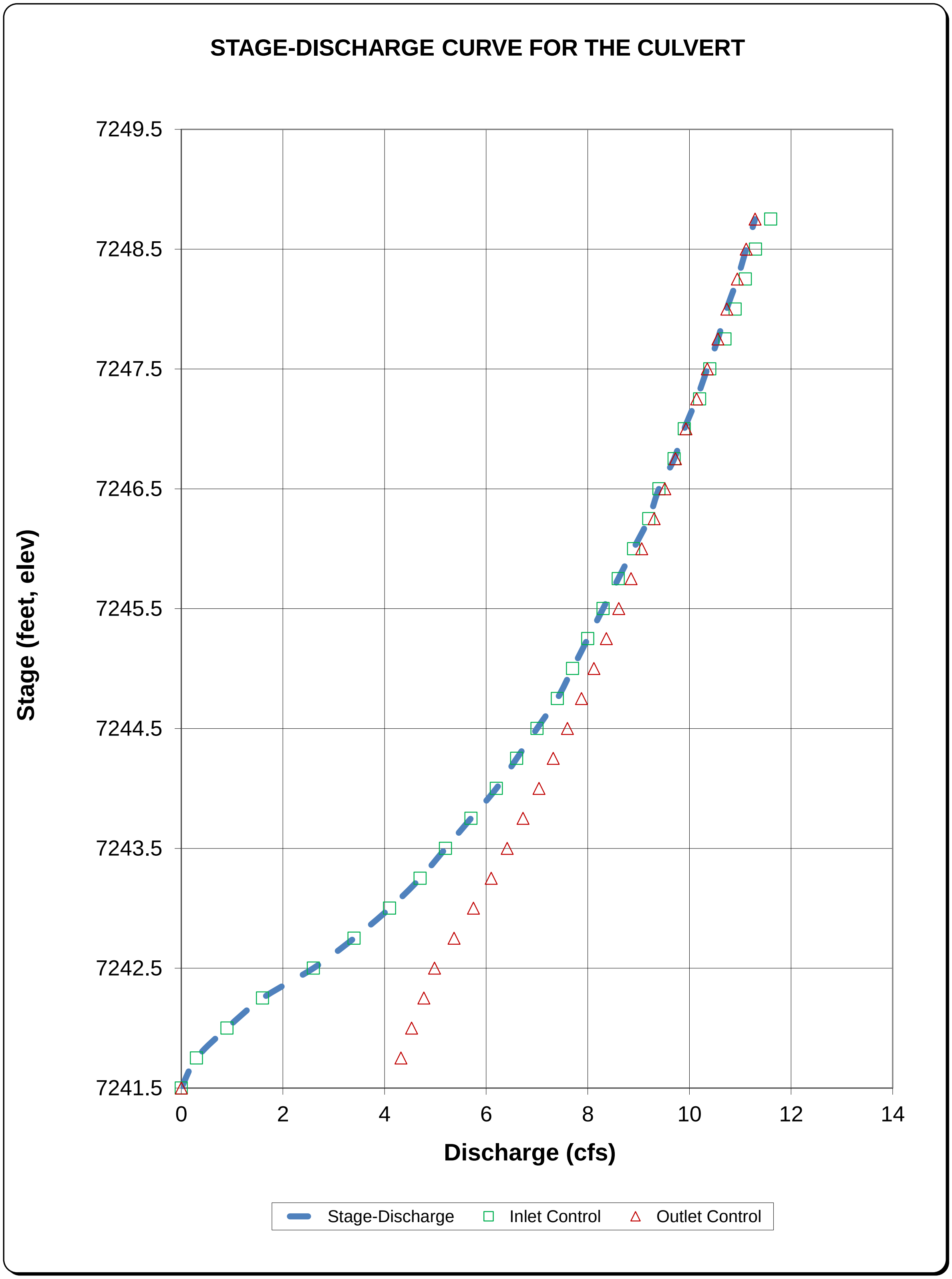
Calculations of Culvert Capacity (output):

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
7241.50		0.00	0.00	**0.00**	No Flow (WS < inlet)	N/A
7241.75		0.30	4.32	**0.30**	Min. Energy. Eqn.	INLET
7242.00		0.90	4.53	**0.90**	Min. Energy. Eqn.	INLET
7242.25		1.60	4.77	**1.60**	Regression Eqn.	INLET
7242.50		2.60	4.98	**2.60**	Regression Eqn.	INLET
7242.75		3.40	5.37	**3.40**	Regression Eqn.	INLET
7243.00		4.10	5.75	**4.10**	Regression Eqn.	INLET
7243.25		4.70	6.10	**4.70**	Regression Eqn.	INLET
7243.50		5.20	6.41	**5.20**	Regression Eqn.	INLET
7243.75		5.70	6.73	**5.70**	Regression Eqn.	INLET
7244.00		6.20	7.04	**6.20**	Regression Eqn.	INLET
7244.25		6.60	7.32	**6.60**	Regression Eqn.	INLET
7244.50		7.00	7.60	**7.00**	Regression Eqn.	INLET
7244.75		7.40	7.88	**7.40**	Orifice Eqn.	INLET
7245.00		7.70	8.12	**7.70**	Orifice Eqn.	INLET
7245.25		8.00	8.36	**8.00**	Orifice Eqn.	INLET
7245.50		8.30	8.61	**8.30**	Orifice Eqn.	INLET
7245.75		8.60	8.85	**8.60**	Orifice Eqn.	INLET
7246.00		8.90	9.06	**8.90**	Orifice Eqn.	INLET
7246.25		9.20	9.30	**9.20**	Orifice Eqn.	INLET
7246.50		9.40	9.51	**9.40**	Orifice Eqn.	INLET
7246.75		9.70	9.72	**9.70**	Orifice Eqn.	INLET
7247.00		9.90	9.93	**9.90**	Orifice Eqn.	INLET
7247.25		10.20	10.14	**10.14**	Orifice Eqn.	OUTLET
7247.50		10.40	10.35	**10.35**	Orifice Eqn.	OUTLET
7247.75		10.70	10.56	**10.56**	Orifice Eqn.	OUTLET
7248.00		10.90	10.73	**10.73**	Orifice Eqn.	OUTLET
7248.25		11.10	10.94	**10.94**	Orifice Eqn.	OUTLET
7248.50		11.30	11.12	**11.12**	Orifice Eqn.	OUTLET
7248.75		11.60	11.29	**11.29**	Orifice Eqn.	OUTLET

Processing Time: 17.27 Seconds

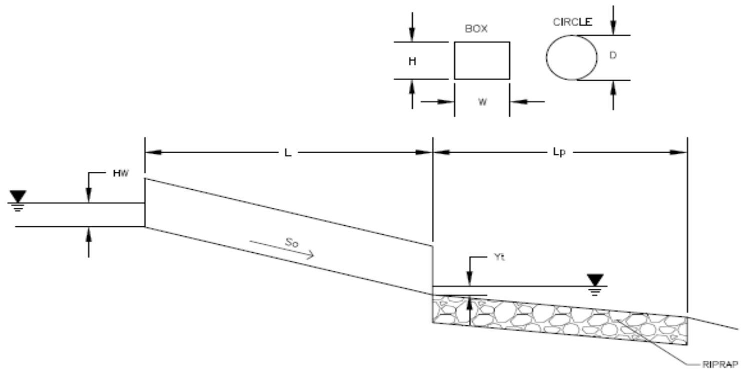
CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Timberridge Estates
Basin ID: SF DP8 Outlet (0.1 cfs) - 12" HDPE



Determination of Culvert Headwater and Outlet Protection

Project: Timberridge Estates
Basin ID: SF DP8 Outlet (0.1 cfs) - 12" HDPE



Soil Type:
Choose One:
(●) Sandy
( ) Non-Sandy

Supercritical Flow! Using Da to calculate protection type.

Design Information (Input):

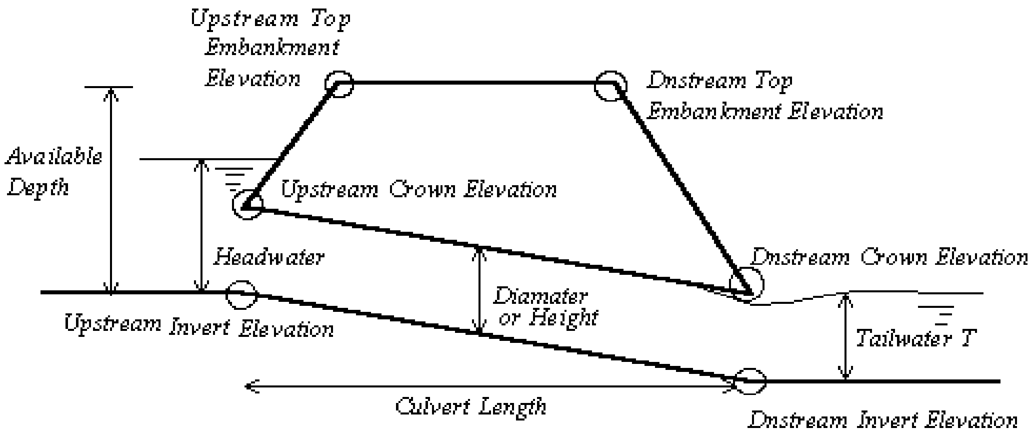
Design Discharge	Q =	0.1	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	12	inches
Inlet Edge Type (Choose from pull-down list)	Grooved End with Headwall		
Box Culvert:		**OR**	
Barrel Height (Rise) in Feet	Height (Rise) =		ft
Barrel Width (Span) in Feet	Width (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	No =	1	
Inlet Elevation	Elev IN =	7241.5	ft
Outlet Elevation **OR** Slope	Elev OUT =	7240	ft
Culvert Length	L =	46	ft
Manning's Roughness	n =	0.012	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	Elev Y_t =		ft
Max Allowable Channel Velocity	V =	5	ft/s

Required Protection (Output):

Tailwater Surface Height	Y_t =	0.40	ft
Flow Area at Max Channel Velocity	A_t =	0.02	ft^2
Culvert Cross Sectional Area Available	A =	0.79	ft^2
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	1.22	
Sum of All Losses Coefficients	k_s =	2.42	ft
Culvert Normal Depth	Y_n =	0.08	ft
Culvert Critical Depth	Y_c =	0.13	ft
Tailwater Depth for Design	d =	0.56	ft
Adjusted Diameter **OR** Adjusted Rise	D_a =	0.54	ft
Expansion Factor	1/(2*tan(Θ)) =	6.70	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	0.10	$ft^{0.5}/s$
Froude Number	Fr =	2.36	**Supercritical!**
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	0.74	
Inlet Control Headwater	HW_I =	0.21	ft
Outlet Control Headwater	HW_O =	-0.93	
Design Headwater Elevation	**HW =**	**7,241.71**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**0.21**	
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 =**	**2**	**ft**

Vertical Profile for the Culvert

Project = **Timberridge Estates**
Box ID = **SF DP8 Outlet (0.1 cfs) - 12" HDPE**



Culvert Information (Input)			
Barrel Diameter or Height	D or H =	12.00	inches
Barrel Length	L =	46.00	ft
Barrel Invert Slope	So =	0.0330	ft/ft
Downstream Invert Elevation	EDI =	7240.00	ft
Downstream Top Embankment Elevation	EDT =	7243.00	ft
Upstream Top Embankment Elevation	EUT =	7246.00	ft
Design Headwater Depth (not elev.)	Hw =	0.21	ft
Tailwater Depth (not elev.)	Yt =	0.56	ft
Culvert Hydraulics (Calculated)			
Available Headwater Depth	HW-a =	4.48	ft
Design Hw/D ratio	Hw/D =	0.21	
Culvert Vertical Profile			
Upstream Invert Elevation	EUI =	7241.52	ft
Upstream Crown Elevation	EUC =	7242.52	ft
Upstream Soil Cover Depth	Upsoil =	3.48	ft
Downstream Invert Elevation	EDI =	7240.00	ft
Downstream Crown Elevation	EDC =	7241.00	ft
Downstream Soil Cover Depth	Dnsoil =	2.00	ft

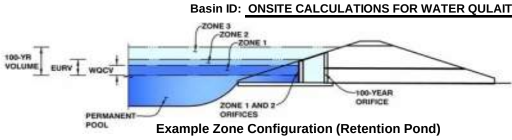
DETENTION CALCULATIONS

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: **TIMBERRIDGE ESTATES**

Basin ID: **ONSITE CALCULATIONS FOR WATER QULAITY CAPTURE VOLUME ONLY**



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	**EDB**			
Watershed Area =	49.70	acres		
Watershed Length =	2,040	ft		
Watershed Slope =	0.020	ft/ft		
Watershed Imperviousness =	5.69%	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		
Desired WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	User Input			
Water Quality Capture Volume (WQCV) =	0.169	acre-feet	Optional User Override 1-hr Precipitation	
Excess Urban Runoff Volume (EURV) =	0.254	acre-feet		
2-yr Runoff Volume (P1 = 1.19 in.) =	0.165	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.269	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.836	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	2.742	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	3.922	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	5.463	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3 in.) =	8.059	acre-feet	3.00	inches
Approximate 2-yr Detention Volume =	0.153	acre-feet		
Approximate 5-yr Detention Volume =	0.252	acre-feet		
Approximate 10-yr Detention Volume =	0.695	acre-feet		
Approximate 25-yr Detention Volume =	1.047	acre-feet		
Approximate 50-yr Detention Volume =	1.072	acre-feet		
Approximate 100-yr Detention Volume =	1.424	acre-feet		

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.169	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.086	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.170	acre-feet
Total Detention Basin Volume =	1.424	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = 1 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	405	0.009		
	--	0.33	--	--	--	521	0.012	148	0.003
	--	1.00	--	--	--	6,408	0.147	2,410	0.055
	--	3.00	--	--	--	15,296	0.351	24,178	0.555
	--	5.00	--	--	--	19,725	0.453	59,199	1.359
	--	7.00	--	--	--	23,887	0.548	103,657	2.380
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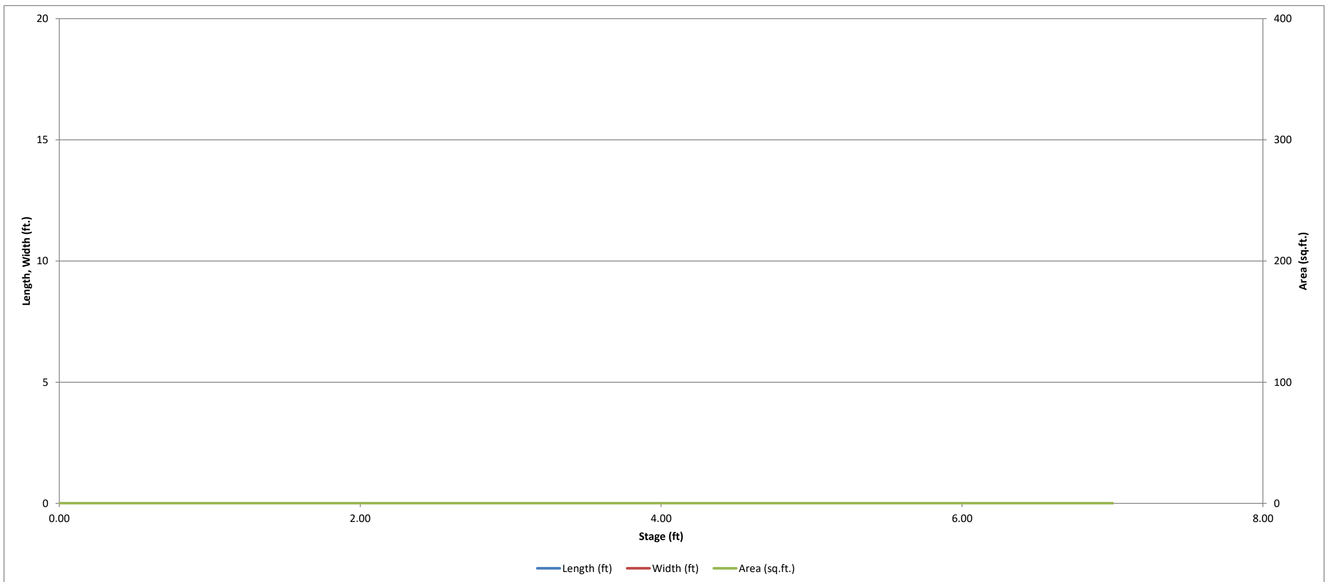
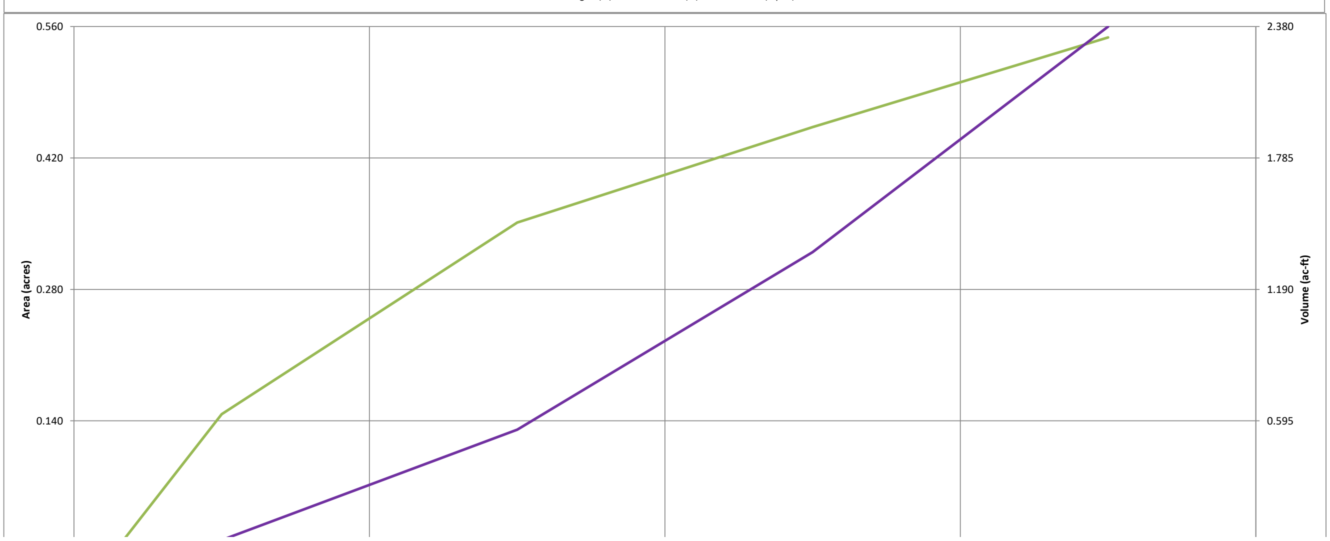
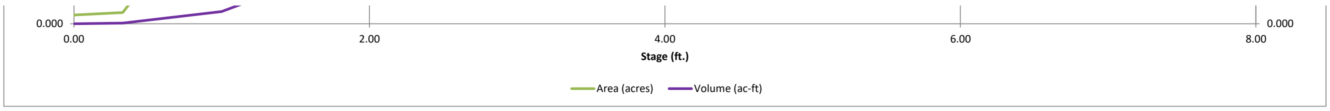
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)





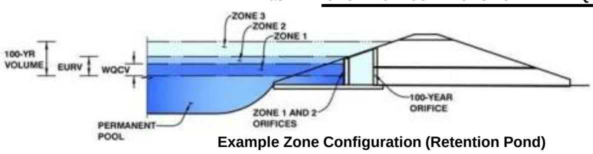

0.000
0.00
2.00
4.00
6.00
8.00
0.000
Stage (ft.)
Area (acres)
Volume (ac-ft)

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: TIMBERRIDGE ESTATES

Basin ID: ONSITE CALCULATIONS FOR WATER QULAITY CAPTURE VOLUME ONLY



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.63	0.169	Orifice Plate
Zone 2 (EURV)	2.00	0.086	Orifice Plate
Zone 3 (100-year)	5.15	1.170	Weir&Pipe (Restrict)
		1.424	Total

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

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

Calculated Parameters for Underdrain

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

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	2.00	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	8.00	inches
Orifice Plate: Orifice Area per Row =	1.02	sq. inches (diameter = 1-1/8 inches)

Calculated Parameters for Plate

WQ Orifice Area per Row =	7.083E-03	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.70	1.40					
Orifice Area (sq. inches)	1.02	1.02	1.02					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.00	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	2.00	N/A	feet
Over Flow Weir Slope Length =	4.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	2.28	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	11.20	N/A	ft^2
Overflow Grate Open Area w/ Debris =	5.60	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	30.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	30.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	4.91	N/A	ft^2
Outlet Orifice Centroid =	1.25	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.30	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	40.00	feet
Spillway End Slopes =	8.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

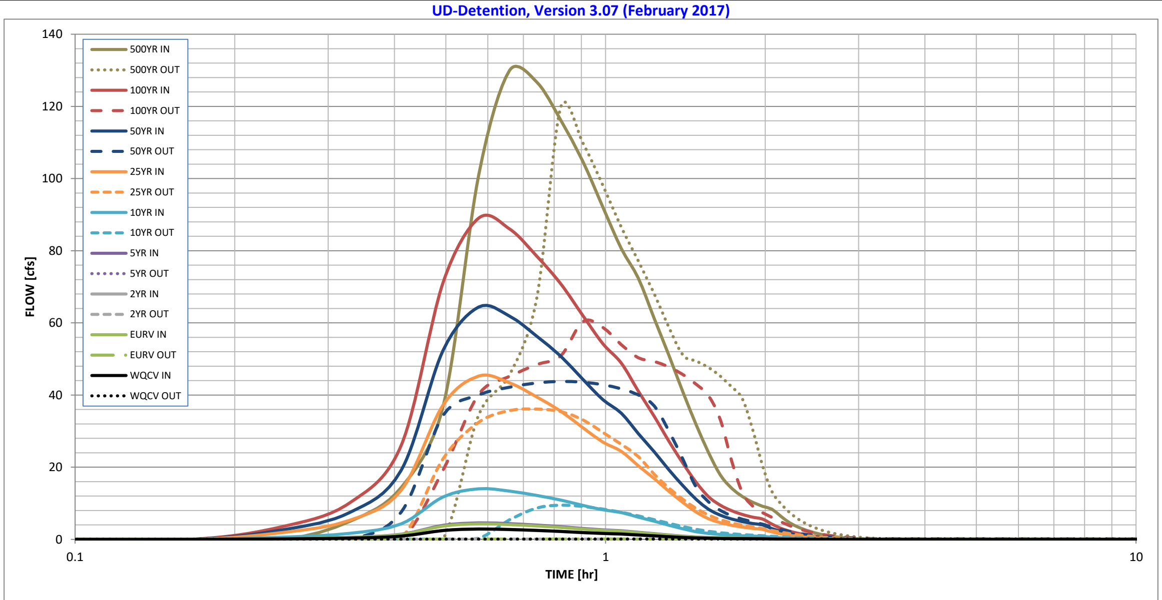
Spillway Design Flow Depth=	0.70	feet
Stage at Top of Freeboard =	7.00	feet
Basin Area at Top of Freeboard =	0.57	acres

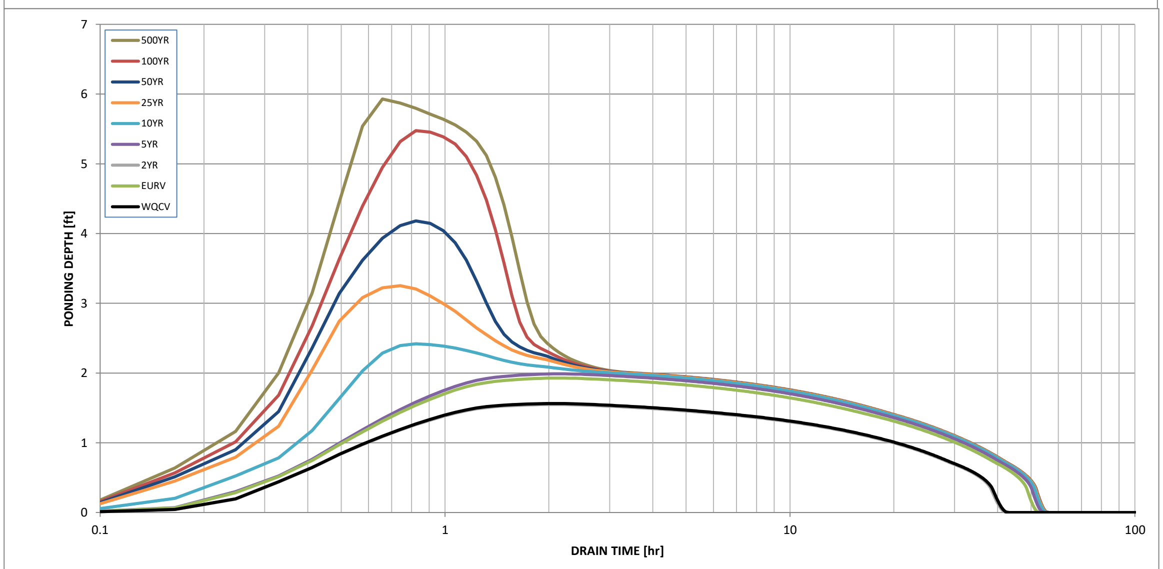
Routed Hydrograph Results

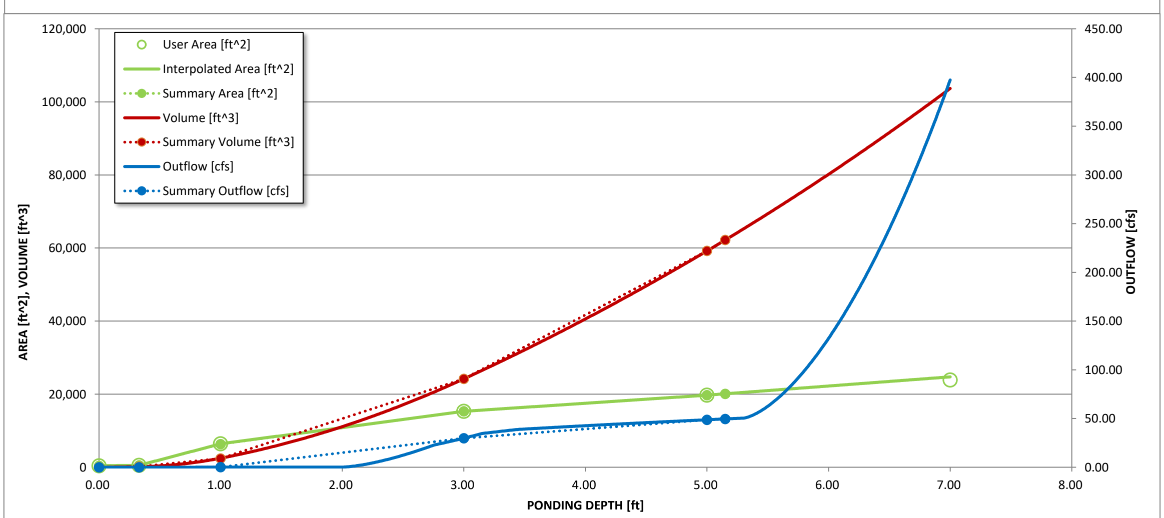
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.00
Calculated Runoff Volume (acre-ft) =	0.169	0.254	0.165	0.269	0.836	2.742	3.922	5.463	8.059
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.168	0.253	0.165	0.269	0.836	2.742	3.921	5.461	8.048
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.20	0.67	0.93	1.25	1.77
Predevelopment Peak Q (cfs) =	0.0	0.0	0.6	1.1	10.2	33.5	46.4	62.3	88.0
Peak Inflow Q (cfs) =	2.9	4.3	2.8	4.6	14.0	45.3	64.4	89.0	129.9
Peak Outflow Q (cfs) =	0.1	0.1	0.1	0.1	9.5	36.1	43.8	60.4	119.9
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.1	0.9	1.1	0.9	1.0	1.4
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Outlet Plate 1	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.8	3.2	3.9	4.6	4.8
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	47	38	48	41	28	21	14	5
Time to Drain 99% of Inflow Volume (hours) =	**40**	49	40	51	49	41	38	34	28
Maximum Ponding Depth (ft) =	1.56	1.93	1.55	1.99	2.42	3.25	4.18	5.47	5.93
Area at Maximum Ponding Depth (acres) =	0.20	0.24	0.20	0.25	0.29	0.36	0.41	0.48	0.51
Maximum Volume Stored (acre-ft) =	0.155	0.235	0.151	0.250	0.366	0.644	1.005	1.578	1.805

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







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

Detention Basin Outlet Structure Design

Outflow Hydrograph Workbook Filename:

Storm Inflow Hydrographs UD-Detention, Version 3.07 (February 2017)

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

	SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
4.94 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:04:56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrograph	0:09:53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Constant	0:14:49	0.13	0.19	0.13	0.21	0.62	1.92	2.68	3.60	4.97
1.012	0:19:46	0.35	0.52	0.34	0.55	1.67	5.29	7.44	10.12	14.35
	0:24:42	0.89	1.33	0.88	1.41	4.28	13.57	19.11	25.99	36.86
	0:29:38	2.46	3.67	2.42	3.89	11.76	37.24	52.40	71.20	100.85
	0:34:35	2.87	4.30	2.83	4.56	14.01	45.26	64.38	89.02	129.89
	0:39:31	2.73	4.10	2.68	4.34	13.38	43.40	61.90	86.07	126.81
	0:44:28	2.48	3.73	2.44	3.95	12.18	39.49	56.35	78.56	116.18
	0:49:24	2.20	3.31	2.16	3.51	10.89	35.52	50.76	70.81	104.80
	0:54:20	1.88	2.84	1.85	3.01	9.42	30.96	44.38	62.06	92.13
	0:59:17	1.65	2.48	1.62	2.63	8.20	26.96	38.74	54.25	80.63
	1:04:13	1.49	2.25	1.46	2.38	7.43	24.40	34.98	48.86	72.39
	1:09:10	1.21	1.84	1.19	1.95	6.15	20.39	29.30	41.09	61.22
	1:14:06	0.98	1.49	0.96	1.58	5.03	16.85	24.27	34.09	50.89
	1:19:02	0.73	1.13	0.72	1.20	3.89	13.27	19.22	27.13	40.74
	1:23:59	0.53	0.82	0.52	0.88	2.91	10.18	14.83	21.03	31.74
	1:28:55	0.39	0.60	0.39	0.64	2.10	7.54	11.06	15.79	23.97
	1:33:52	0.31	0.47	0.30	0.50	1.62	5.69	8.31	11.79	17.78
	1:38:48	0.25	0.39	0.25	0.41	1.34	4.61	6.68	9.44	14.15
	1:43:44	0.22	0.33	0.21	0.35	1.13	3.88	5.63	7.93	11.86
	1:48:41	0.19	0.29	0.19	0.31	0.99	3.39	4.90	6.89	10.28
	1:53:37	0.17	0.26	0.17	0.28	0.89	3.03	4.38	6.15	9.16
	1:58:34	0.16	0.25	0.16	0.26	0.82	2.78	4.01	5.63	8.37
	2:03:30	0.12	0.18	0.12	0.19	0.60	2.06	2.99	4.23	6.37
	2:08:26	0.09	0.13	0.08	0.14	0.44	1.50	2.16	3.06	4.60
	2:13:23	0.06	0.10	0.06	0.10	0.33	1.10	1.60	2.26	3.41
	2:18:19	0.05	0.07	0.04	0.07	0.24	0.82	1.19	1.68	2.53
	2:23:16	0.03	0.05	0.03	0.05	0.17	0.60	0.87	1.24	1.87
	2:28:12	0.02	0.03	0.02	0.04	0.12	0.43	0.62	0.89	1.35
	2:33:08	0.02	0.02	0.02	0.03	0.09	0.31	0.45	0.65	0.98
	2:38:05	0.01	0.02	0.01	0.02	0.06	0.21	0.32	0.45	0.69
	2:43:01	0.01	0.01	0.01	0.01	0.03	0.14	0.20	0.30	0.46
	2:47:58	0.00	0.00	0.00	0.00	0.02	0.08	0.12	0.17	0.27
	2:52:54	0.00	0.00	0.00	0.00	0.01	0.03	0.05	0.08	0.13
	2:57:50	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.04
	3:02:47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:07:43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:12:40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:17:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:22:32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:27:29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:32:25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:37:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:42:18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:47:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:52:11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:57:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:02:04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:07:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:11:56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:16:53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:21:49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:26:46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:31:42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:36:38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:41:35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:46:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:51:28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:56:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:01:20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:06:17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:11:13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:16:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:21:06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:26:02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Summary Stage-Area-Volume-Discharge Relationships

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

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

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
	0.00	405	0.009	0	0.000	0.00
	0.33	518	0.012	148	0.003	0.02
	1.00	6,320	0.145	2,410	0.055	0.05
	3.00	15,296	0.351	24,178	0.555	29.82
	5.00	19,725	0.453	59,199	1.359	48.73
	5.15	20,100	0.461	62,186	1.428	49.58

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

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

TIMBERRIDGE ESTATES
NORTHEAST AND SOUTHWEST FORBAY WALL NOTCH

Wall Notch - northeast forbay

Notch to releae 2% of the undetained 100-year peak discharge

100-y peak discharge	=	76.4	cfs
2%	=	1.53	cfs

The general form of the equation for horizontal crested weirs is Q = CLH3/2 where:

Q = Weir flow discharge (cfs)	**1.53**	
C = Weir flow coefficient	3.4	
H = Depth of flow over the weir (ft)	1.60	Opening Height
L = Length of the weir (ft)	**0.22**	Length
L = Length of the weir (in)	**3**	

Notch to releae 2% of the undetained 100-year peak discharge is 3" wide by 19" high

Wall Notch - southeast forbay

Notch to releae 2% of the undetained 100-year peak discharge

100-y peak discharge	=	9.4	cfs
2%	=	0.19	cfs

The general form of the equation for horizontal crested weirs is Q = CLH3/2 where:

Q = Weir flow discharge (cfs)	**0.19**	
C = Weir flow coefficient	3.4	
H = Depth of flow over the weir (ft)	1.00	Opening Height
L = Length of the weir (ft)	**0.06**	Length
L = Length of the weir (in)	**1**	

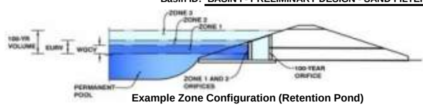
Notch to releae 2% of the undetained 100-year peak discharge is 1" wide by 12" high

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: TIMBERRIDGE ESTATES

Basin ID: BASIN i - PRELIMINARY DESIGN - SAND FILTER AT DESIGN POINT 7



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	**SF**		
Watershed Area =	2.43	acres	**Note: L / W Ratio > 8**
Watershed Length =	1,020	ft	**L / W Ratio = 9.8**
Watershed Slope =	0.033	ft/ft	
Watershed Imperviousness =	29.00%	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	
Desired WQCV Drain Time =	40.0	hours	**Drain Time Too Long**
Location for 1-hr Rainfall Depths =	User Input		
Water Quality Capture Volume (WQCV) =	0.024	acre-feet	Optional User Override 1-hr Precipitation
Excess Urban Runoff Volume (EURV) =	0.072	acre-feet	
2-yr Runoff Volume (P1 = 1.19 in.) =	0.055	acre-feet	1.19 inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.079	acre-feet	1.50 inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.121	acre-feet	1.75 inches
25-yr Runoff Volume (P1 = 2 in.) =	0.205	acre-feet	2.00 inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.261	acre-feet	2.25 inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.333	acre-feet	2.52 inches
500-yr Runoff Volume (P1 = 3 in.) =	0.455	acre-feet	3.00 inches
Approximate 2-yr Detention Volume =	0.051	acre-feet	
Approximate 5-yr Detention Volume =	0.074	acre-feet	
Approximate 10-yr Detention Volume =	0.108	acre-feet	
Approximate 25-yr Detention Volume =	0.126	acre-feet	
Approximate 50-yr Detention Volume =	0.133	acre-feet	
Approximate 100-yr Detention Volume =	0.158	acre-feet	

Stage-Storage Calculation

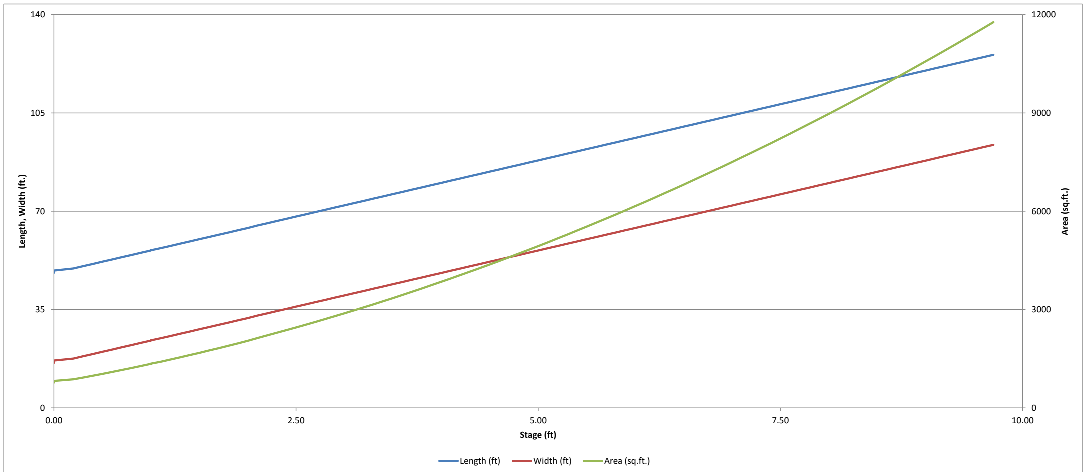
Zone 1 Volume (WQCV) =	0.024	acre-feet	
Select Zone 2 Storage Volume (Optional) =		acre-feet	**Total detention volume is less than 100-year volume.**
Select Zone 3 Storage Volume (Optional) =		acre-feet	
Total Detention Basin Volume =	0.024	acre-feet	
Initial Surcharge Volume (ISV) =	N/A	ft^3	
Initial Surcharge Depth (ISD) =	N/A	ft	
Total Available Detention Depth (H_{total}) =	1.00	ft	
Depth of Trickle Channel (H_{TC}) =	N/A	ft	
Slope of Trickle Channel (S_{TC}) =	N/A	ft/ft	
Slopes of Main Basin Sides (S_{main}) =	4	H:V	
Basin Length-to-Width Ratio ($R_{L/W}$) =	3		
Initial Surcharge Area (A_{ISV}) =	0	ft^2	
Surcharge Volume Length (L_{ISV}) =	0.0	ft	
Surcharge Volume Width (W_{ISV}) =	0.0	ft	
Depth of Basin Floor (H_{FLOOR}) =	0.00	ft	
Length of Basin Floor (L_{FLOOR}) =	48.1	ft	
Width of Basin Floor (W_{FLOOR}) =	16.0	ft	
Area of Basin Floor (A_{FLOOR}) =	771	ft^2	
Volume of Basin Floor (V_{FLOOR}) =	0	ft^3	
Depth of Main Basin (H_{MAIN}) =	1.00	ft	
Length of Main Basin (L_{MAIN}) =	56.1	ft	
Width of Main Basin (W_{MAIN}) =	24.0	ft	
Area of Main Basin (A_{MAIN}) =	1,349	ft^2	
Volume of Main Basin (V_{MAIN}) =	1,047	ft^3	
Calculated Total Basin Volume (V_{total}) =	**0.024**	acre-feet	

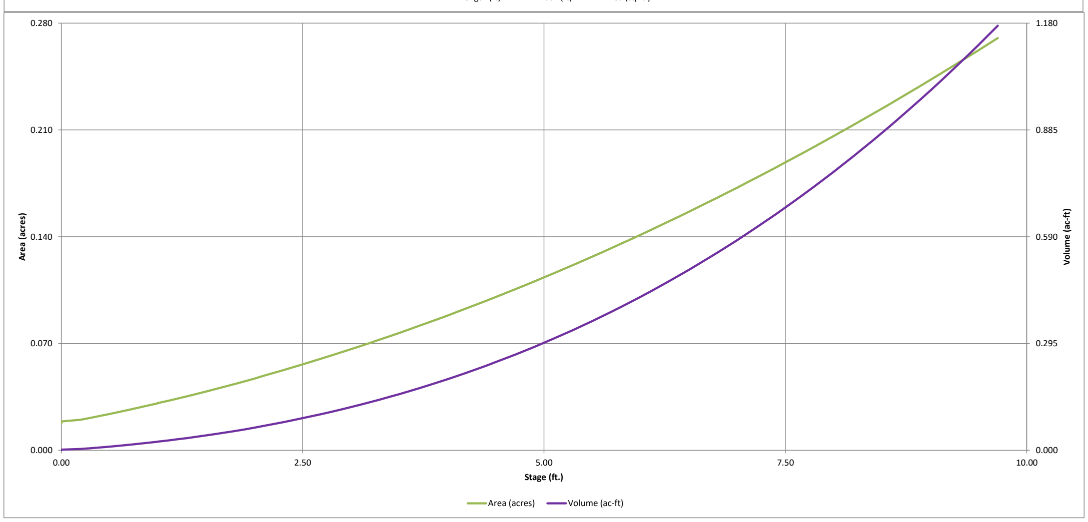
Depth Increment = 0.1 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Media Surface	0.00		48.1	16.0	771		0.018		
	0.10		48.9	16.8	823		0.019	80	0.002
	0.20		49.6	17.6	871		0.020	156	0.004
	0.30		50.4	18.4	926		0.021	246	0.006
	0.40		51.2	19.2	981		0.023	341	0.008
	0.50		52.0	20.0	1,038		0.024	442	0.010
	0.60		52.8	20.8	1,096		0.025	549	0.013
	0.70		53.6	21.6	1,156		0.027	661	0.015
	0.80		54.4	22.4	1,217		0.028	780	0.018
	0.90		55.2	23.2	1,279		0.029	905	0.021
	1.00		56.0	24.0	1,342		0.031	1,036	0.024
Zone 1 (WQCV)	1.00		56.1	24.0	1,349		0.031	1,049	0.024
	1.10		56.8	24.8	1,407		0.032	1,173	0.027
	1.20		57.6	25.6	1,473		0.034	1,317	0.030
	1.30		58.4	26.4	1,540		0.035	1,468	0.034
	1.40		59.2	27.2	1,608		0.037	1,625	0.037
	1.50		60.0	28.0	1,678		0.039	1,790	0.041
	1.60		60.8	28.8	1,749		0.040	1,961	0.045
	1.70		61.6	29.6	1,821		0.042	2,139	0.049
	1.80		62.4	30.4	1,895		0.044	2,325	0.053
	1.90		63.2	31.2	1,970		0.045	2,518	0.058
	2.00		64.0	32.0	2,046		0.047	2,719	0.062
	2.10		64.9	32.8	2,131		0.049	2,949	0.068
	2.20		65.7	33.6	2,210		0.051	3,166	0.073
	2.30		66.5	34.4	2,290		0.053	3,391	0.078
	2.40		67.3	35.2	2,372		0.054	3,624	0.083
	2.50		68.1	36.0	2,454		0.056	3,865	0.089
	2.60		68.9	36.8	2,538		0.058	4,115	0.094
	2.70		69.7	37.6	2,623		0.060	4,373	0.100
	2.80		70.5	38.4	2,710		0.062	4,640	0.107
	2.90		71.3	39.2	2,798		0.064	4,915	0.113
	3.00		72.1	40.0	2,887		0.066	5,199	0.119
	3.10		72.9	40.8	2,977		0.068	5,492	0.126
	3.20		73.7	41.6	3,069		0.070	5,795	0.133
	3.30		74.5	42.4	3,162		0.073	6,106	0.140
	3.40		75.3	43.2	3,256		0.075	6,427	0.148
	3.50		76.1	44.0	3,351		0.077	6,757	0.155
	3.60		76.9	44.8	3,448		0.079	7,097	0.163
	3.70		77.7	45.6	3,546		0.081	7,447	0.171
	3.80		78.5	46.4	3,645		0.084	7,807	0.179
	3.90		79.3	47.2	3,746		0.086	8,176	0.188
	4.00		80.1	48.0	3,848		0.088	8,556	0.196
	4.10		80.9	48.8	3,951		0.091	8,946	0.205
	4.20		81.7	49.6	4,056		0.093	9,346	0.215
	4.30		82.5	50.4	4,161		0.096	9,757	0.224
	4.40		83.3	51.2	4,268		0.098	10,179	0.234
	4.50		84.1	52.0	4,376		0.100	10,611	0.244
	4.60		84.9	52.8	4,486		0.103	11,054	0.254
	4.70		85.7	53.6	4,597		0.106	11,508	0.264
	4.80		86.5	54.4	4,709		0.108	11,973	0.275
	4.90		87.3	55.2	4,822		0.111	12,450	0.286
	5.00		88.1	56.0	4,937		0.113	12,938	0.297
	5.10		88.9	56.8	5,053		0.116	13,437	0.308
	5.20		89.7	57.6	5,170		0.119	13,948	0.320
	5.30		90.5	58.4	5,289		0.121	14,471	0.332
	5.40		91.3	59.2	5,409		0.124	15,006	0.344
	5.50		92.1	60.0	5,530		0.127	15,553	0.357
	5.60		92.9	60.8	5,652		0.130	16,112	0.370
	5.70		93.7	61.6	5,776		0.133	16,684	0.383
	5.80		94.5	62.4	5,901		0.135	17,267	0.396
	5.90		95.3	63.2	6,027		0.138	17,864	0.410
	6.00		96.1	64.0	6,154		0.141	18,473	0.424
	6.10		96.9	64.8	6,283		0.144	19,095	0.438
	6.20		97.7	65.6	6,413		0.147	19,729	0.453
	6.30		98.5	66.4	6,544		0.150	20,377	0.468
	6.40		99.3	67.2	6,677		0.153	21,038	0.483
	6.50		100.1	68.0	6,811		0.156	21,713	0.498
	6.60		100.9	68.8	6,946		0.159	22,400	0.514
	6.70		101.7	69.6	7,082		0.163	23,102	0.530
	6.80		102.5	70.4	7,220		0.166	23,817	0.547
	6.90		103.3	71.2	7,359		0.169	24,546	0.563
	7.00		104.1	72.0	7,499		0.172	25,289	0.581
	7.10		104.9	72.8	7,641		0.175	26,046	0.598
	7.20		105.7	73.6	7,784		0.179	26,817	0.616
	7.30		106.5	74.4	7,928		0.182	27,603	0.634
	7.40		107.3	75.2	8,073		0.185	28,403	0.652
	7.50		108.1	76.0	8,220		0.189	29,217	0.671
	7.60		108.9	76.8	8,368		0.192	30,047	0.690
	7.70		109.7	77.6	8,517		0.196	30,891	0.709
	7.80		110.5	78.4	8,668		0.199	31,750	0.729
	7.90		111.3	79.2	8,819		0.202	32,624	0.749
	8.00		112.1	80.0	8,972		0.206	33,514	0.769
	8.10		112.9	80.8	9,127		0.210	34,419	0.790
	8.20		113.7	81.6	9,282		0.213	35,339	0.811
	8.30		114.5	82.4	9,439		0.217	36,276	0.833
	8.40		115.3	83.2	9,598		0.220	37,227	0.855
	8.50		116.1	84.0	9,757		0.224	38,195	0.877
	8.60		116.9	84.8	9,918		0.228	39,179	0.899
	8.70		117.7	85.6	10,080		0.231	40,179	0.922
	8.80		118.5	86.4	10,243		0.235	41,195	0.946
	8.90		119.3	87.2	10,408		0.239	42,227	0.969
	9.00		120.1	88.0	10,574		0.243	43,276	0.993
	9.10		120.9	88.8	10,741		0.247	44,342	1.018
	9.20		121.7	89.6	10,909		0.250	45,425	1.043
	9.30		122.5	90.4	11,079		0.254	46,524	1.068
	9.40		123.3	91.2	11,250		0.258	47,640	1.094
	9.50		124.1	92.0	11,422		0.262	48,774	1.120
	9.60		124.9	92.8	11,596		0.266	49,925	1.146
	9.70		125.7	93.6	11,771		0.270	51,093	1.173

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)



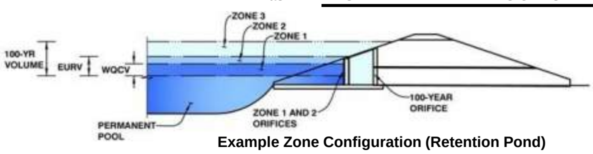


Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: TIMBERRIDGE ESTATES

Basin ID: BASIN I - PRELIMINARY DESIGN - SAND FILTER AT DESIGN POINT 7



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.00	0.024	Filtration Media
Zone 2			
Zone 3			
		0.024	Total

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

Underdrain Orifice Invert Depth =	2.17	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	0.40	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	0.0	ft^2
Underdrain Orifice Centroid =	0.02	feet

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

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

Calculated Parameters for Plate

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

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

	Row 1 (optional)	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)								
Orifice Area (sq. inches)								

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =			ft^2
Vertical Orifice Centroid =			feet

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

	Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =	1.00		ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	1.50		feet
Overflow Weir Slope =	0.00		H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	1.50		feet
Overflow Grate Open Area % =	70%		%, grate open area/total area
Debris Clogging % =	50%		%

Calculated Parameters for Overflow Weir

	Not Selected	Not Selected	
Height of Grate Upper Edge, H_t =	1.00		feet
Over Flow Weir Slope Length =	1.50		feet
Grate Open Area / 100-yr Orifice Area =			should be ≥ 4
Overflow Grate Open Area w/o Debris =	1.58		ft^2
Overflow Grate Open Area w/ Debris =	0.79		ft^2

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

	Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =			inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Not Selected	Not Selected	
Outlet Orifice Area =			ft^2
Outlet Orifice Centroid =			feet
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway

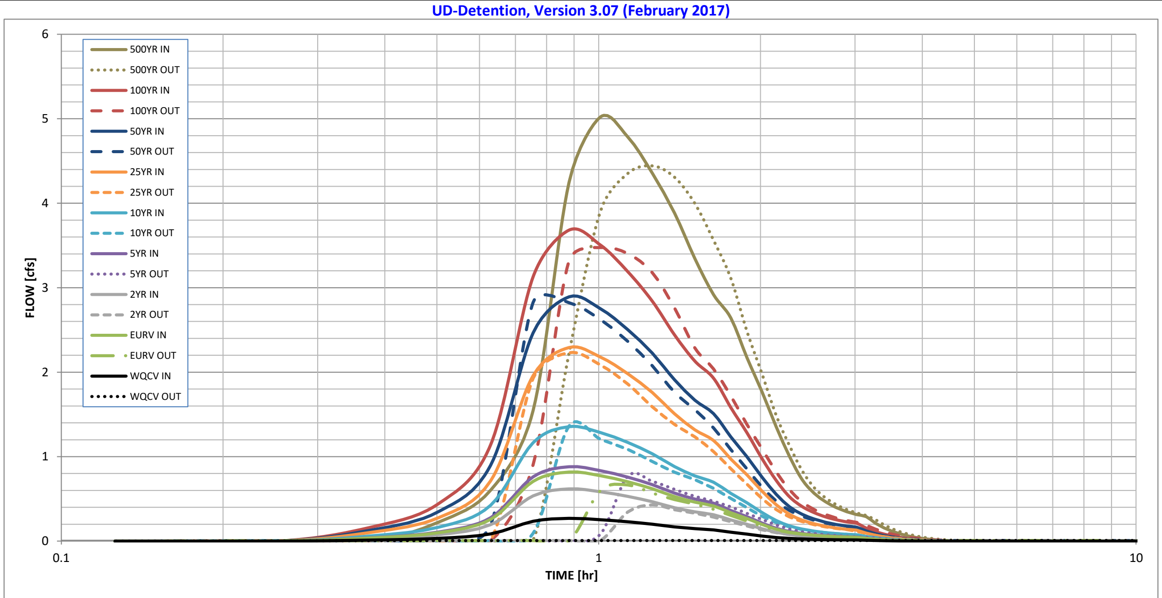
Spillway Design Flow Depth=		feet
Stage at Top of Freeboard =		feet
Basin Area at Top of Freeboard =		acres

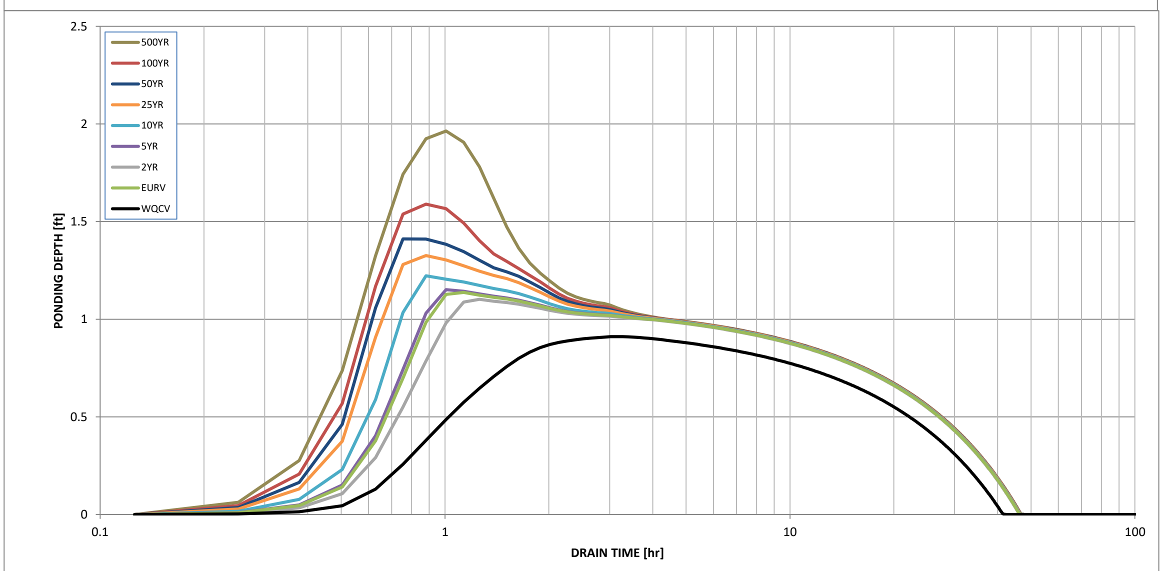
Routed Hydrograph Results

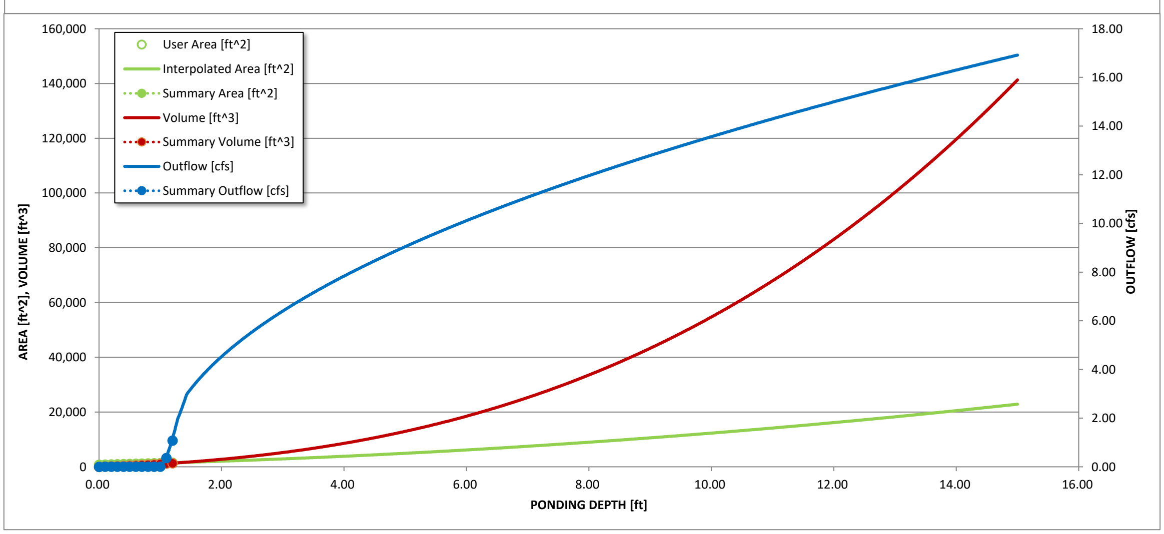
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.00
Calculated Runoff Volume (acre-ft) =	0.024	0.072	0.055	0.079	0.121	0.205	0.261	0.333	0.455
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.023	0.072	0.054	0.078	0.120	0.205	0.260	0.332	0.455
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.01	0.14	0.48	0.67	0.91	1.29
Predevelopment Peak Q (cfs) =	0.0	0.0	0.0	0.0	0.3	1.2	1.6	2.2	3.1
Peak Inflow Q (cfs) =	0.3	0.8	0.6	0.9	1.4	2.3	2.9	3.7	5.0
Peak Outflow Q (cfs) =	0.0	0.7	0.4	0.8	1.4	2.2	2.8	3.5	4.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	21.4	4.1	1.9	1.7	1.6	1.4
Structure Controlling Flow =	Filtration Media	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1
Max Velocity through Grate 1 (fps) =	N/A	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	40	42	43	42	40	35	32	28	22
Time to Drain 99% of Inflow Volume (hours) =	**41**	45	45	45	44	43	42	40	38
Maximum Ponding Depth (ft) =	0.91	1.14	1.10	1.15	1.22	1.33	1.41	1.59	1.96
Area at Maximum Ponding Depth (acres) =	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.05
Maximum Volume Stored (acre-ft) =	0.021	0.028	0.027	0.029	0.031	0.035	0.038	0.045	0.061

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







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

Detention Basin Outlet Structure Design

Outflow Hydrograph Workbook Filename:

Storm Inflow Hydrographs **UD-Detention, Version 3.07 (February 2017)**

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

	SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
7.55 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:07:33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrograph	0:15:06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Constant	0:22:39	0.01	0.04	0.03	0.04	0.06	0.10	0.13	0.17	0.22
0.663	0:30:12	0.03	0.10	0.08	0.11	0.16	0.28	0.35	0.44	0.60
	0:37:45	0.09	0.26	0.19	0.28	0.42	0.71	0.90	1.14	1.55
	0:45:18	0.23	0.71	0.54	0.76	1.16	1.96	2.46	3.13	4.25
	0:52:51	0.27	0.82	0.62	0.88	1.35	2.29	2.89	3.68	5.02
	1:00:24	0.25	0.77	0.58	0.83	1.29	2.18	2.75	3.51	4.79
	1:07:57	0.23	0.70	0.53	0.76	1.17	1.98	2.50	3.19	4.36
	1:15:30	0.20	0.62	0.47	0.67	1.03	1.76	2.23	2.84	3.88
	1:23:03	0.17	0.53	0.40	0.57	0.88	1.51	1.91	2.44	3.35
	1:30:36	0.15	0.46	0.35	0.50	0.77	1.32	1.67	2.13	2.92
	1:38:09	0.13	0.42	0.31	0.45	0.70	1.19	1.51	1.93	2.64
	1:45:42	0.11	0.34	0.25	0.36	0.57	0.97	1.23	1.58	2.17
	1:53:15	0.08	0.27	0.20	0.29	0.45	0.78	1.00	1.28	1.77
	2:00:48	0.06	0.20	0.15	0.21	0.34	0.59	0.76	0.98	1.35
	2:08:21	0.04	0.14	0.10	0.15	0.24	0.43	0.55	0.72	1.00
	2:15:54	0.03	0.10	0.08	0.11	0.18	0.32	0.41	0.52	0.73
	2:23:27	0.03	0.08	0.06	0.09	0.14	0.25	0.32	0.41	0.57
	2:31:00	0.02	0.07	0.05	0.07	0.12	0.21	0.26	0.34	0.47
	2:38:33	0.02	0.06	0.04	0.06	0.10	0.18	0.22	0.29	0.40
	2:46:06	0.02	0.05	0.04	0.06	0.09	0.15	0.20	0.25	0.35
	2:53:39	0.02	0.05	0.04	0.05	0.08	0.14	0.18	0.23	0.31
	3:01:12	0.01	0.04	0.03	0.05	0.08	0.13	0.16	0.21	0.29
	3:08:45	0.01	0.03	0.02	0.04	0.06	0.09	0.12	0.15	0.21
	3:16:18	0.01	0.02	0.02	0.03	0.04	0.07	0.09	0.11	0.16
	3:23:51	0.01	0.02	0.01	0.02	0.03	0.05	0.06	0.08	0.11
	3:31:24	0.00	0.01	0.01	0.01	0.02	0.04	0.05	0.06	0.08
	3:38:57	0.00	0.01	0.01	0.01	0.01	0.03	0.03	0.04	0.06
	3:46:30	0.00	0.01	0.00	0.01	0.01	0.02	0.02	0.03	0.04
	3:54:03	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.03
	4:01:36	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02
	4:09:09	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
	4:16:42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	4:24:15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:31:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:39:21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:46:54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:54:27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:02:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:09:33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:17:06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:24:39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:32:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:39:45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:47:18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:54:51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:02:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:09:57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:17:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:25:03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:32:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:40:09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:47:42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:55:15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:02:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:10:21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:17:54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:25:27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:33:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:40:33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:48:06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:55:39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	8:03:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	8:10:45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	8:18:18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	8:25:51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	8:33:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	8:40:57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	8:48:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	8:56:03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	9:03:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Summary Stage-Area-Volume-Discharge Relationships

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

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

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
	0.00	771	0.018	0	0.000	0.00
	0.10	823	0.019	80	0.002	0.01
	0.20	871	0.020	156	0.004	0.01
	0.30	926	0.021	246	0.006	0.01
	0.40	981	0.023	341	0.008	0.01
	0.50	1,038	0.024	442	0.010	0.01
	0.60	1,096	0.025	549	0.013	0.01
	0.70	1,156	0.027	661	0.015	0.01
	0.80	1,217	0.028	780	0.018	0.01
	0.90	1,279	0.029	905	0.021	0.01
	1.00	1,342	0.031	1,036	0.024	0.01
	1.10	1,407	0.032	1,173	0.027	0.36
	1.20	1,473	0.034	1,317	0.030	1.08

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

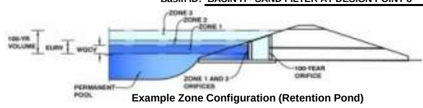
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: TIMBERRIDGE ESTATES

Basin ID: BASIN H - SAND FILTER AT DESIGN POINT 8



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	**SF**				
Watershed Area =	1.38	acres	**Note: L / W Ratio > 8**		
Watershed Length =	1,100	ft	**L / W Ratio = 20.1**		
Watershed Slope =	0.048	ft/ft			
Watershed Imperviousness =	27.00%	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			
Desired WQCV Drain Time =	40.0	hours	**Drain Time Too Long**		
Location for 1-hr Rainfall Depths =	User Input				
Water Quality Capture Volume (WQCV) =	0.013	acre-feet	Optional User Override		
Excess Urban Runoff Volume (EURV) =	0.038	acre-feet	1-hr Precipitation		
2-yr Runoff Volume (P1 = 1.19 in.) =	0.029	acre-feet	1.19	inches	
5-yr Runoff Volume (P1 = 1.5 in.) =	0.041	acre-feet	1.50	inches	
10-yr Runoff Volume (P1 = 1.75 in.) =	0.065	acre-feet	1.75	inches	
25-yr Runoff Volume (P1 = 2 in.) =	0.113	acre-feet	2.00	inches	
50-yr Runoff Volume (P1 = 2.25 in.) =	0.145	acre-feet	2.25	inches	
100-yr Runoff Volume (P1 = 2.52 in.) =	0.186	acre-feet	2.52	inches	
500-yr Runoff Volume (P1 = 3 in.) =	0.256	acre-feet	3.00	inches	
Approximate 2-yr Detention Volume =	0.027	acre-feet			
Approximate 5-yr Detention Volume =	0.039	acre-feet			
Approximate 10-yr Detention Volume =	0.058	acre-feet			
Approximate 25-yr Detention Volume =	0.068	acre-feet			
Approximate 50-yr Detention Volume =	0.072	acre-feet			
Approximate 100-yr Detention Volume =	0.086	acre-feet			

Stage-Storage Calculation

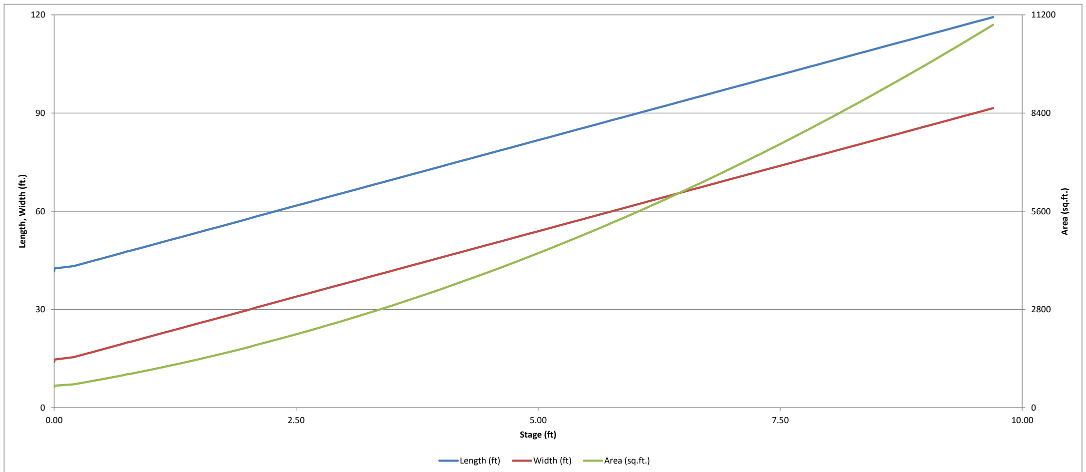
Zone 1 Volume (WQCV) =	0.013	acre-feet	
Select Zone 2 Storage Volume (Optional) =		acre-feet	**Total detention volume is less than 100-year volume.**
Select Zone 3 Storage Volume (Optional) =		acre-feet	
Total Detention Basin Volume =	0.013	acre-feet	
Initial Surcharge Volume (ISV) =	N/A	ft^3	
Initial Surcharge Depth (ISD) =	N/A	ft	
Total Available Detention Depth (H_{total}) =	0.75	ft	
Depth of Trickle Channel (H_{TC}) =	N/A	ft	
Slope of Trickle Channel (S_{TC}) =	N/A	ft/ft	
Slopes of Main Basin Sides (S_{main}) =	4	H:V	
Basin Length-to-Width Ratio ($R_{L/W}$) =	3		
Initial Surcharge Area (A_{ISV}) =	0	ft^2	
Surcharge Volume Length (L_{ISV}) =	0.0	ft	
Surcharge Volume Width (W_{ISV}) =	0.0	ft	
Depth of Basin Floor (H_{FLOOR}) =	0.00	ft	
Length of Basin Floor (L_{FLOOR}) =	41.7	ft	
Width of Basin Floor (W_{FLOOR}) =	13.9	ft	
Area of Basin Floor (A_{FLOOR}) =	580	ft^2	
Volume of Basin Floor (V_{FLOOR}) =	0	ft^3	
Depth of Main Basin (H_{MAIN}) =	0.75	ft	
Length of Main Basin (L_{MAIN}) =	47.7	ft	
Width of Main Basin (W_{MAIN}) =	19.9	ft	
Area of Main Basin (A_{MAIN}) =	950	ft^2	
Volume of Main Basin (V_{MAIN}) =	568	ft^3	
Calculated Total Basin Volume (V_{total}) =	**0.013**	acre-feet	

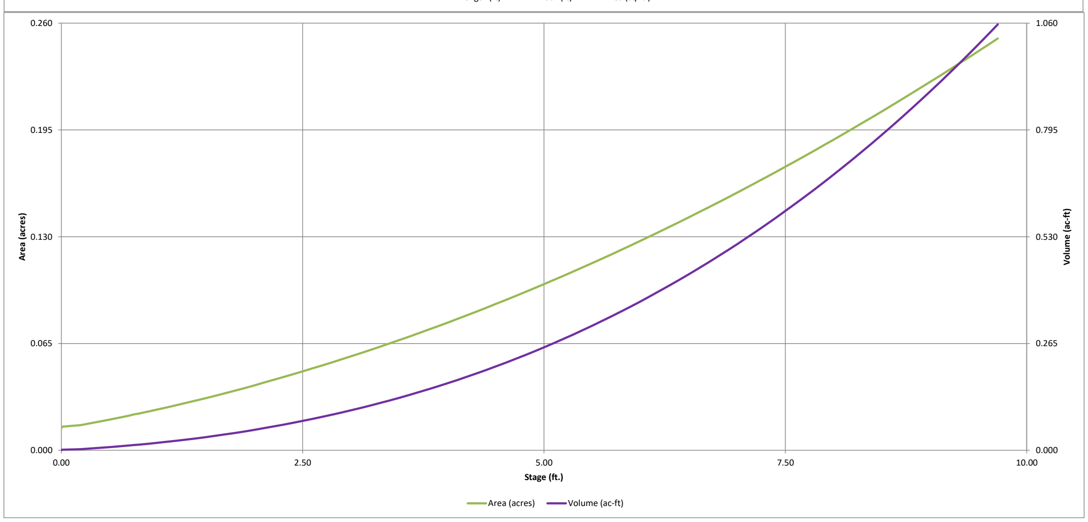
Depth Increment = 0.1 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Media Surface	0.00		41.7	13.9	580		0.013		
	0.10		42.5	14.7	625		0.014	60	0.001
	0.20		43.2	15.4	667		0.015	118	0.003
	0.30		44.0	16.2	715		0.016	187	0.004
	0.40		44.8	17.0	763		0.018	261	0.006
	0.50		45.6	17.8	814		0.019	340	0.008
	0.60		46.4	18.6	865		0.020	424	0.010
	0.70		47.2	19.4	918		0.021	513	0.012
Zone 1 (WQCV)	0.75		47.7	19.9	950		0.022	569	0.013
	0.80		48.0	20.2	972		0.022	608	0.014
	0.90		48.8	21.0	1,027		0.024	708	0.016
	1.00		49.6	21.8	1,083		0.025	813	0.019
	1.10		50.4	22.6	1,141		0.026	924	0.021
	1.20		51.2	23.4	1,200		0.028	1,041	0.024
	1.30		52.0	24.2	1,261		0.029	1,164	0.027
	1.40		52.8	25.0	1,322		0.030	1,294	0.030
	1.50		53.6	25.8	1,385		0.032	1,429	0.033
	1.60		54.4	26.6	1,450		0.033	1,571	0.036
	1.70		55.2	27.4	1,515		0.035	1,719	0.039
	1.80		56.0	28.2	1,582		0.036	1,874	0.043
	1.90		56.8	29.0	1,650		0.038	2,035	0.047
	2.00		57.6	29.8	1,719		0.039	2,204	0.051
	2.10		58.5	30.7	1,797		0.041	2,397	0.055
	2.20		59.3	31.5	1,869		0.043	2,580	0.059
	2.30		60.1	32.3	1,942		0.045	2,771	0.064
	2.40		60.9	33.1	2,017		0.046	2,969	0.068
	2.50		61.7	33.9	2,093		0.048	3,174	0.073
	2.60		62.5	34.7	2,170		0.050	3,387	0.078
	2.70		63.3	35.5	2,248		0.052	3,608	0.083
	2.80		64.1	36.3	2,328		0.053	3,837	0.088
	2.90		64.9	37.1	2,409		0.055	4,074	0.094
	3.00		65.7	37.9	2,491		0.057	4,319	0.099
	3.10		66.5	38.7	2,575		0.059	4,572	0.105
	3.20		67.3	39.5	2,660		0.061	4,834	0.111
	3.30		68.1	40.3	2,746		0.063	5,104	0.117
	3.40		68.9	41.1	2,833		0.065	5,383	0.124
	3.50		69.7	41.9	2,922		0.067	5,671	0.130
	3.60		70.5	42.7	3,012		0.069	5,968	0.137
	3.70		71.3	43.5	3,103		0.071	6,273	0.144
	3.80		72.1	44.3	3,195		0.073	6,588	0.151
	3.90		72.9	45.1	3,289		0.076	6,912	0.159
	4.00		73.7	45.9	3,384		0.078	7,246	0.166
	4.10		74.5	46.7	3,481		0.080	7,589	0.174
	4.20		75.3	47.5	3,578		0.082	7,942	0.182
	4.30		76.1	48.3	3,677		0.084	8,305	0.191
	4.40		76.9	49.1	3,777		0.087	8,678	0.199
	4.50		77.7	49.9	3,879		0.089	9,060	0.208
	4.60		78.5	50.7	3,981		0.091	9,453	0.217
	4.70		79.3	51.5	4,085		0.094	9,857	0.226
	4.80		80.1	52.3	4,191		0.096	10,271	0.236
	4.90		80.9	53.1	4,297		0.099	10,695	0.246
	5.00		81.7	53.9	4,405		0.101	11,130	0.256
	5.10		82.5	54.7	4,514		0.104	11,576	0.266
	5.20		83.3	55.5	4,625		0.106	12,033	0.276
	5.30		84.1	56.3	4,736		0.109	12,501	0.287
	5.40		84.9	57.1	4,849		0.111	12,980	0.298
	5.50		85.7	57.9	4,964		0.114	13,471	0.309
	5.60		86.5	58.7	5,079		0.117	13,973	0.321
	5.70		87.3	59.5	5,196		0.119	14,487	0.333
	5.80		88.1	60.3	5,314		0.122	15,012	0.345
	5.90		88.9	61.1	5,434		0.125	15,550	0.357
	6.00		89.7	61.9	5,554		0.128	16,099	0.370
	6.10		90.5	62.7	5,676		0.130	16,661	0.382
	6.20		91.3	63.5	5,799		0.133	17,234	0.396
	6.30		92.1	64.3	5,924		0.136	17,820	0.409
	6.40		92.9	65.1	6,050		0.139	18,419	0.423
	6.50		93.7	65.9	6,177		0.142	19,030	0.437
	6.60		94.5	66.7	6,305		0.145	19,654	0.451
	6.70		95.3	67.5	6,435		0.148	20,291	0.466
	6.80		96.1	68.3	6,566		0.151	20,941	0.481
	6.90		96.9	69.1	6,698		0.154	21,605	0.496
	7.00		97.7	69.9	6,831		0.157	22,281	0.512
	7.10		98.5	70.7	6,966		0.160	22,971	0.527
	7.20		99.3	71.5	7,102		0.163	23,674	0.543
	7.30		100.1	72.3	7,239		0.166	24,391	0.560
	7.40		100.9	73.1	7,378		0.169	25,122	0.577
	7.50		101.7	73.9	7,518		0.173	25,867	0.594
	7.60		102.5	74.7	7,659		0.176	26,626	0.611
	7.70		103.3	75.5	7,801		0.179	27,399	0.629
	7.80		104.1	76.3	7,945		0.182	28,186	0.647
	7.90		104.9	77.1	8,090		0.186	28,988	0.665
	8.00		105.7	77.9	8,236		0.189	29,804	0.684
	8.10		106.5	78.7	8,384		0.192	30,635	0.703
	8.20		107.3	79.5	8,533		0.196	31,481	0.723
	8.30		108.1	80.3	8,683		0.199	32,342	0.742
	8.40		108.9	81.1	8,834		0.203	33,217	0.763
	8.50		109.7	81.9	8,987		0.206	34,108	0.783
	8.60		110.5	82.7	9,141		0.210	35,015	0.804
	8.70		111.3	83.5	9,296		0.213	35,937	0.825
	8.80		112.1	84.3	9,452		0.217	36,874	0.847
	8.90		112.9	85.1	9,610		0.221	37,827	0.868
	9.00		113.7	85.9	9,769		0.224	38,796	0.891
	9.10		114.5	86.7	9,930		0.228	39,781	0.913
	9.20		115.3	87.5	10,091		0.232	40,782	0.936
	9.30		116.1	88.3	10,254		0.235	41,799	0.960
	9.40		116.9	89.1	10,418		0.239	42,833	0.983
	9.50		117.7	89.9	10,584		0.243	43,883	1.007
	9.60		118.5	90.7	10,750		0.247	44,950	1.032
	9.70		119.3	91.5	10,918		0.251	46,033	1.057

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)



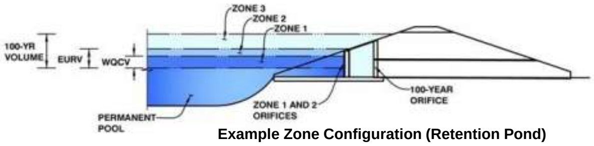


Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: TIMBERRIDGE ESTATES

Basin ID: BASIN H - SAND FILTER AT DESIGN POINT 8



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.75	0.013	Filtration Media
Zone 2			
Zone 3			
		0.013	Total

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

Underdrain Orifice Invert Depth =	2.17	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	0.30	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	0.0	ft^2
Underdrain Orifice Centroid =	0.01	feet

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

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

Calculated Parameters for Plate

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

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

	Row 1 (optional)	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)								
Orifice Area (sq. inches)								

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =			ft^2
Vertical Orifice Centroid =			feet

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

	Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =	0.75		ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	1.50		feet
Overflow Weir Slope =	0.00		H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	1.50		feet
Overflow Grate Open Area % =	70%		%, grate open area/total area
Debris Clogging % =	50%		%

Calculated Parameters for Overflow Weir

	Not Selected	Not Selected	
Height of Grate Upper Edge, H_t =	0.75		feet
Over Flow Weir Slope Length =	1.50		feet
Grate Open Area / 100-yr Orifice Area =			should be ≥ 4
Overflow Grate Open Area w/o Debris =	1.58		ft^2
Overflow Grate Open Area w/ Debris =	0.79		ft^2

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

	Not Selected	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =			inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Not Selected	Not Selected	
Outlet Orifice Area =			ft^2
Outlet Orifice Centroid =			feet
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway

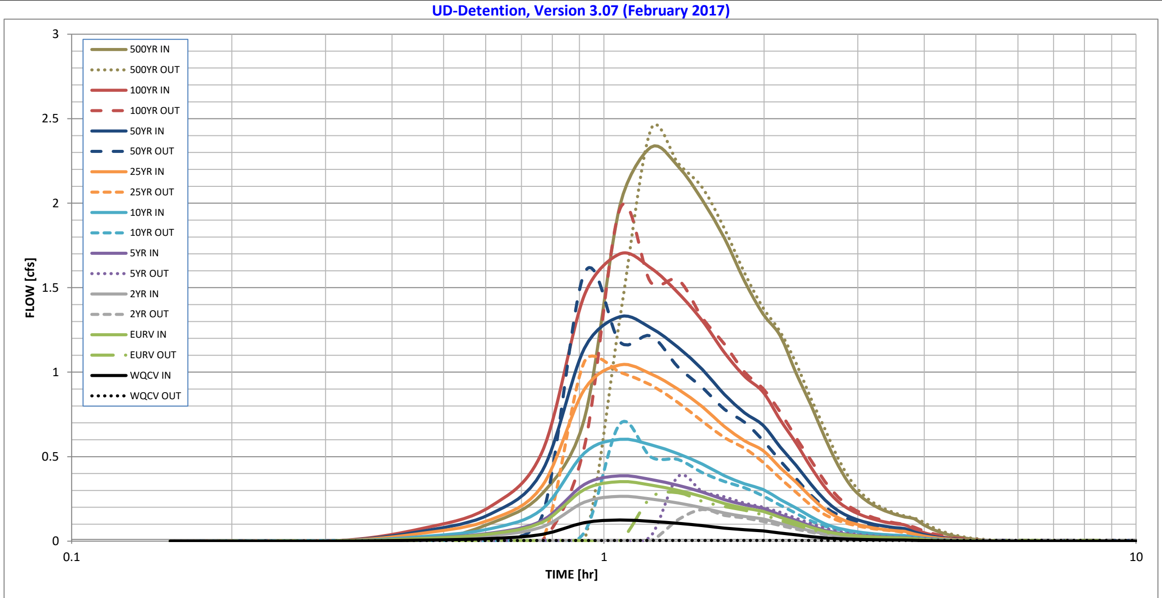
Spillway Design Flow Depth=		feet
Stage at Top of Freeboard =		feet
Basin Area at Top of Freeboard =		acres

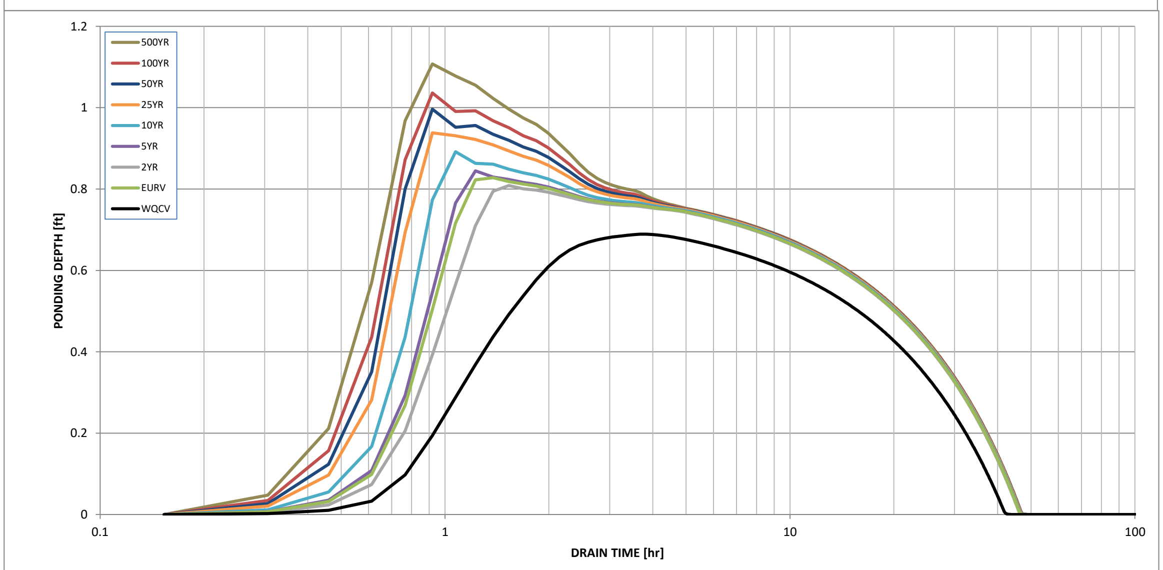
Routed Hydrograph Results

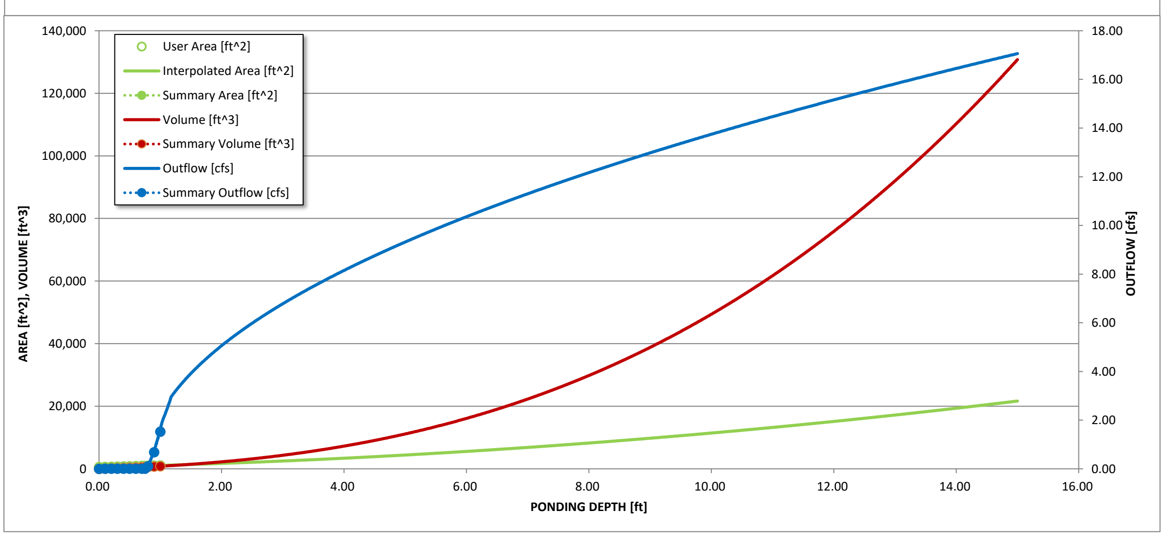
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.00
Calculated Runoff Volume (acre-ft) =	0.013	0.038	0.029	0.041	0.065	0.113	0.145	0.186	0.256
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.013	0.037	0.028	0.041	0.065	0.113	0.144	0.185	0.255
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.14	0.50	0.69	0.94	1.34
Predevelopment Peak Q (cfs) =	0.0	0.0	0.0	0.0	0.2	0.7	1.0	1.3	1.8
Peak Inflow Q (cfs) =	0.1	0.4	0.3	0.4	0.6	1.0	1.3	1.7	2.3
Peak Outflow Q (cfs) =	0.0	0.3	0.2	0.4	0.7	1.1	1.6	2.0	2.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	18.1	3.5	1.5	1.7	1.5	1.3
Structure Controlling Flow =	Filtration Media	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1
Max Velocity through Grate 1 (fps) =	N/A	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	41	43	44	42	40	36	33	29	22
Time to Drain 99% of Inflow Volume (hours) =	**42**	45	46	45	45	43	42	41	38
Maximum Ponding Depth (ft) =	0.69	0.83	0.81	0.84	0.89	0.94	1.00	1.04	1.11
Area at Maximum Ponding Depth (acres) =	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03
Maximum Volume Stored (acre-ft) =	0.012	0.015	0.014	0.015	0.016	0.017	0.019	0.020	0.021

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







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

Detention Basin Outlet Structure Design

Outflow Hydrograph Workbook Filename:

Storm Inflow Hydrographs **UD-Detention, Version 3.07 (February 2017)**

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

Time Interval	Hydrograph Constant
9.19 min	0.544

SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK
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]
0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:09:11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:18:23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:27:34	0.01	0.02	0.01	0.02	0.03	0.05	0.06	0.08	0.11
0:36:46	0.02	0.04	0.03	0.05	0.07	0.13	0.16	0.21	0.28
0:45:57	0.04	0.11	0.08	0.12	0.19	0.33	0.41	0.53	0.72
0:55:08	0.11	0.31	0.23	0.34	0.52	0.90	1.14	1.45	1.99
1:04:20	0.13	0.35	0.27	0.39	0.60	1.04	1.33	1.70	2.33
1:13:31	0.12	0.33	0.25	0.36	0.57	0.99	1.26	1.62	2.22
1:22:43	0.11	0.30	0.23	0.33	0.52	0.90	1.15	1.47	2.02
1:31:54	0.09	0.26	0.20	0.29	0.46	0.80	1.02	1.30	1.79
1:41:05	0.08	0.22	0.17	0.25	0.39	0.68	0.87	1.12	1.54
1:50:17	0.07	0.20	0.15	0.22	0.34	0.59	0.76	0.98	1.34
1:59:28	0.06	0.18	0.13	0.19	0.31	0.54	0.69	0.88	1.22
2:08:40	0.05	0.14	0.10	0.16	0.25	0.43	0.56	0.72	0.99
2:17:51	0.04	0.11	0.08	0.12	0.20	0.35	0.45	0.58	0.80
2:27:02	0.03	0.08	0.06	0.09	0.14	0.26	0.34	0.44	0.61
2:36:14	0.02	0.06	0.04	0.06	0.10	0.19	0.24	0.32	0.45
2:45:25	0.01	0.04	0.03	0.05	0.08	0.14	0.18	0.23	0.33
2:54:37	0.01	0.03	0.03	0.04	0.06	0.11	0.14	0.18	0.26
3:03:48	0.01	0.03	0.02	0.03	0.05	0.09	0.12	0.15	0.21
3:12:59	0.01	0.02	0.02	0.03	0.04	0.08	0.10	0.13	0.18
3:22:11	0.01	0.02	0.02	0.02	0.04	0.07	0.09	0.11	0.16
3:31:22	0.01	0.02	0.01	0.02	0.03	0.06	0.08	0.10	0.14
3:40:34	0.01	0.02	0.01	0.02	0.03	0.06	0.07	0.10	0.13
3:49:45	0.00	0.01	0.01	0.02	0.02	0.04	0.05	0.07	0.10
3:58:56	0.00	0.01	0.01	0.01	0.02	0.03	0.04	0.05	0.07
4:08:08	0.00	0.01	0.01	0.01	0.01	0.02	0.03	0.04	0.05
4:17:19	0.00	0.01	0.00	0.01	0.01	0.02	0.02	0.03	0.04
4:26:31	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.03
4:35:42	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02
4:44:53	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
4:54:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
5:03:16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:12:28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:21:39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:30:50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:40:02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:49:13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:58:25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:07:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:16:47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:25:59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:35:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:44:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:53:33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7:02:44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7:11:56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7:21:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7:30:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7:39:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7:48:41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7:57:53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8:07:04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8:16:16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8:25:27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8:34:38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8:43:50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8:53:01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9:02:13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9:11:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9:20:35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9:29:47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9:38:58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9:48:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9:57:21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10:06:32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10:15:44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10:24:55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10:34:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10:43:18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10:52:29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11:01:41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Summary Stage-Area-Volume-Discharge Relationships

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

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

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
	0.00	580	0.013	0	0.000	0.00
	0.10	625	0.014	60	0.001	0.00
	0.20	667	0.015	118	0.003	0.00
	0.30	715	0.016	187	0.004	0.00
	0.40	763	0.018	261	0.006	0.00
	0.50	814	0.019	340	0.008	0.00
	0.60	865	0.020	424	0.010	0.00
	0.70	918	0.021	513	0.012	0.00
	0.75	945	0.022	560	0.013	0.00
	0.80	972	0.022	608	0.014	0.11
	0.90	1,027	0.024	708	0.016	0.68
	1.00	1,083	0.025	813	0.019	1.53

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

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

DRAINAGE MAPS

TIMBERRIDGE ESTATES
EL PASO COUNTY
EXISTING DRAINAGE PLAN
FEBRUARY 2019

EXISTING CONDITIONS

BASIN	ACRES	Q5 CFS	Q100 CFS
EX-E1	35.30	6.5	46.1
OS-4A	2.98	0.9	6.5
OS-4B	7.76	1.8	12.7
OS-4C	8.17	1.6	11.4
OS-4D	3.39	0.7	5.4

DESIGN POINT SUMMARY

DP	CONTRIBUTING BASINS	AREA AC.	Q5 CFS	Q10 CFS	Q100 CFS
OS-1	OS-4A	3.00	0.9	---	6.5
OS-2	OS-4B	7.50	1.7	---	12.3
OS-3	OS-4C	8.17	1.6	---	11.4
OS-4	OS-4D	3.39	0.7	---	5.4
EX-1	EX-E1, OS-4A, OS-4B, OS-4C, & OS-4D	57.60	11.5	---	82.1
SC-1*	SAND CREEK DRAINAGE BASIN	---	---	630	2,170
SC-1**	SAND CREEK DRAINAGE BASIN	---	---	---	2,607

*THIS POINT IS FOR THE SAND CREEK CHANNEL, FLOWS PER KIOWA DBPS
**THIS POINT IS FOR THE SAND CREEK CHANNEL, FLOWS PER FEMA

LEGEND

- P-7 / 12.22 — BASIN DESIGNATION / AREA IN BASIN (AC)
- D — DESIGN POINT
- BASIN BOUNDARY
- EXISTING 2' CONTOUR
- 7260 — EXISTING 10' CONTOUR
- FLOW DIRECTION
- SURFACE FLOW CHANNEL

N

100' 0 100' 200'

SCALE: 1"=100'

N:jobs\1733.00\Drawings\SDP\173300 FDM.dwg, EX-DR, 2/28/2019 11:40:09 AM

NO.	DESCRIPTION	DATE

REVISIONS

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Creative Civil Engineering Solutions

721 S. 23RD STREET
COLORADO SPRINGS, CO 80904
OFFICE: 719-635-6422
FAX: 719-635-6426
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TIMBERRIDGE ESTATES
EXISTING DRAINAGE PLAN

DESIGNED BY DLM
DRAWN BY DLM
CHECKED BY LD
H-SCALE 1"=100'
V-SCALE N/A
JOB NO. 1733.00
DATE ISSUED 02/28/19
SHEET NO. 1 OF 6

TIMBERRIDGE ESTATES

EL PASO COUNTY

PROPOSED DRAINAGE PLAN

FEBRUARY 2019

PROPOSED CONDITIONS

BASIN	ACRES	Q5 CFS	Q100 CFS
OS-1	7.76	1.6	11.2
OS-2	2.98	0.9	7.0
OS-3	8.17	1.8	12.9
OS-4	3.39	0.8	6.1
OS-5	3.19	0.7	4.8
OS-6	4.89	1.2	8.8
A	12.38	3.9	21.4
A1	1.83	2.7	6.8
B	1.66	2.1	5.2
C	15.36	4.8	24.7
D	2.60	1.1	4.7
E	1.04	1.8	4.7
F	0.72	0.2	1.7
G	1.16	2.0	5.1
H	1.38	2.2	5.7
I	1.27	2.2	5.6

DESIGN POINT SUMMARY

DP	CONTRIBUTING BASINS	AREA AC.	Q5 CFS	Q10 CFS	Q100 CFS
1	OS-2, A & A1	17.18	6.7	---	24.9
2	OS-2, A, A1 & B	59.26	9.7	---	40.4
3	OS-2, OS-3, OS-4, A, A1, B & C	82.37	16.1	---	76.4
4	D	2.60	1.1	---	4.7
5	OS-2, OS-3,OS-4, OS-5, A, A1, B, C, D, E & F	90.13	20.1	---	93.7
6	OS-6 & G	9.21	2.7	---	9.9
7	I	1.27	2.2	---	5.6
8	H	1.38	2.2	---	5.7
OS-1	OS-1	7.76	1.6	---	11.2
OS-2	OS-2	2.98	0.9	---	7.0
OS-3	OS-3	8.17	1.8	---	12.9
OS-4	OS-4	3.39	0.8	---	6.1
OS-5	OS-5	3.19	0.7	---	4.8
OS-6	OS-6	4.89	1.2	---	8.8
SC-1*	SAND CREEK DRAINAGE BASIN	---	---	630	2,170
SC-1**	SAND CREEK DRAINAGE BASIN	---	---	---	2,607

*THIS POINT IS FOR THE SAND CREEK CHANNEL, FLOWS PER KIOWA DBPS

**THIS POINT IS FOR THE SAND CREEK CHANNEL, FLOWS PER FEMA

DRAINAGE NOTES

1. EXTENDED DETENTION BASIN ACCESS IS FROM ARROYA LANE OR THE SOUTHERN END OF NATURE REFUGE WAY.
2. DRAINAGE EASEMENT MAINTENANCE ACCESS IF FROM NATURE REFUGE WAY AND/OR FROM ARROYA LANE.
3. SAND FILTER ACCESS WILL BE FROM THE FUTURE ROADS ADJACENT TO EACH SAND FILTER.
4. SAND FILTERS TO BE INSTALLED PRIOR TO THE PAVING OF ARROYA LANE. SAND FILTERS WILL NOT BE PUT INTO OPERATION WHILE ARROYA LANE IS STILL A GRAVEL ROAD.
5. PROPOSED DRAINAGE EASEMENTS ARE BASED ON EXISTING CONDITIONS, 100-YEAR STORM EVENTS, 1' FREEBOARD, AND ARE PRELIMINARY.
6. DRAINAGE CHANNEL GRADING AND EASEMENT FOR LOTS R-1, R-2, R-3, AND R-4 HAVE NOT BEEN INCLUDED. THESE ITEMS WILL BE ADDRESSED ON A LOT BY LOT BASIS AS PART OF THE CONSTRUCTION PLANS FOR THE INDIVIDUAL LOTS.
7. REINFORCE PROPOSED SWALES PR4, PR7, PR8, PR9, PR10, & PR11 WITH TURF REINFORCEMENT MATS (NORTH AMERICAN GREEN VMAX SC250, VMAX C350, OR SIMILAR). TURF REINFORCEMENT MATS ARE NOT REQUIRED FOR SWALE AREAS WITH RIPRAP.

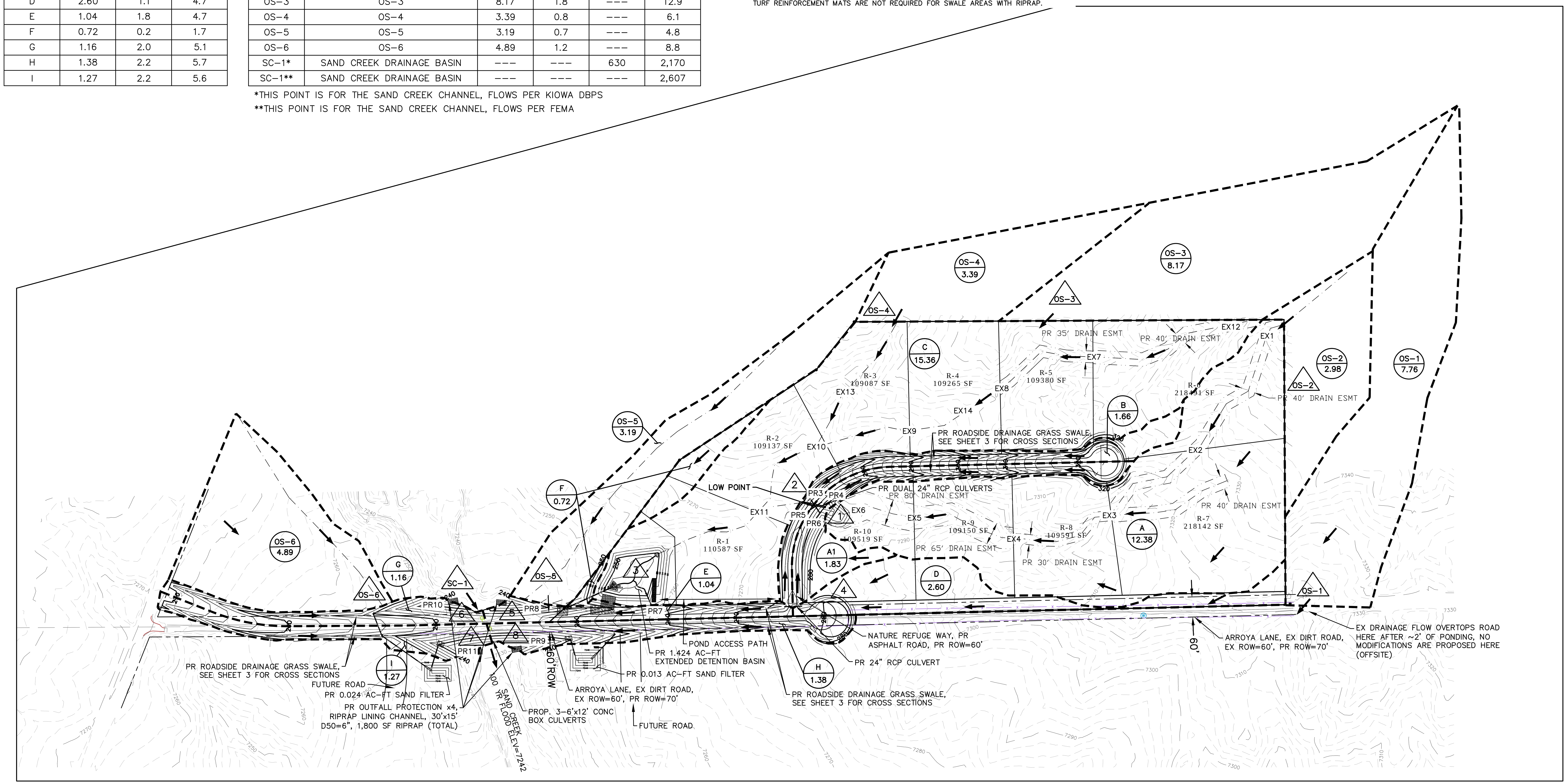
LEGEND

- P-7 / 12.22 — BASIN DESIGNATION / AREA IN BASIN (AC)
- D — DESIGN POINT
- BASIN BOUNDARY
- EXISTING 2' CONTOUR
- 7260 — EXISTING 10' CONTOUR
- PROPOSED 2' CONTOUR
- 260 — PROPOSED 10' CONTOUR
- FLOW DIRECTION
- SURFACE FLOW CHANNEL
- PROPOSED DRAINAGE EASEMENT
- EX# / PR# — OPEN CHANNEL FLOW CALC POINT

N

150' 0 150' 300'

SCALE: 1"=150'



REVISIONS

NO.	DESCRIPTION	DATE
1	REV'D PER 6/2/16 CTY COMMENTS	8/22/16

UNTIL SUCH TIME AS THESE DRAWINGS ARE APPROVED BY THE APPROPRIATE REVIEWING AGENCIES, TERRA NOVA ENGINEERING, INC. APPROVES THEIR USE ONLY FOR THE PURPOSES DESIGNATED BY WRITTEN AUTHORIZATION.

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COLORADO SPRINGS, CO 80904
OFFICE: 719-635-6422
FAX: 719-635-6426
www.tneinc.com

TIMBERRIDGE ESTATES

PROPOSED DRAINAGE PLAN

DESIGNED BY DLM
DRAWN BY DLM
CHECKED BY LD
H-SCALE 1"=150'
V-SCALE N/A
JOB NO. 1733.00
DATE ISSUED 02/28/19
SHEET NO. 2 OF 6

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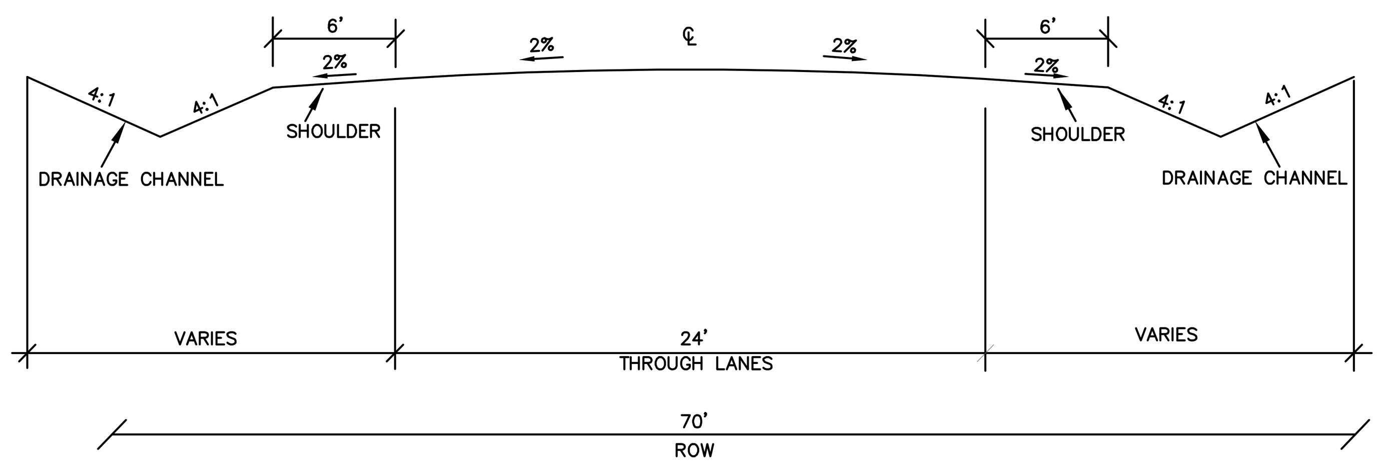
TIMBERRIDGE ESTATES

EL PASO COUNTY

PROPOSED DRAINAGE PLAN

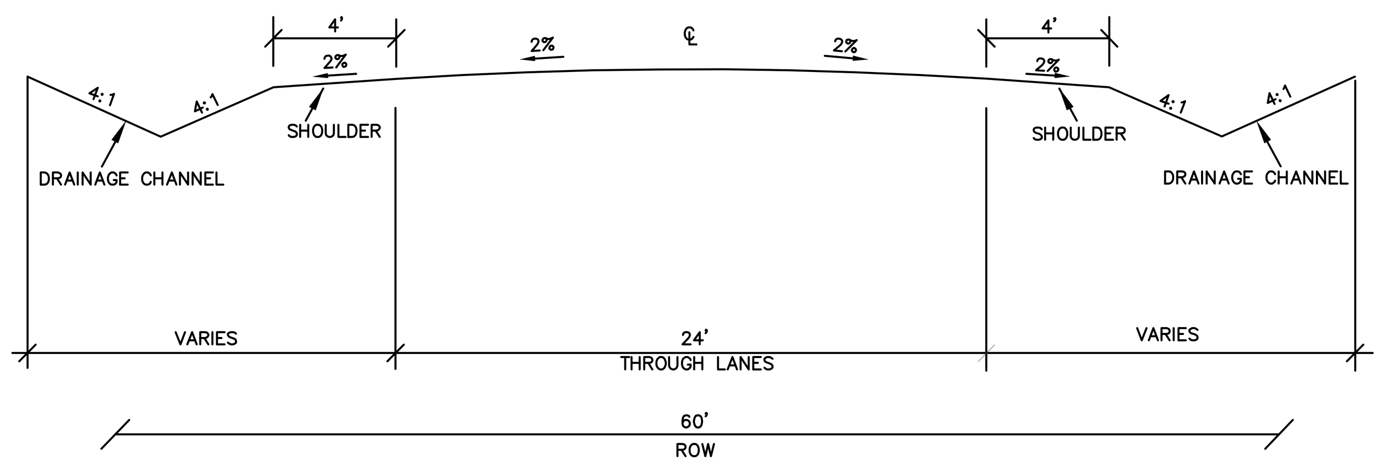
FEBRUARY 2019

PRELIMINARY DRAWING
NOT FOR CONSTRUCION



TYPICAL STREET SECTION (RURAL MINOR COLLECTOR) – ARROYA LANE

NOT TO SCALE

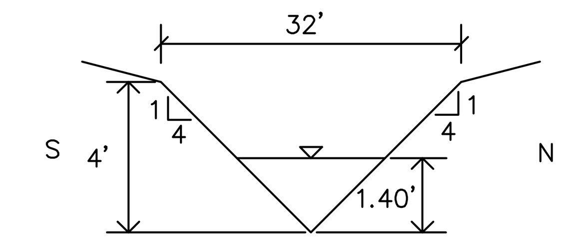


TYPICAL STREET SECTION (RURAL LOCAL) – NATURE REFUGE WAY

NOT TO SCALE

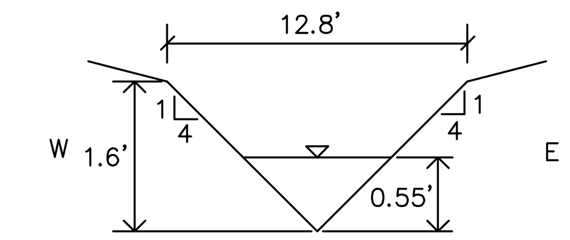
DRAINAGE NOTES

1. REINFORCE PROPOSED SWALES PR4, PR7, PR8, PR9, PR10, & PR11 WITH TURF REINFORCEMENT MATS (NORTH AMERICAN GREEN VMAX SC250, VMAX C350, OR SIMILAR). TURF REINFORCEMENT MATS ARE NOT REQUIRED FOR SWALE AREAS WITH RIPRAP.



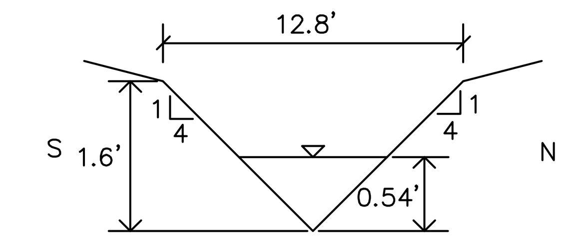
Q = 67.1 CFS
SLOPE = 5.0%
n VALUE = 0.03
DEPTH = 1.40'
VELOCITY = 8.56 FT/S
*EXPANDED TO ALLOW FOR POSSIBLE FUTURE FLOW INCREASES
*REINFORCE CHANNEL SIDES, SEE NOTE 1

SWALE CROSS SECTION – PR8



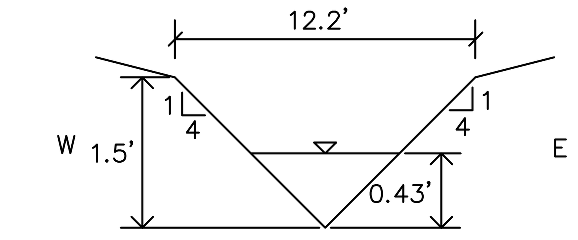
Q = 4.8 CFS
SLOPE = 3.8%
n VALUE = 0.03
DEPTH = 0.55'
VELOCITY = 4.00 FT/S

SWALE CROSS SECTION – PR3



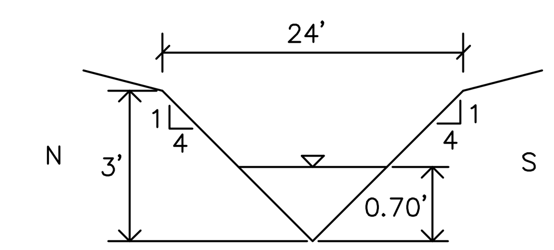
Q = 5.8 CFS
SLOPE = 6.0%
n VALUE = 0.03
DEPTH = 0.54'
VELOCITY = 4.97 FT/S
*REINFORCE CHANNEL SIDES, SEE NOTE 1

SWALE CROSS SECTION – PR9



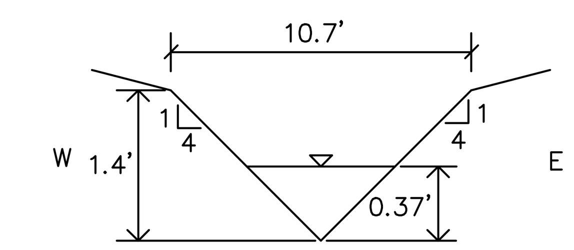
Q = 3.3 CFS
SLOPE = 6.3%
n VALUE = 0.03
DEPTH = 0.43'
VELOCITY = 4.37 FT/S
*REINFORCE CHANNEL SIDES, SEE NOTE 1

SWALE CROSS SECTION – PR4



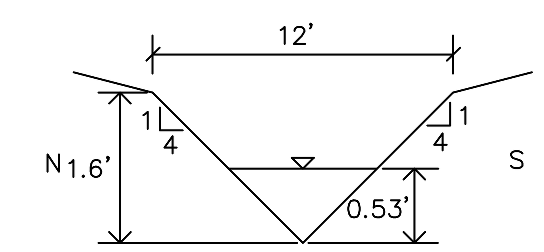
Q = 10.7 CFS
SLOPE = 5.9%
n VALUE = 0.03
DEPTH = 0.70'
VELOCITY = 5.84 FT/S
*EXPANDED TO ALLOW FOR POSSIBLE FUTURE FLOW INCREASES
*REINFORCE CHANNEL SIDES, SEE NOTE 1

SWALE CROSS SECTION – PR10



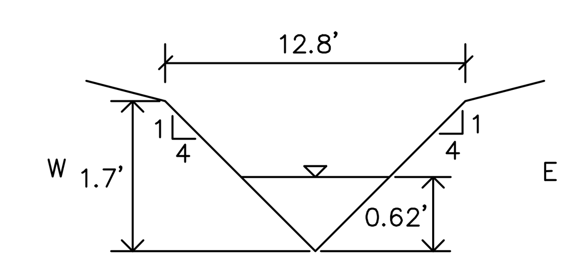
Q = 0.9 CFS
SLOPE = 1.3%
n VALUE = 0.03
DEPTH = 0.37'
VELOCITY = 1.79 FT/S

SWALE CROSS SECTION – PR5



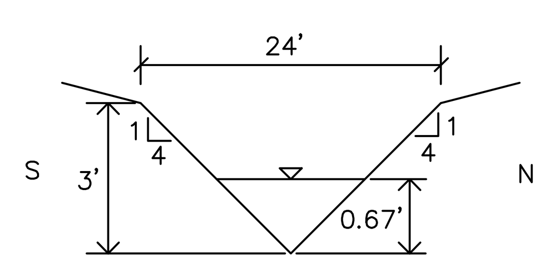
Q = 5.9 CFS
SLOPE = 7.8%
n VALUE = 0.03
DEPTH = 0.53'
VELOCITY = 5.58 FT/S
*REINFORCE CHANNEL SIDES, SEE NOTE 1

SWALE CROSS SECTION – PR11



Q = 3.6 CFS
SLOPE = 1.3%
n VALUE = 0.03
DEPTH = 0.62'
VELOCITY = 2.53 FT/S

SWALE CROSS SECTION – PR6

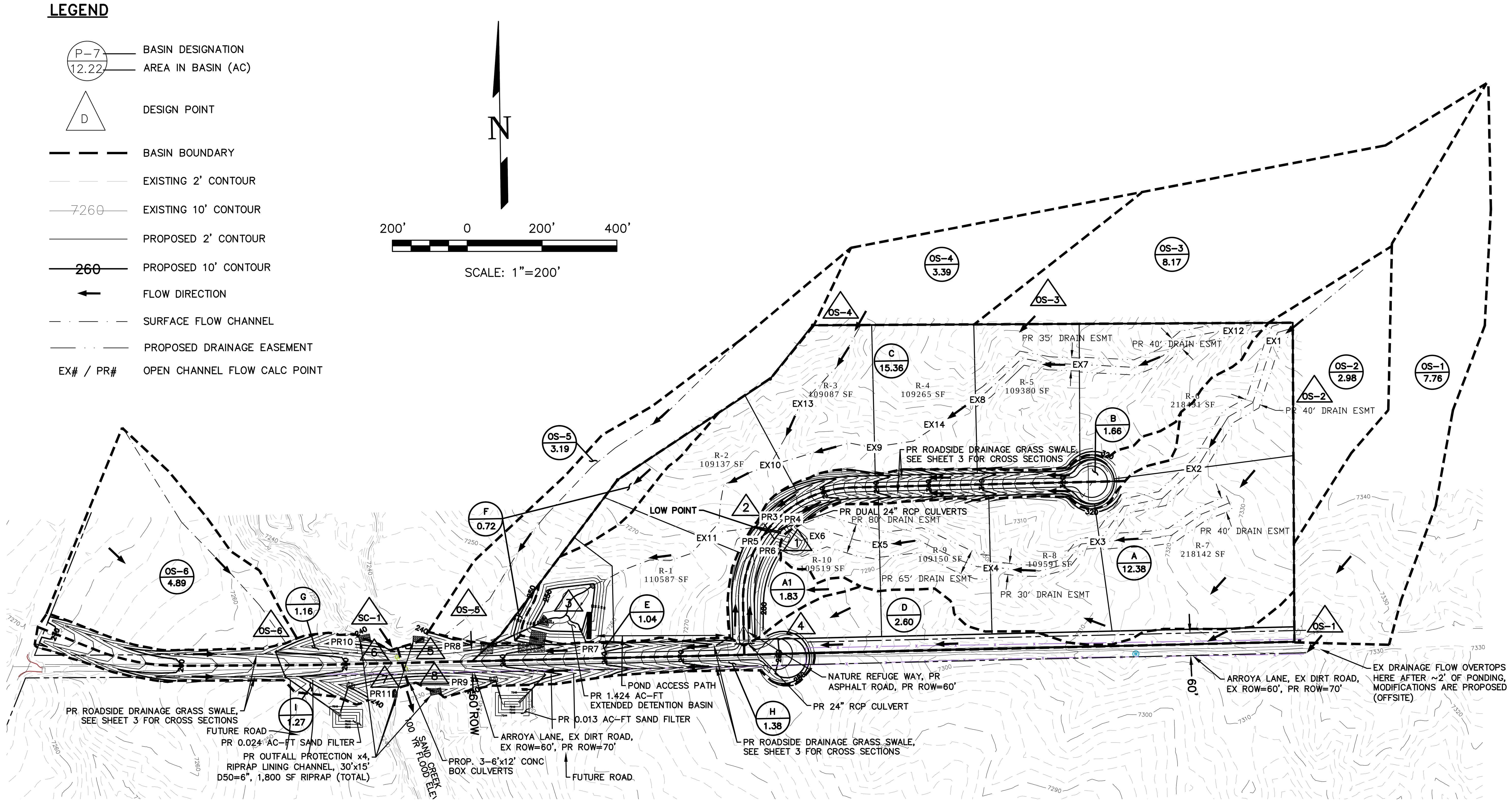


Q = 8.3 CFS
SLOPE = 5.2%
n VALUE = 0.03
DEPTH = 0.67'
VELOCITY = 5.30 FT/S
*EXPANDED TO ALLOW FOR POSSIBLE FUTURE FLOW INCREASES
*REINFORCE CHANNEL SIDES, SEE NOTE 1

SWALE CROSS SECTION – PR7

LEGEND

- P-7 / 12.22 — BASIN DESIGNATION / AREA IN BASIN (AC)
- D — DESIGN POINT
- BASIN BOUNDARY
- EXISTING 2' CONTOUR
- 7260 — EXISTING 10' CONTOUR
- PROPOSED 2' CONTOUR
- 260 — PROPOSED 10' CONTOUR
- FLOW DIRECTION
- SURFACE FLOW CHANNEL
- PROPOSED DRAINAGE EASEMENT
- EX# / PR# — OPEN CHANNEL FLOW CALC POINT



REVISIONS — NO. — DESCRIPTION — DATE

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TIMBERRIDGE ESTATES

PROPOSED DRAINAGE DETAILS

DESIGNED BY DLM
DRAWN BY DLM
CHECKED BY LD
H-SCALE 1"=200'
V-SCALE N/A
JOB NO. 1733.00
DATE ISSUED 02/28/19
SHEET NO. 3 OF 6

N:\jobs\1733.00\Drawings\SDP\173300 FDM.dwg, PR-DR #2, 2/28/2019 11:40:26 AM

TIMBERRIDGE ESTATES

EL PASO COUNTY

PROPOSED DETENTION BASIN DETAILS

FEBRUARY 2019

PRELIMINARY DRAWING
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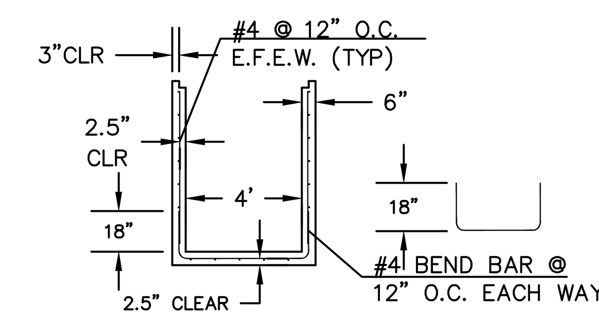
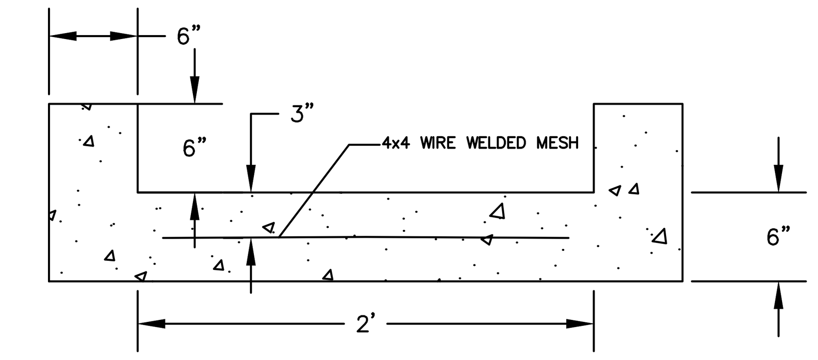


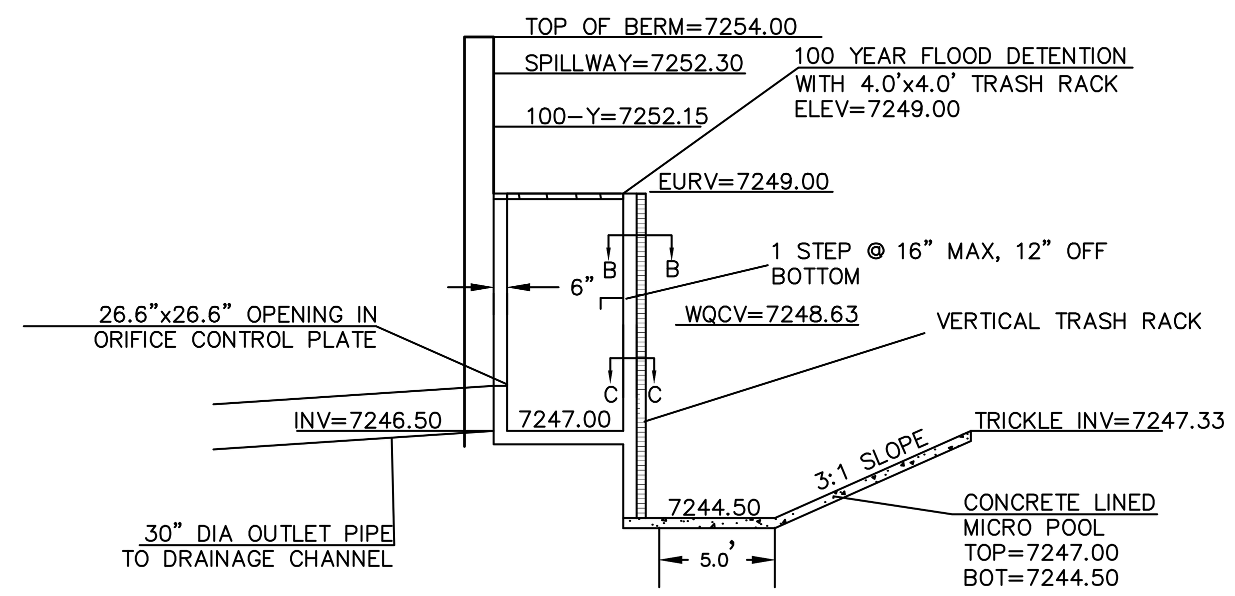
4'x4' OUTLET BOX STRUCTURAL DETAIL

NOT TO SCALE



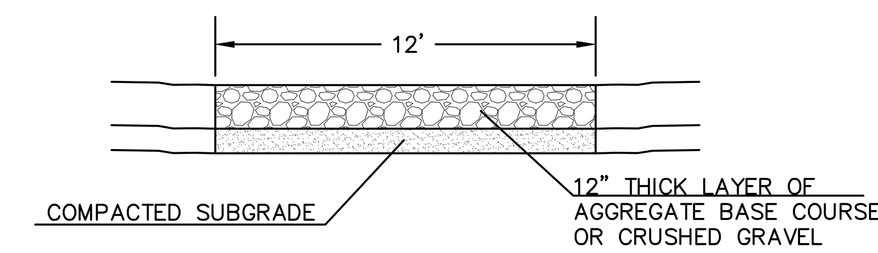
2' CONCRETE TRICKLE CHANNEL

NOT TO SCALE



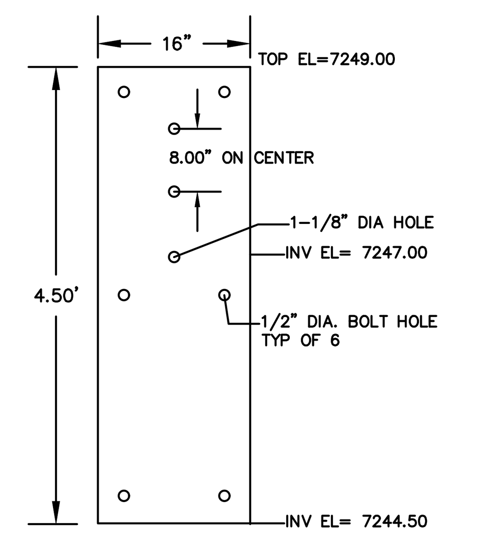
OUTLET STRUCTURE

NOT TO SCALE



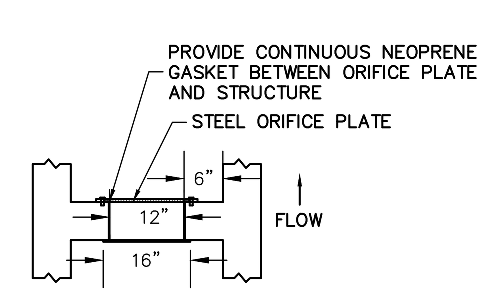
12' MAINTENANCE ACCESS ROAD SECTION

NOT TO SCALE



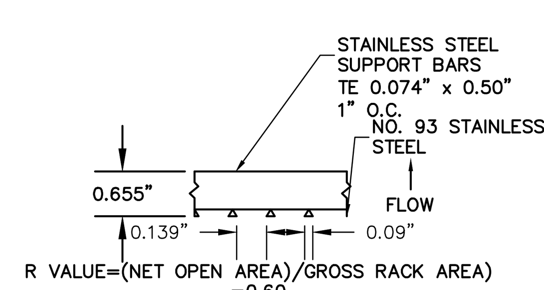
ORIFICE PLATE PERFORATED HOLE PATTERN

NOT TO SCALE



SECTION B-B

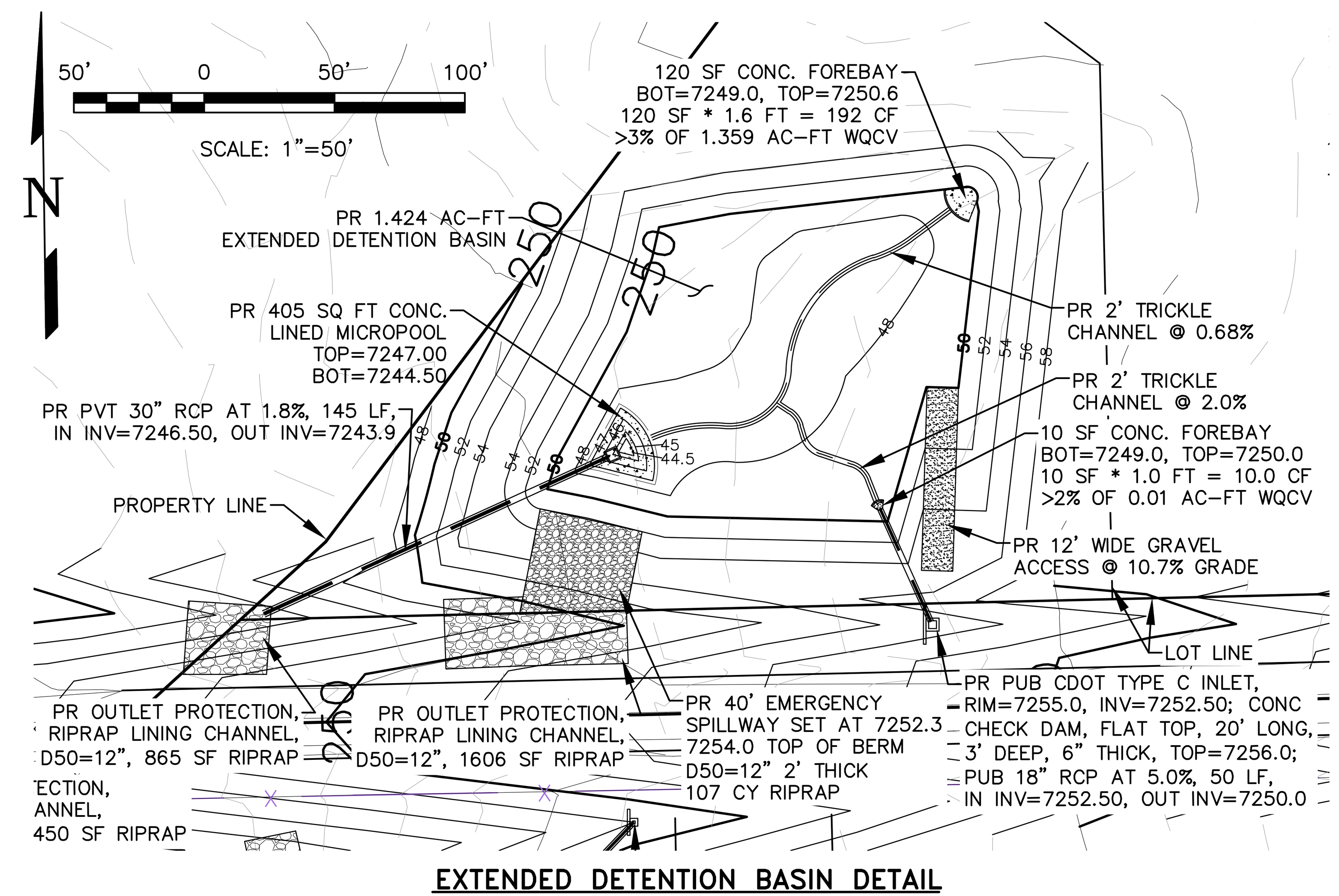
NOT TO SCALE



SECTION C-C

NOT TO SCALE

POND OUTLET OVERALL DETAIL



EXTENDED DETENTION BASIN DETAIL

REVISIONS		
NO.	DESCRIPTION	DATE
1	REV'D PER 6/2/16 CTY COMMENTS	8/22/16

UNTIL SUCH TIME AS THESE DRAWINGS ARE APPROVED BY THE APPROPRIATE REVIEWING AGENCIES, TERRA NOVA ENGINEERING, INC. APPROVES THEIR USE ONLY FOR THE PURPOSES DESIGNATED BY WRITTEN AUTHORIZATION.

PREPARED FOR:
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TIMBERRIDGE ESTATES

PROPOSED DETENTION BASIN DETAILS

DESIGNED BY DLM
DRAWN BY DLM
CHECKED BY LD
H-SCALE 1"=200'
V-SCALE N/A
JOB NO. 1733.00
DATE ISSUED 02/28/19
SHEET NO. 4 OF 6

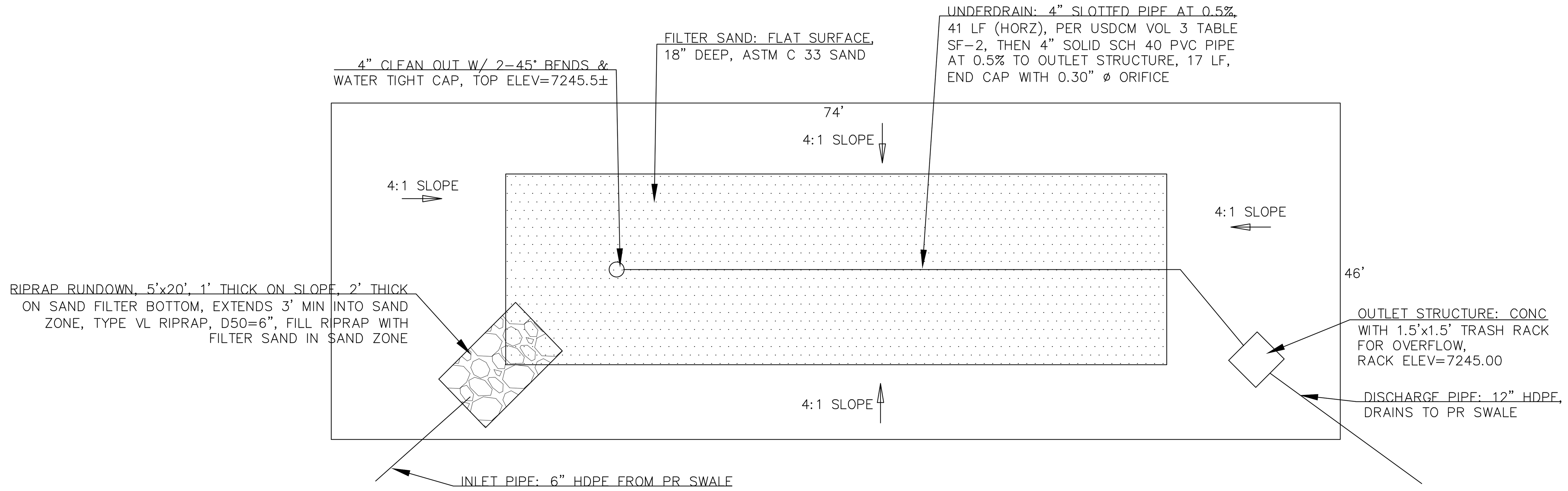
TIMBERRIDGE ESTATES

EL PASO COUNTY

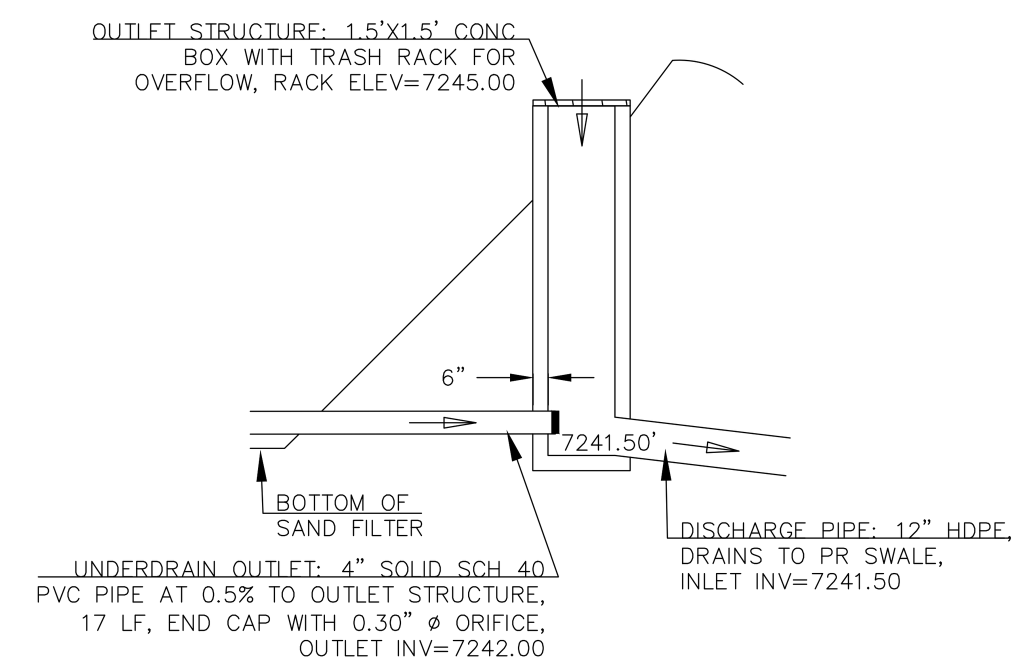
PROPOSED SAND FILTER DP8 DETAILS

FEBRUARY 2019

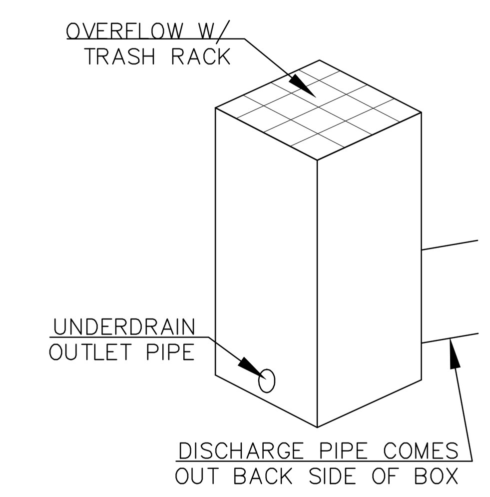
PRELIMINARY DRAWING
NOT FOR CONSTRUCION



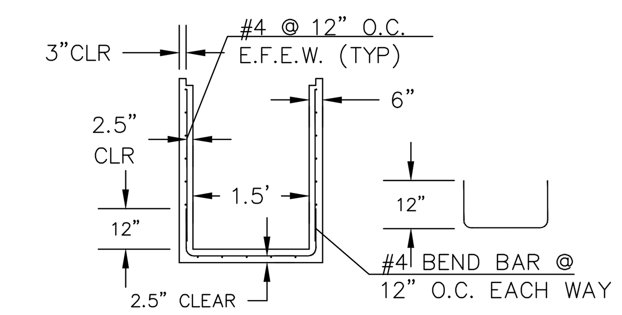
SAND FILTER DP8 DESIGN – PLAN VIEW
N.T.S.



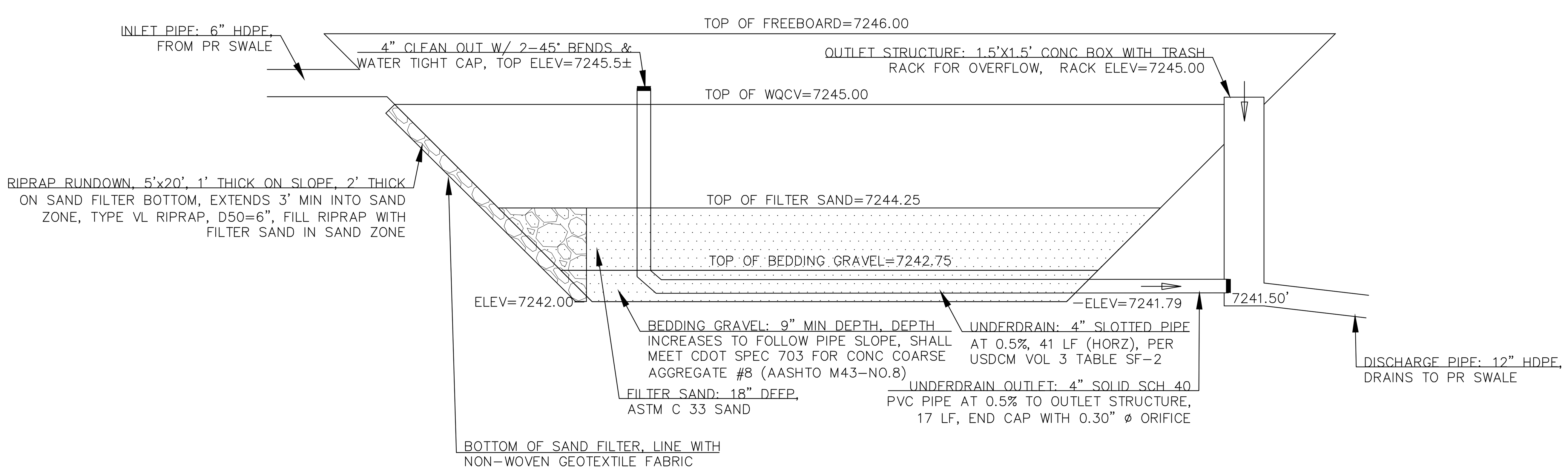
OUTLET STRUCTURE DETAIL (CONCRETE & STEEL)



OUTLET STRUCTURE CONCEPT SKETCH



1.5'x1.5' OUTLET BOX STRUCTURAL DETAIL



SAND FILTER DP8 DESIGN – PROFILE VIEW
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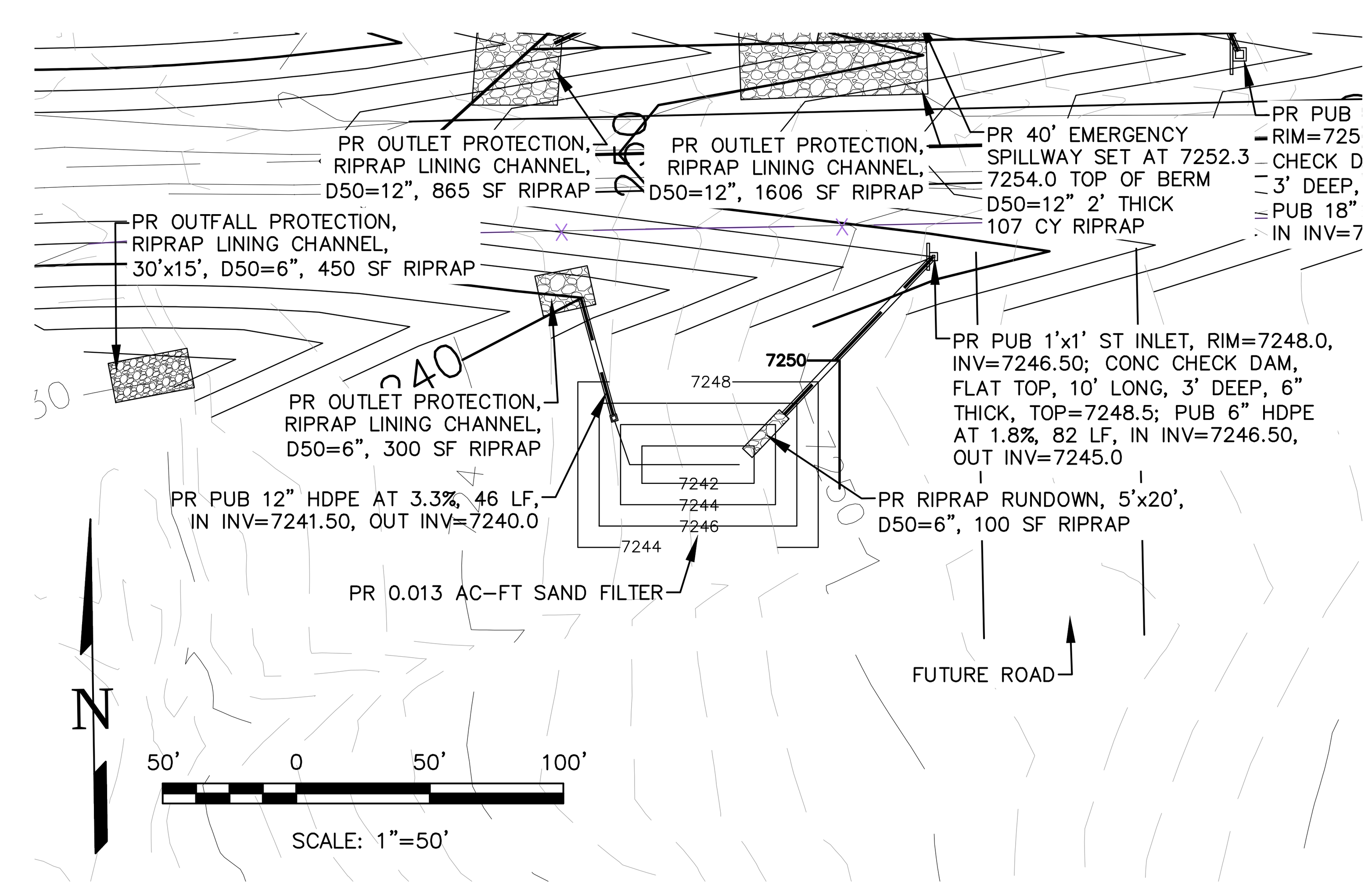

SAND FILTER DP8 DETAIL

REVISIONS

NO.	DESCRIPTION	DATE
1	REV'D PER 6/2/16 CITY COMMENTS	8/22/16

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TIMBERRIDGE ESTATES

PROPOSED SAND FILTER DP8 DETAILS

DESIGNED BY DLM
DRAWN BY DLM
CHECKED BY LD
H-SCALE 1"=200'
V-SCALE N/A
JOB NO. 1733.00
DATE ISSUED 02/28/19
SHEET NO. 5 OF 6

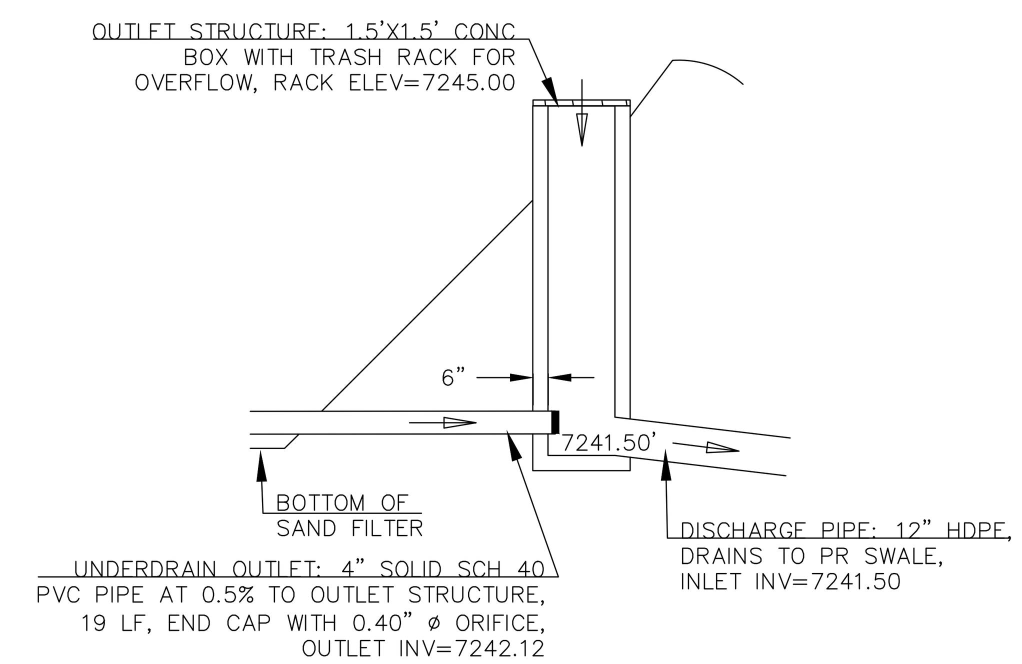
TIMBERRIDGE ESTATES

EL PASO COUNTY

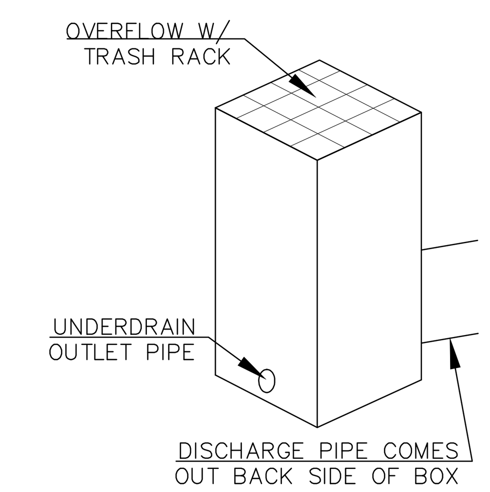
PROPOSED SAND FILTER DP7 DETAILS

FEBRUARY 2019

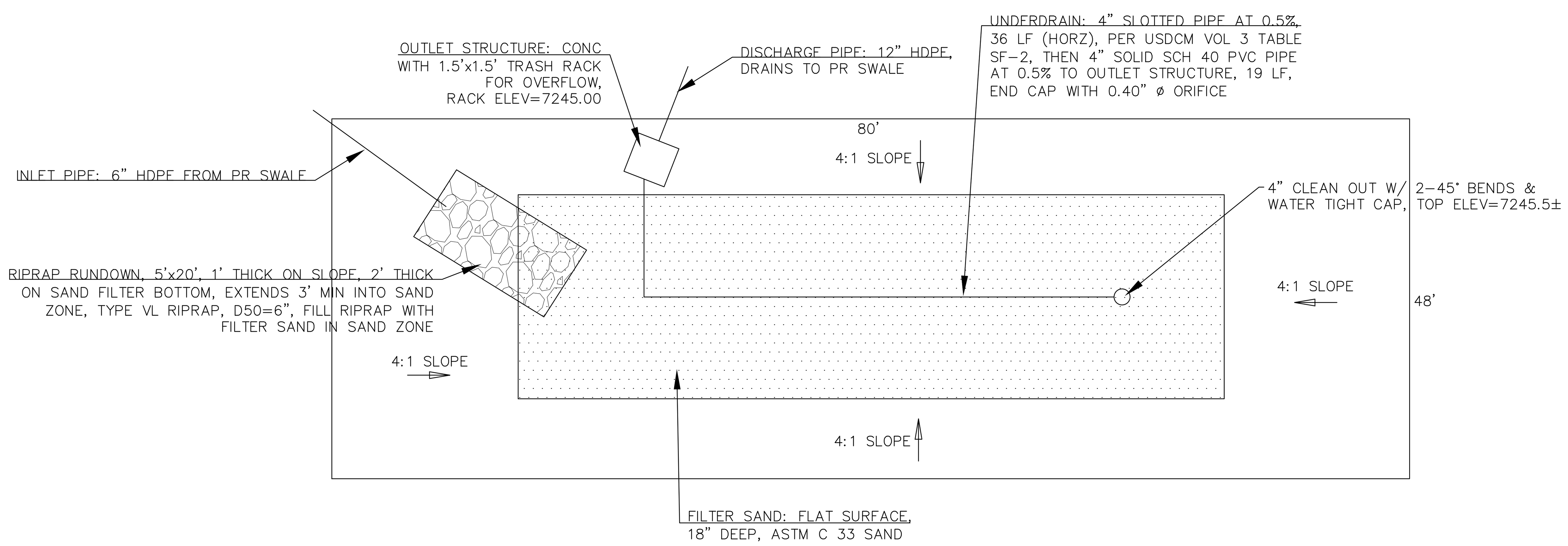
PRELIMINARY DRAWING NOT FOR CONSTRUCION



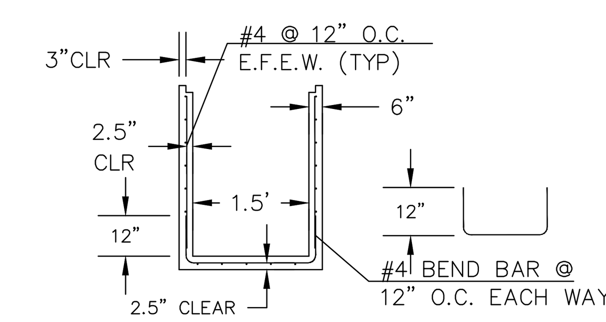
OUTLET STRUCTURE DETAIL (CONCRETE & STEEL)



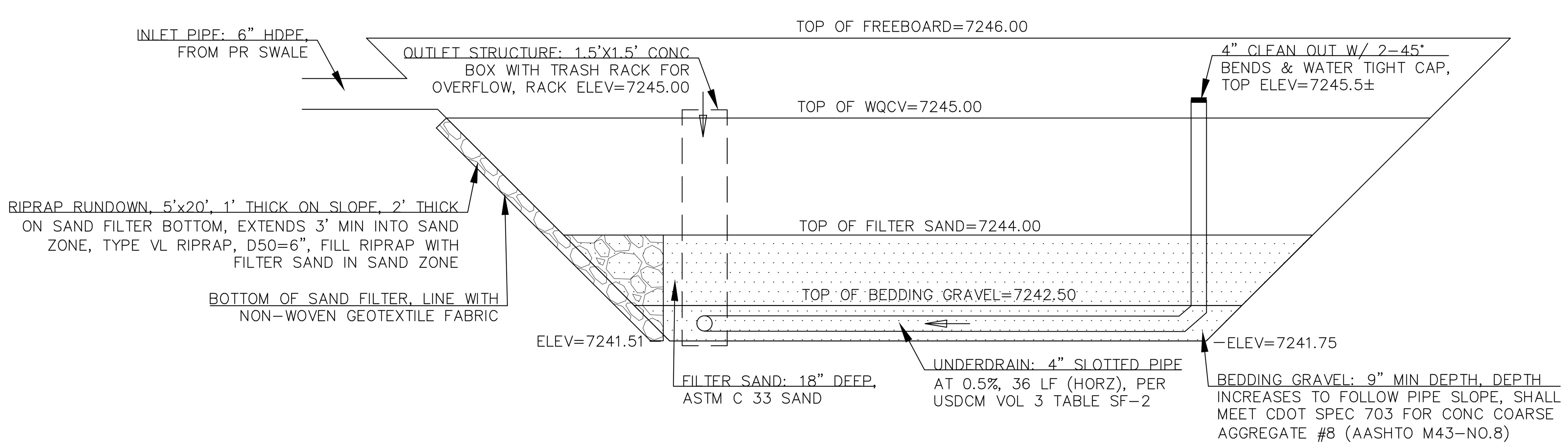
OUTLET STRUCTURE CONCEPT SKETCH



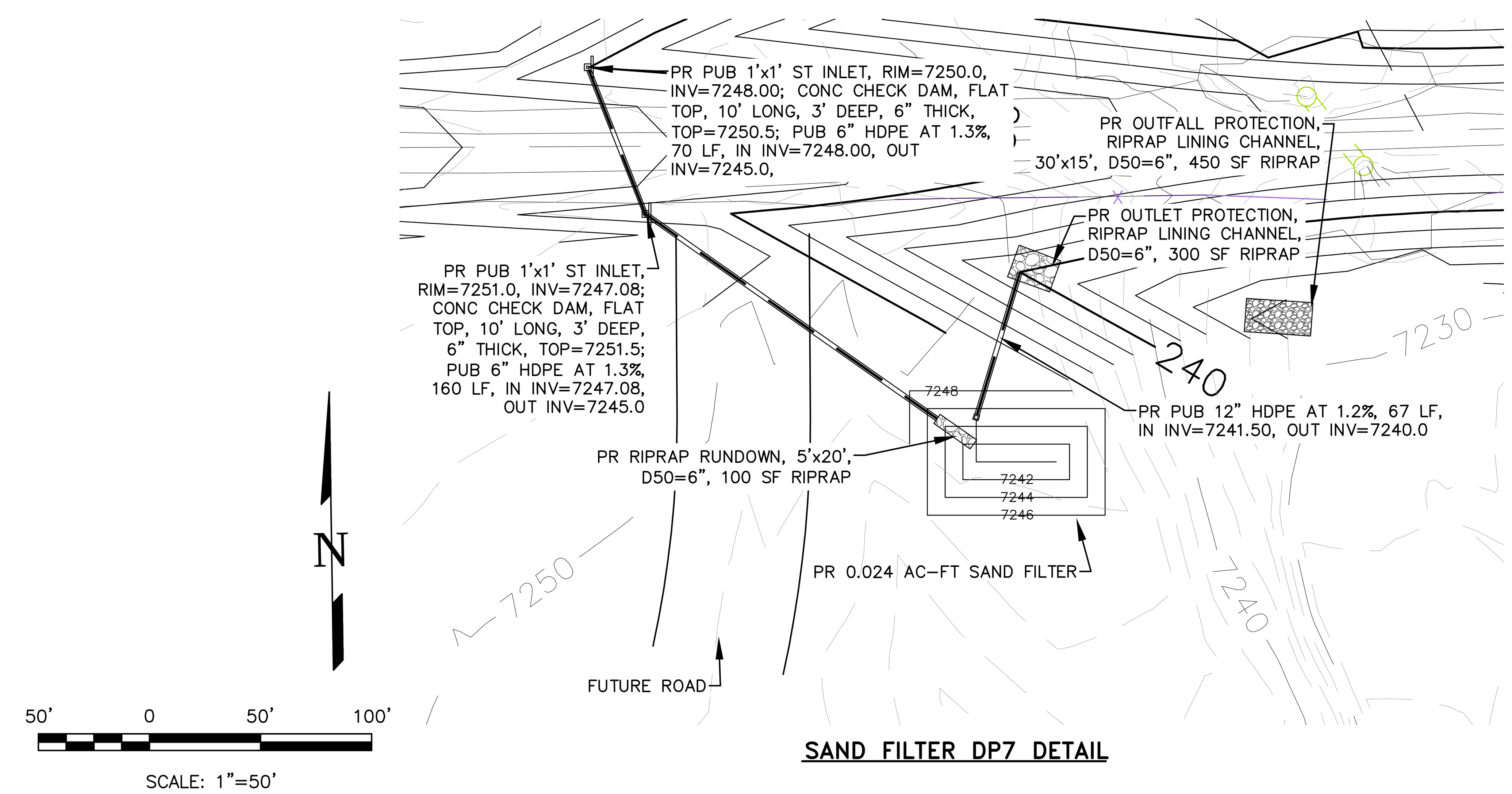
SAND FILTER DP7 DESIGN – PLAN VIEW
N.T.S.



1.5'x1.5' OUTLET BOX STRUCTURAL DETAIL



SAND FILTER DP7 DESIGN – PROFILE VIEW
N.T.S.



SAND FILTER DP7 DETAIL

REVISIONS		
NO.	DESCRIPTION	DATE
1	REV'D PER 6/2/16 CITY COMMENTS	8/22/16

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TIMBERRIDGE ESTATES

PROPOSED SAND FILTER DP7 DETAILS

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SHEET NO. 6 OF 6