AN AMENDMENT TO THE
MASTER DRAINAGE DEVELOPMENT PLAN
FOR
WATERVIEW

WATERVIEW NORTH

EL PASO COUNTY, COLORADO

November 2020

PREPARED FOR:

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PROJECT NO. 02-19-05

PCD File No. SKP202

CERTIFICATIONS

Design Engineer's Statement:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. This drainage report has been prepared to satisfy criteria established and set forth by El Paso County for drainage reports. This drainage report is in conformance with the applicable 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.

_____ Seal

Charles K. Cothern, P.E. #24997

Owner/Developer's Statement:

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

By (signature): _____ Date: _____

Title: CPR Entitlements, LLC

P.A. Koscielski, Manager

Address: 31 N. Tejon, Suite 500

Colorado Springs, CO 80903

El Paso County:

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

_____ _____

Jennifer Irvine, P.E., Date

County Engineer / ECM Administrator

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INTRODUCTION

Waterview North is a proposed multi-use development located within the greater Waterview Subdivision, in El Paso County, Colorado. The Waterview North site encompasses approximately 116.5 acres of development that include Industrial, Commercial and Residential uses with varying density.

Purpose & Scope of Study

This report is presented in conjunction with the Sketch Plan Amendment for Waterview as an Amendment to the Master Drainage and Development Plan for Waterview. Improvements proposed as part of Waterview North, Phase III of development on the Waterview Sketch Plan Amendment, are included as reference material in Appendix B. The purpose of this Amendment is to append findings presented with previously approved MDDP Amendments as well as the original Master Development and Drainage Plan (MDDP) for Waterview. Proposed changes to Land Use associated with the Amended Sketch Plan for Waterview are accompanied by updated hydrology calculations, updated Water Quality and Detention Pond Designs, and updated hydraulic calculations. Developments shown on the referenced, Amended Sketch Plan for Waterview are proposed in a manner that satisfies the requirements and criteria set forth by El Paso County's Engineering Criteria Manual as well as Volumes 1 and 2 of the Drainage Criteria Manual. Runoff quantities and proposed facilities have been calculated and sized using current El Paso County Development Standards and Drainage Criteria.

GENERAL DESCRIPTION AND LOCATION

Waterview North is located within the Waterview Subdivision, which encompasses approximately 721.8 acres. Waterview North occupies approximately 116.5 acres of the Northeast corner of the Waterview Sketch Plan. The Southwest Corner of the property coincides with the Northeast Corner of the intersection at Powers Boulevard and Bradley Road, in El Paso County, Colorado. The site is bound on the west and south by Powers Boulevard and Bradley Road, respectively. The Colorado Springs Airport lies to north, beyond a 3400' swath of undeveloped property. The Colorado Springs City Limits coincide with the northern boundary of Waterview North. The eastern boundary of the site and the Widefield Transportation Center D3 to the east are separated by a 1200-foot wide swath of undeveloped land and Foreign Trade Zone Blvd.

Of the 116.5 acres that is Waterview North, Residential accounts for 69 acres, Industrial covers 28.5 acres and Commercial occupies 18.6 acres.

Climate

The climate of the site is typical of a sub-humid to semiarid climate with mild summers and winters. The average temperature is 31F degrees in the winter and 68.4F degrees in the summer. Total annual precipitation is 15.21 inches.

Floodplain Statement

The Flood Insurance Rate Map (FIRM No. 08041C 0768G dated 12/07/2018) indicates that there is no floodplain in the vicinity of the proposed site. Please refer to the Annotated FIRM Panel, located in Appendix A at the back of this report.

Utilities & Other Encumbrances

There is an existing petroleum line that runs north / south on the westerly portion of Waterview North, along the inside of the eastern boundary of the Powers Boulevard easement. Said gas line is reflected on the plans and drainage exhibits.
There is a pair of existing 42" CMP culverts that cross Bradley Road approximately 950 feet to the east of the intersection at Powers Boulevard.
There are above-ground power lines that cross Bradley Road and follow the eastern boundary of the site. Distribution lines exist among said group of above-ground power lines.

Referenced Drainage Studies

Waterview North occupies the northeast quadrant of the greater Waterview Subdivision and straddles two major drainage basins as identified by El Paso County. A DBPS for each of the 2 major basins were referenced in addition to two Final Drainage Reports for nearly adjacent portions of the Waterview Subdivision and one Amendment to the MDDP for Waterview. A listing of the referenced Studies and Reports is as follows:

- ***Jimmy Camp Creek Drainage Basin Planning Study: Development of Alternatives and Design of Selected Plan Report"***, by Kiowa Engineering, dated March 2015.

- ***West Fork Jimmy Camp Creek Drainage Basin Planning Study"***, by Kiowa Engineering, dated October 2003.

- ***"Amendment to the MDDP for Waterview ",*** completed by Springs Engineering and approved in July of 2014.

- ***"Final Drainage Report for Trails at Aspen Ridge, Filing No. 1",*** completed by Matrix Design Group and approved in January of 2020.

- ***"Final Drainage Report for Trails at Aspen Ridge, Filing No. 2",*** completed by Matrix Design Group and approved in February of 2020.

SOIL CONDITIONS

Soils that underly the project site and the site's offsite tributary areas are analyzed and classified by their by Hydrologic Soil Type. Soils can be classified into four different hydrologic groups; A, B, C, & D. This manner of classification is applied to account for a soils' potential to produce runoff.
Hydrologic group "A" is characterized by well-drained coarse-grained soils that have high infiltration rates and high rates of saturated hydraulic conductivity. Type "A" soils have low runoff potential. Group "D" typically has a clay layer at or near to the surface, or a very shallow depth to impervious bedrock. As such, Type D soils have very slow infiltration rates and a high runoff potential. Please refer to the Soils Map, included in Appendix A. The table on the following page summarizes site soils by Hydrologic Type.
Pre-Development site conditions may be described as undeveloped high desert terrain having sparse natural vegetative cover ($\leq$50% cover) consisting of brush, weeds and grass with brush being the most abundant. About a third of onsite soils are classified as type A. It should be noted that post development consideration of onsite areas does not recognize type A soil. All type A soils, onsite, are to be

considered as Type B Soils for post development conditions. The following is a summary table which lists the various soils of which the site is comprised:

Site Soil Summary Table

Map Unit Symbol	Map Unit Name	Hydrologic Soil Type	Acreage of AOI	Percentage of AOI
8	Blakeland loamy sand, 1 to 9 % slopes	A	43.7	32.50%
31	Fort Collins loam, 3 to 8 % slopes	B	33.2	24.70%
56	Nelson-Tassel fine sandy loams 3 to 18% slopes	B	33.4	24.80%
86	Stoneham sandy loam, 3 to 8 % slopes	B	19.8	14.70%
95	Truckton loamy sand, 1 to 9% slopes	A	0.2	0.10%
108	Wiley silt loam, 3 to 9 % slopes	B	4.4	3.30%
		Totals for Area of Interest	134.7	100%

DRAINAGE BASINS & SUB-BASINS

The Waterview North development site is located within 2 major drainage basins; Big Johnson/Crews Gulch and Jimmy Camp Creek. The sites location lies in the upper reaches of each of the mentioned major watersheds. Portions of the site that belong to the Big Johnson/Crews Gulch Basin Tributary occupy western and northwestern reaches of the property. The western portion of the offsite tributary to Waterview North also belongs to the Big Johnson/Crews Gulch Basin Tributary. A portion of the site that covers the western boundary of Waterview North, characterized as Basin BJD-EX14 on the Pre-Dev Basin Map, located in Appendix B, presently drains to the west, over and across Powers Boulevard and ultimately into Big Johnson/Crews Gulch Basin. CDOT construction of Powers Boulevard Improvements will result in a hydraulic barrier to surface runoff generated over Basin BJD-EX14, as it presently conveys. Post Development conditions refer to the subject area as Basin BJDEV-14. While runoff generated over Basin BJDEV14 will not continue to convey in historic fashion as surface flow that crosses Powers Blvd., it is assumed that construction of the Powers Blvd. Improvements will maintain the historic drainage pattern in some form or fashion, and Basin BJDEV14 runoff will continue to convey to Big Johnson/Crews Gulch Basin. Post development conditions for this site consider this basin as undeveloped since construction of CDOT improvements to Powers will likely predate its development into a commercial property.

The remainder of Waterview North lies within one of two sub-basins belonging to the Jimmy Camp Creek Tributary. A 10-acre piece that occupies the southwest corner of the property is part of the West Fork Tributary to Jimmy Camp Creek. The remainder of the site, as well as the eastern portion of the offsite tributary are part of the MarkSheffel Tributary to Jimmy Camp Creek.

Basin IDs used in this study agree with those established for each of the Tributaries in the reference material. Areas ultimately tributary to Big Johnson/Crews Gulch Basin are labelled with a "BJD"

prefix, those tributary to Jimmy Camp Creek have a "JCD" prefix. Concentration points and Ponds are all labelled to be consistent with the reference material with the exception of Design Pt. A, which corresponds to Design Point "1-OS" as referenced from the Final Drainage Reports for Trails at Aspen Ridge, Filing No. 1 & Trails at Aspen Ridge, Filing No. 2.

Approximately 82 acres of Waterview North lie in the upper reaches of the Marksheffel Tributary to Jimmy Camp Creek. This drainage basin was studied in the ***"Jimmy Camp Creek Drainage Basin Planning Study: Development of Alternatives and Design of Selected Plan Report"***, by Kiowa Engineering, dated March 2015.

Approximately 16.2 acres of Waterview North lie in the upper reaches of the West Fork Tributary to Jimmy Camp Creek. This drainage basin was studied in the ***"West Fork Jimmy Camp Creek Drainage Basin Planning Study"***, by Kiowa Engineering, dated October 2003, and in The FDRs for Trails at Aspen Ridge, Filing No.1 and Filing No.2.

Development of Waterview North will comply with the findings presented in each of the above-mentioned Studies by providing onsite detention and water quality treatment for developed runoff. Offsite areas that lie upstream of Waterview North will be required to provide onsite detention and water quality treatment as they develop.

Design, phasing, responsibility and maintenance of proposed improvements will be discussed in future final drainage reports, at a later time. Fees will be assessed and paid according to current rates at the time of platting for each filing.

Sub-Basin Description

Historic Drainage Patterns

The historic drainage patterns of the site were analyzed in the Master Development Drainage Plan for Waterview by Merrick and Company. Offsite tributary areas are re-examined in this study. The offsite tributary to Waterview North lies to the north. A portion of the offsite tributary, approximately 63 acres, lies within the Big Johnson/Crews Gulch Basin Tributary. The remaining portion of the offsite watershed amounts to 56.7 acres, all of which lies within the Marksheffel Tributary to Jimmy Camp Creek. The reason that the offsite tributary was re-examined is because review of the existing topography along the north boundary of the site revealed a depression whose volume exceeds 35 acre-feet. Most of the Big Johnson/Crews Gulch offsite tributary area (54 out of 63 acres, area BJD-12a) appears to drain into this depression. Soils in this region are classified as Hydrologic Type A. The hydraulic conductivity for soils that coincide with the offsite pond's location translates to a percolation rate that exceeds 8-inches per hour. The remainder of the offsite tributary to Big Johnson/Crews Gulch Basin drains to an existing Box Culvert Crossing along Powers Blvd.
Onsite Basin JCDEX-3.3 consists of ten acres that coincide with the southwest corner of the property. JCDEX-3.3 runoff conveys to an existing dual 42-inch CMP crossing under Bradley Road where it discharges from the site and continues to convey south.

Runoff produced over the Marksheffel tributary to Jimmy Camp Creek accounts for the majority of onsite runoff generated. The portion of the Marksheffel Tributary considered with this analysis is represented by offsite Basins JCD OS-1A & JCD OS-1B, and by onsite Basins JCDEX-3.1 & JCDEX-3.2. Runoff generated over these basins conveys to the south and east and discharges from the site over the eastern boundary. Runoff produced on JCDEX-3.2 flows south and then east being conveyed

eastward in the north side Bradley Road ditch combined with Bradley Road runoff within the Bradley Road RIGHT-OF-WAY. JCDEX-3.2 runoff and Bradley Road runoff leaves the Bradley Road RIGHT-OF-WAY and flows north across the subject property as Bradley Road approaches the eastern property boundary; this is due to no continuation of the north Bradley Road ditch east of the property related to a utility corridor access running north south along the east side of the subject property. Bradley Road ditch flow including Basin JCDEX3.2 runoff then flows north and combines with Basin JCDEX3.1 runoff and discharges across the southern portion of the eastern boundary of the site at a low point in the utility access corridor. Flows generated over the other 3 basins discharge across the eastern site boundary as well. Topography along the eastern boundary does not seem to indicate the presence of concentrated flow patterns, although the southern portion of the eastern boundary bears a depression. Design Point JCD-D has been loosely placed to coincide with said depression. Please refer to the Pre-Development Drainage Map, included in Appendix B. The length of the low region along the eastern boundary is between 300 and 400 feet. About 30' beyond the depression due east, there lies an elevated mound of dirt (utility access). Above-ground power poles follow the eastern boundary. With the exception of the mentioned mound of dirt, the manner of fall in and around this area is generally to the east and south of east. Runoff will convey eastward, north of Bradley Road in somewhat of an unconcentrated manner, for 950 to 1000 feet. As runoff approaches the western side of Foreign Trade Boulevard, the depression in which the runoff conveys narrows to form a headwater pool for the culvert crossing at Foreign Trade Boulevard. Said culvert crossing consists four-48" Diameter RCPs.

Off-Site Drainage

There are two off-site basins for Waterview North. One of them is located in the Big Johnson/Crews Gulch Tributary and the other lies within the Marksheffel Tributary to Jimmy Camp Creek. These basins were analyzed in the MDDP for Waterview by Merrick. Flows generated over these areas have been re-calculated in this study with the discovery of the depression located within Basin BJD-12a.

DRAINAGE DESIGN CRITERIA

Development Criteria Reference

The El Paso County Drainage Criteria Manual (DCM), Volumes 1 & 2 were used in preparation of this report in conjunction with El Paso County's Engineering Criteria Manual (ECM) and Resolutions 15-042 and 19-245.

In addition to the DCM, Denver's Urban Storm Drainage Criteria Manuals, Volumes 1-3, published by the Urban Drainage and Flood Control District, latest update, have been used to supplement the DCM for water quality capture criteria.

Hydrologic Criteria

Rational Method

The rational method was used to calculate onsite peak flows, as required by the current City of Colorado Springs/El Paso County Drainage Criteria Manual (DCM) for drainage basins having an area of less than 130 acres. The 5-year and 100-year storms constitute the major and minor events with these analyses, respectively.

Rational Method calculations are included in Appendix B, at the back of the report. Rational Method results are summarized and in tabular format on each of the respective drainage exhibits.

The results of the rational analysis are used to evaluate hydraulic street and channel capacities and to size storm drain appurtenances and components such as drop inlets/catch basins and pipe sizes. The Rational Method uses the following equation:

$$Q=C*i*A$$

Where:
Q = Maximum runoff rate in cubic feet per second (cfs)
C = Runoff coefficient
i = Average rainfall intensity (inches per hour)
A = Area of drainage sub-basin (acres)

Runoff Coefficients

Rational Method runoff coefficients are referenced from Table 6-6 of the Drainage Criteria Manual. Pre-Development runoff coefficients are based on hydrologic soil type and vegetative cover type. Weighted runoff coefficients for existing or pre-development conditions are calculated for basins comprised by more than one hydrologic soil type. Weighted runoff coefficients for post development conditions are based on hydrologic soil type and anticipated land use. Weighted coefficient calculations are not performed for basins that consist of one hydrologic soil type, for which one type of land use is anticipated. Please refer to the Runoff Coefficient Exhibit, included in Appendix B. Summary tables for runoff coefficients during both pre and post development conditions are included as well as a map which shows the site with land-use and soil-type overlays. Percent Impervious for each basin during pre-development conditions is assumed to be zero.

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

Percent Impervious values, runoff coefficients, and curve numbers for each basin during post development conditions are weighted according to the combination of hydrologic soil type and land use-type. There are proposed residential areas where the density exceeds 8 dwelling units per acre. Runoff coefficients for these areas are extrapolated from the values shown with Table 6-6.

Time of Concentration

Time of concentration values are calculated as required by the DCM. The time of concentration consists of the initial time of overland flow (Ti), characterized by Equation 6-8 from the DCM, and the travel time (Tt) for channel or street flow to the inlet or point of interest, characterized by Equation 6-9 from the DCM. Equation 6-9 includes a conveyance coefficient, Cv, whose value is chosen from Table 6-7 of the DCM. Table 6.7 is shown below:

Table 6-7. Conveyance Coefficient, C_v

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

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

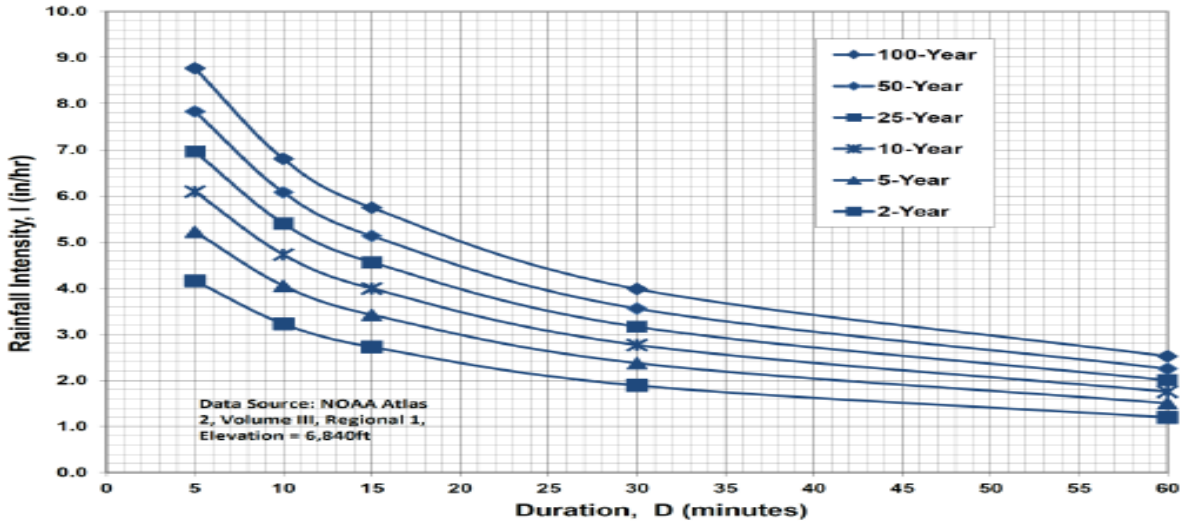
Pre-Development Conveyance Coefficients are representative of short pasture and lawns. Post Development Conveyance Coefficients reflect grassed waterways, which coincide with the 90-foot zoning buffers proposed along the northern and eastern property boundaries, and paved areas or shallow paved swales which coincide with proposed onsite streets and parking.

The time of concentration (Tc) is equal to the sum of the initial and travel times (Equation 6-7 from the DCM). A minimum time of concentration of 10-minutes is used for modeling undeveloped conditions and for developed conditions in non-urban areas. A minimum Tc of 5 minutes is utilized during post development conditions for urban areas.

Rainfall Intensity

The hypothetical rainfall depths for the 1-hour storm duration were taken from Table 6-2 of the Drainage Criteria Manual. Table 6-2 lists the rainfall depth for the Major and Minor 1-hour storm events. The rainfall depths are translated into intensity values to be used with the rational formula by application of the IDF curves described on Figure 6-5 and shown, below. The referenced table and figures may be found in the front portion of Appendix B.

Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency



Curves presented on Figure 6-5 are developed from the IDF Equations shown below:

IDF Equations

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

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

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

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

$I_{5} = -1.50 \ln(D) + 7.583$

$I_{2} = -1.19 \ln(D) + 6.035$

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

Culvert Design

There are two culverts that exist along this site's boundary from which onsite flows discharge. An existing 10' by 6' RCBC along Powers Blvd. , and a dual 42-inch diameter CMP crossing under Bradley Road. Both culverts are analyzed during pre and post development conditions in this study. Placement of a proposed culvert along the north side of Bradley Road, adjacent to the eastern boundary of the site, is discussed and design calculations are included. Said calculations are located in Appendix D and were executed using HY-8. While the use of culverts is anticipated with future development of this property, there are no culverts proposed as part of this study.

Detention Storage Criteria

This report addresses the preliminary design of the detention / water quality ponds within the proposed development. Proposed ponds are designed as Full Spectrum. Pond hydraulics, treatment efficacy, and outlet structure performance are modelled with MHFD's software, MHFD-Detention_v4 02.

Storage volumes and outflows have been calculated for all detention facilities proposed herein. The proposed ponds serve to offsite peak developed flows adequately. The final design for each pond will be completed and submitted for approval with a subsequent Final Drainage Report, at a later time. The dimensions and performance of subsequent final pond designs are subject to change as long as code requirements are satisfied. Please note, while Pond A serves to treat developed runoff from proposed onsite commercial areas, the actual development for each of the commercially zoned lots will require that the developer be responsible for balancing and treating their own post development runoff. That is, each commercial lot will require its own pond.

HYDROLOGIC ANALYSES

Pre-Development Drainage Analysis

Big Johnson/Crews Gulch Basin & Jimmy Camp Creek Basins

Adjacent portions of the Big Johnson/Crews Gulch and Jimmy Camp Creek watersheds are presented on the Pre-Development Drainage Map, included in Appendix B.

Big Johnson/Crews Gulch Basin Tributary

The portion of the site that belongs to Big Johnson/Crews Gulch Tributary produces runoff that concentrates at Design Point BJD-K. There is also an offsite basin, BJD-12b that covers 9.54 acres and produces runoff that conveys to Design Point BJD-K. The peak flow rate that occurs at Design Point BJD-K during pre-development conditions is equal to 4 cfs and 31 cfs for the 5 and 100-year storms, respectively.

Offsite Basin BJD-12a runoff conveys into an existing 34+ acre-foot depression. The volume of the depression exceeds the volume of runoff for both 5 and 100-yr events. A basin calculation using the MHFD-Detention_v4 02 spreadsheet is included in Appendix C and shows the volume of runoff for the various events versus the volume of the existing offsite pond/depression. Runoff produced over Basin BJD-12a is not accepted onsite and does not impact Design Point BJD-K.

Basin BJDEX14 is part of the Big Johnson Reservoir Tributary.

Jimmy Camp Basin

The historic basins for both tributaries of Jimmy Camp Creek are analyzed with the rational formula. Flows shown with the basin identifiers on the Drainage Exhibits reflect the results of said rational analysis. The Pre-Dev Drainage Basin Map and calculations are included in Appendix B for reference and are summarized below:

- Design Point A (Q_5=3cfs, Q_{100}=19cfs) is located on the north side of the adjacent western portion of Bradley Road. Design Pt. A receives runoff generated over Basin JCDEX-3.3. These flows convey south, across Bradley Road via an existing dual 42" CMP Culvert Crossing. Flows conveyed by the dual culvert crossing discharge into an existing swale on the south side of Bradley and continue to convey south. Design Point A is represented by Design Point 1-OS in the referenced FDR for Filing No. 1 of Trails at Aspen Ridge. Referenced peak flow rate values at Design Point 1-OS during pre-development conditions equal 5.0 cfs and 25.3cfs for the 5 & 100-year events, respectively. Flows discharged from Design Pt. A feed the West Fork Tributary to Jimmy Camp Creek.

- Design Point JCD-D has been placed to loosely coincide with a depression that occurs along the eastern boundary of the site. Said depression stretches 300 feet across, due north from the northern edge of Bradley Road, and is approximately 1-foot deep at its deepest point as measured along the eastern property boundary. A mound of dirt has been placed within said depression, by others, just beyond the eastern property boundary, as part of utility access from Bradley Road north for the existing power poles along the east boundary. Said mound of dirt serves to obscure historic flow patterns. Design Point JCD-D is the location where runoff from the north side of Bradley Road ROW, onsite Basins JCDEX-3.1 & JCDEX-3.2 and offsite Basins JCD-OS1A & JCD-OS1B combine and convey east to feed the Marksheffel Tributary to Jimmy Camp Creek. Major and minor flows at Design Point JCD-D are equal to 84cfs & 12cfs, respectively.

Review 2 comment is unresolved. Narrative has been changed to state that BJDEV-14 no longer drains to Pond A therefore wq/detention facility is required.
Update the proposed map, narrative and pond summary table (pg 18) to provide WQ/Detention facility for BJDEV14.

Post Devel

Big Johnson/

Onsite runo…rews Gulch Basin Tributary are captured an…ite Basin BJDEV-14.

The portion…iew North, characterized as Basin BJDEV14 on the Post Development Drainage Plan, presently drains to the west, over and across Powers Boulevard and ultimately into Big Johnson/Crews Gulch Basin. CDOT construction of Powers Boulevard Improvements will result in a hydraulic barrier to surface runoff generated over Basin BJD-EX14, as it presently conveys. Post Development conditions refer to the subject area as Basin BJDEV-14. While runoff generated over Basin BJDEV14 will not continue to convey in historic fashion, as surface flow that crosses Powers Blvd., it is assumed that construction of the Powers Improvements will see the historic drainage pattern maintained in some form or fashion, and Basin BJDEV14 runoff will continue to convey to Big Johnson/Crews Gulch Basin.

Pond BJD-K

Flows generated over onsite Basin BJD-12c convey into Pond BJD-K. Pond BJD-K is located about 70 feet to the north of the existing RCBC Powers crossing. Pond BJD-K has 8.454 Ac-Ft of volume and serves to satisfy Full Spectrum requirements. The containment berm for the pond is almost entirely above grade. The model and calculations for Pond BJD-K are located in Appendix C. Pond BJD-K serves to offset developed peak flows from the site to below historic levels and provides full spectrum treatment of onsite runoff. Runoff generated over offsite Basin BJD-12b bypasses Pond BJD-K and conveys as channel flow directly to the existing 10' by 6' RCBC Culvert crossing under Powers Boulevard. The bypass serves to offset the times of concentration between the two basins so that peak flows do not combine. Post development peak discharge rates at Design Point BJD-K equal 2 cfs and 15 cfs for the 5 & 100-year events, respectively. The pre-developed rate of discharge from the site at Design Point BJD-K was determined to be 4 and 31cfs for the 5 and 100-year events, so post development discharge occurs at below-historic levels.

In the Amendment to the MDDP for Waterview, completed by Springs Engineering and approved in July of 2014, post development flows at the same location were shown to be 239cfs and 215cfs for the major and minor storms, respectively. The depression shown to the north of the Waterview North site on the pre & post development Drainage Exhibits is not accounted for in the referenced analysis.

Update the narrative to identify the calculated offset time of concentration.
Add a statement that this will be analyzed with the preliminary drainage report to verify the two hydrographs with post development condition does not exceed historic discharge rates.

Suitable Outfal…

The existing 1…at conveys south to the loc…ements, then further so…d Drainage Map for Waterview II, from the Amendment to Waterview MDDP, produced by Springs Engineering on 7/21/2014 and approved on 8/28/2014. Flows at the existing RCBC Crossing under Powers Blvd are shown to be 109.8 cfs and 170.9 cfs for the 10 & 100-year events, respectively. Post Development discharge at Design Point BJD-K, as presented with the findings contained herein, amount to 2 & 15 cfs for the 5 & 100-year events, respectively. The channel improvements, as they exist, are more than adequate to accommodate outfall from the Waterview North site.

Jimmy Camp Creek Basin

There are 2 onsite and 2 offsite drainage basins located within the Marksheffel Tributary to Jimmy Camp Creek.

Offsite Basins JCDOS-1A & JCDOS-1B account for 56.7 acres of undeveloped offsite tributary. Runoff generated from these basins is accepted onsite. Runoff from these two basins is accommodated for during post development conditions by an onsite, grass lined diversion channel. Said channel is proposed within a 90-foot wide landscape buffer that follows the northern and eastern boundaries of the site. The subject diversion channel's width will exceed 30-feet, so it will be constructed with access ways on both sides so as to satisfy requirements set forth by ECM Section 3.3.3.K.1. The diversion channel shall be free of fencing and proposed structures and will not be used to store construction materials. Flows conveyed within the proposed channel will convey east, along the northern boundary, then south, adjacent to the eastern boundary of the site. Flows conveyed within this channel will combine with discharge from Pond JCD-D before discharging across the eastern boundary. Peak Flows are calculated by routing offsite basins JCDOS-1A & JCDOS-1B through the proposed diversion channel to Design Point JCD-D. Pond JCD-D discharge rate is then checked at the resulting, coincident time of concentration (Tc= 51.8 minutes = 0.863 hrs) and added to the combined bypass flows. Major and minor peak flows at Design Point JCD-D equal 138 & 8 cfs, respectively. Possible modes of conveyance to the east are discussed as part of suitable outfall for Pond JCD-D below.

Onsite developed flows will convey to Pond JCD-D where runoff will be treated, and peak flows attenuated to at or below historic levels prior to discharging from the pond. Pond JCD-D is situated along the eastern boundary of the site. Onsite runoff is generated over 2 basins; JCDEV-3.1 & JCDEV-3.2. Runoff from JCDEV-3.2 will convey south and east to Pond JCD-D; site grading will modify existing conditions and will not allow flow from this basin to enter Bradley Road ROW. Discharge into Pond JCD-D will either be by way of a culvert crossing under the entrance to the site, or through future storm drain improvements for the area. Runoff produced over area JCDEV-3.1 will convey to Pond JCD-D as a combination of surface flows and storm drain discharge. Basins JCDEV-3.1 & JCDEV-3.2 account for approximately 82 acres of onsite development.

Pond JCD-D

Pond JCD-D has a volume of 11.25 Acre-Feet and is designed to provide Full Spectrum Treatment to onsite developed runoff. The Water Quality Capture Volume (WQCV) for the pond is 2.317 Acre-Ft and the Excess Urban Runoff Volume (EURV) is 7.441 Acre-Ft. Pond JCD-D is approximately 8.0 feet deep on the high side of the containment berm. The peak outflow from Pond JCD-D, given a 100-yr event, is equal to 101 cfs. Discharge from Pond JCD-D combine with offsite flows from basins JCDOS-1A & JCDOS-1B prior to discharging east.

Suitable Outfall

Flows that discharge from Pond JCD-D combine with the offsite flows in the eastside diversion channel along with the northerly roadside ditch of Bradley Road; the Bradley Road ditch flow is blocked from following Bradley Road east and leaves the right-of-way and flows north onto the subject property as described in the historic conditions section of this report. Runoff that is tributary to this confluence, offsite flows from the diversion channel, discharge from Pond JCD-D and Bradley Road ditch flow must discharge from the site to the east.

There are two primary feasible options. Both options assume the confluence of Pond JCD-D discharge, the east side diversion channel and the northerly roadside ditch for Bradley Road:

- Unconcentrated Discharge: The diversion channel, the pond discharge and flow from Bradley Road right-of-way would naturally follow the existing flow to the east through an existing depression where ponding would occur until flow is deep enough to continue east. Control of this discharge could be enhanced with a flow spreader consisting of a weir approximately 300-

feet long matching the existing depression width. Flow over this weir is estimated to be about 4-inches deep under 100-year conditions. Erosion protection could be added upstream and downstream of the weir. This option allows flows to follow existing flow patterns to the east; however, it does not address the issue that Bradley Road runoff does not stay within Bradley Road.

- Concentrated Discharge: Concentrated discharge to a public right-of-way could be accomplished by correcting the Bradley Road ditch issue east of the property by installing a culvert through the existing berm. Preliminary sizing indicates the culvert would be 48-inches and approximately 100-feet long. This correction would Bradley Road right-of-way runoff to stay in the right-of-way and would allow discharge of Pond JCD-D and the east side diversion ditch to a public right-of-way. Any long-term detrimental effects to the property along this sites eastern boundary and to areas further to the east from the site discharge or Bradley Road ditch flows could be significantly reduced. Errant and erratic flow patterns associated with release of flows in unconcentrated fashion, or as sheet flow, could be avoided.

Pond A

Detention Pond A is located along the north side of the western portion of Bradley Road and serves to treat and attenuate runoff generated over Basin JCD-3.3. Basin JCD-3.3 represents the portion of the commercially zoned property that feeds the West Fork Tributary to Jimmy Camp Creek. Please refer to the Developed Condition Drainage Plan, located in Appendix E at the back of the report. Aside from certain hydrologic parameters, there are many unknowns with regard to how Basin JCD-3.3 will develop. The number of buyers will determine if the property is to be subdivided into lots or developed as one lot. Development of the entire property may occur at one time or in phased fashion, sequentially. In light of these unknown factors, the water quality and detention requirements for this area have been determined and may be fulfilled in one of two ways:

1. Construct water quality and detention ponds on each of several lots. Each individual lot is responsible for treating and balancing their own developed runoff.
2. Construct one pond to serve and fulfill the requirements of the entire area, collectively.

Since the manner in which this area will develop is unknown at this time, detention requirements for the entire commercial area are addressed, collectively, by proposed Pond A. If several ponds are developed, their collective performance will be required to meet or exceed the developed peak flows to Design Point A developed in this study.

The location at which Basin JCD-3.3 runoff discharges from the site is Design Point A. Design Point A is situated between Pond A and the existing dual 42-inch diameter CMP crossing under Bradley Road. The outlet pipe from Pond A will terminate immediately upstream of Design Point A where flows will convey south to the low side of the culvert crossing. Perhaps the Pond A outlet pipe will marry to the Bradley Road culvert crossing with a junction structure. Per the Filing 1 Final Drainage Report for Trails at Aspen Ridge, a 24-inch RCP storm pipe will be sleeved into one of the existing 42-inch CMP cross-road pipes by others to minimize disturbance to Bradley Road and avoid conflicts with existing utilities. The second 42-inch diameter CMP at this location will be plugged by others. The crossing is modelled both ways in Appendix D of this study. Onsite peak discharge rates from the site at Design Point A amount to 1 & 17 cfs for the minor and major events, respectively. Site discharge at Design Point A occurs at below-historic rates.

This culvert crossing was analyzed in the FDR for Filing 1of The Trails at Aspen Ridge. Design Point A in the Pre-Development Analysis included with this study coincides with Design Point 1-OS from the referenced Study. Table 7.7a from page 12 of the above-mentioned FDR indicates major and minor peak flow rates of 27 and 4 cfs, respectively, at Design Point OS-1, or Design Point A.

Suitable Outfall

Pond A will discharge from the site through a 24" RCP pipe that is sleeved through one of the dual 42-inch diameter CMPs that crosses under Bradley Road as referenced from the FDR for Trails at Aspen Ridge, Filing No. 1. The calculated discharge at Design Point A is less than the reference values from which the downstream improvements were designed. Design Point A continues to provide a suitable outfall for developed runoff from this project site.

The following is a table that summarizes some of the properties of each of the proposed ponds:

WATERVIEW NORTH
POND SUMMARY TABLE

POND ID	WQVC	EURV	TOTAL VOL.	MAX DEPTH	LENGTH TO WIDTH RATIO	POND DIMENSIONS OF MAIN STAGE	100-YR DEPTH	SURFACE AREA AT 100-YR DEPTH	PEAK F L O W S			
									$Q_{(5)}$ in	Q100 in	Q5 out	Q100 out
	(Ac-Ft)	(Ac-Ft)	(Ac-Ft)	(Ft)		(Ft. x Ft.)	(Ac-Ft)	(Ac.)	(c.f.s.)	(c.f.s.)	(c.f.s.)	(c.f.s.)
POND A	0.347	1.029	1.517	7.0	2.5	165 x 94	5.92	0.32	**38**	**84**	**1**	**17**
POND BJD-K	0.50	1.67	2.51	6.5	2.0	210 x 125	5.17	0.54	**37**	**74**	**1**	**9**
POND JCD-D	2.32	7.44	11.25	8.0	2.0	403 x 229	7.53	2.08	**164**	**320**	**14**	**101**

As commercial, industrial and residential development begins in this area, storm drain improvements will be implemented, and drainage systems designed. Each phase of residential and/or commercial development will require site-specific Preliminary and/or Final Drainage Studies to ensure that new developments do not increase peak rates of discharge or result in adverse effect to surrounding, upstream or downstream properties or facilities. Development of each commercial lot will also require a preliminary and or final drainage study as each lot will be required to balance its developed runoff.

REFERENCE MATERIALS

1. "City of Colorado Springs/El Paso County Drainage Criteria Manual" September 1987, Revised November 1991, Revised October 1994.

2. "City of Colorado Springs/El Paso County Drainage Criteria Manual, Volume 2: Stormwater Quality Policies, Procedures and Best Management Practices" November 1, 2002.

3. Soils Survey of El Paso County Area, Natural Resources Conservation Services of Colorado.

4. ***"Master Development Drainage Plan for Waterview"***, by Merrick & Co., May 2006

5. ***"Big Johnson/Crews Gulch Basin/Crews Gulch Drainage Basin Planning Study***", Kiowa Engineering Corporation, September 1991.

6. ***"Final Drainage Report for Trails at Aspen Ridge, Filing No. 1***" by The Matrix Design Group, January, 2020.

7. ***"Final Drainage Report for Trails at Aspen Ridge, Filing No. 2***" by The Matrix Design Group, February, 2020.

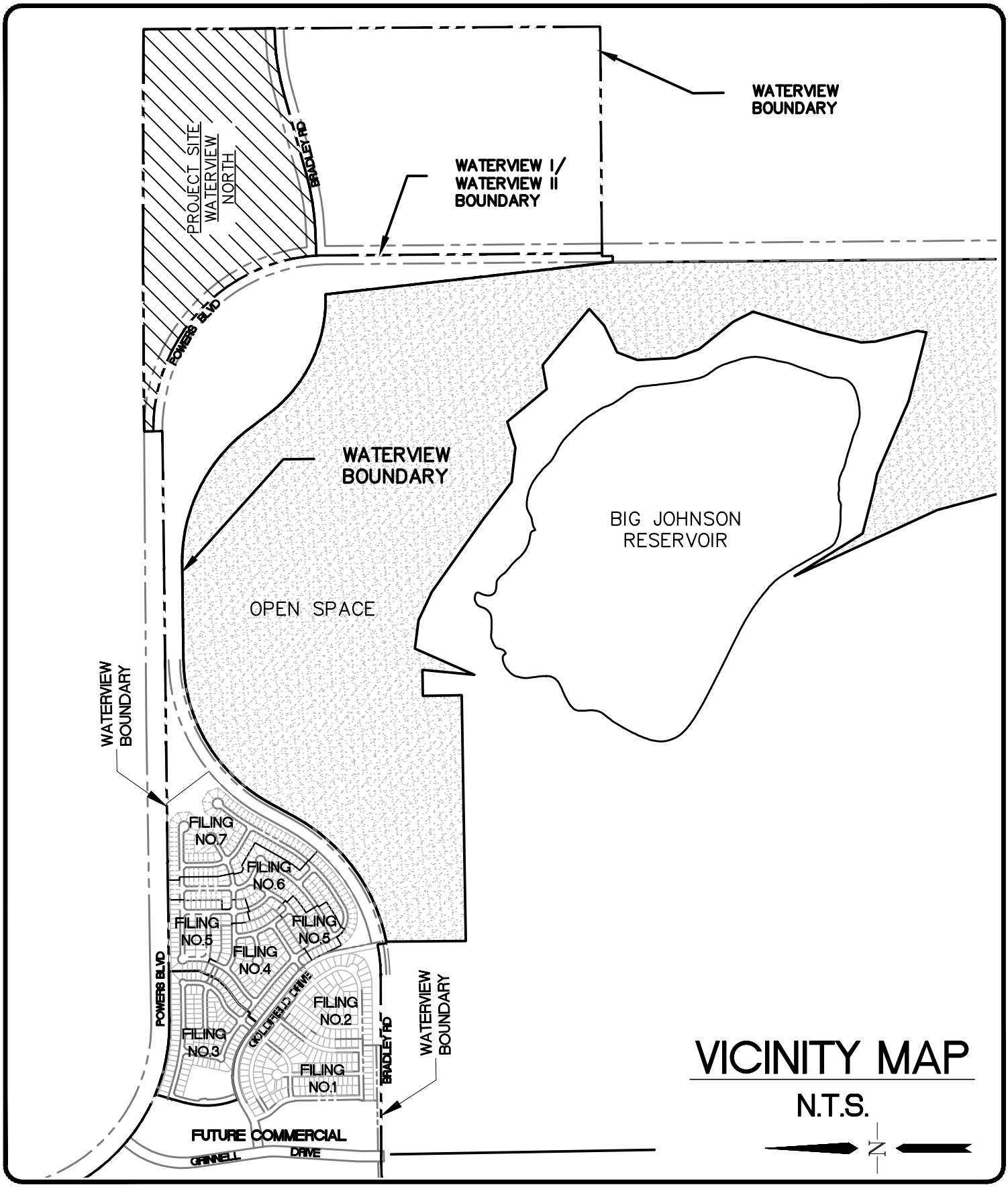
8. ***"Amendment to the MDDP for Waterview"*** by Springs Engineering, July, 2014.

APPENDIX A

VICINITY MAP

SOILS MAP

ANNOTATED FIRMette



VICINITY MAP

N.T.S.

WATERVIEW MDDP AMEND

VICINITY MAP

DSE Dakota Springs Engineering
31 N. TEJON, SUITE 518
COLORADO SPRINGS, CO 80918
P: (719) 227-7388
F: (719) 227-7392

FIGURE 1

PROJECT NO. 19-05

Hydrologic Soil Group—El Paso County Area, Colorado
(WATERVIEW NORTH)

104° 41' 25" W
104° 40' 19" W
38° 46' 3" N
38° 45' 34" N

526900 527000 527100 527200 527300 527400 527500 527600 527700 527800 527900 528000 528100 528200 528300 528400

4291000 4290900 4290800 4290700 4290600 4290500 4290400 4290300 4290200

95
8
31
86
56
108
56
86

Powers Blvd
Bradley
Bradley Rd
Powers

Soil Map may not be valid at this scale.

Map Scale: 1:4,300 if printed on B landscape (17" x 11") sheet.

N

Meters
0 50 100 200 300

Feet
0 200 400 800 1200

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

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

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

Soil Rating Lines

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

Soil Rating Points

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

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 17, Sep 13, 2019

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

Date(s) aerial images were photographed: Aug 19, 2018—Sep 23, 2018

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
8	Blakeland loamy sand, 1 to 9 percent slopes	A	43.7	32.5%
31	Fort Collins loam, 3 to 8 percent slopes	B	33.2	24.7%
56	Nelson-Tassel fine sandy loams, 3 to 18 percent slopes	B	33.4	24.8%
86	Stoneham sandy loam, 3 to 8 percent slopes	B	19.8	14.7%
95	Truckton loamy sand, 1 to 9 percent slopes	A	0.2	0.1%
108	Wiley silt loam, 3 to 9 percent slopes	B	4.4	3.3%
Totals for Area of Interest			**134.7**	**100.0%**

Description

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

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

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

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

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

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

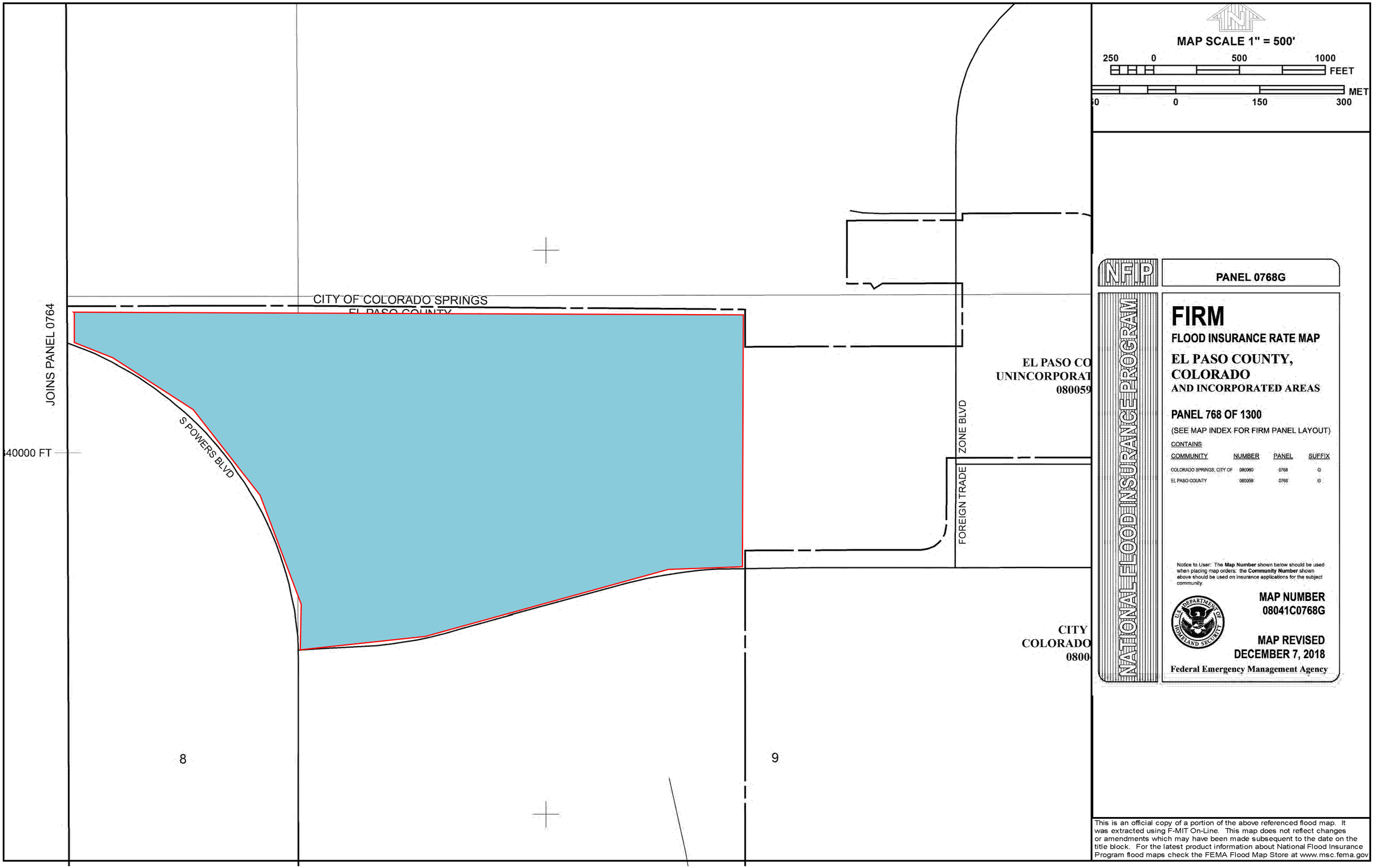
If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher



NFIP

PANEL 0768G

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 768 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS

COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0768	G
EL PASO COUNTY	080059	0768	G

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

MAP NUMBER
08041C0768G

MAP REVISED
DECEMBER 7, 2018

Federal Emergency Management Agency

NATIONAL FLOOD INSURANCE PROGRAM

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

APPENDIX B

PRE & POST DEVELOPMENT RATIONAL ANALYSES

PRE-DEVELOPMENT BASIN MAP

POST DEVELOPMENT DRAINAGE PLAN

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EL PASO COUNTY REFERENCE INFO
RATIONAL ANALYSIS

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

Table 6-2. Rainfall Depths for Colorado Springs

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

Where Z= 6,840 ft/100

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

2.2 Design Storms

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

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

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

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 (12 units/acre 80)				0.6								0.68	
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.

Table 6-7. Conveyance Coefficient, C_v

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

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

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

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

3.2.3 First Design Point Time of Concentration in Urban Catchments

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

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

Where:

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

L = waterway length (ft)

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

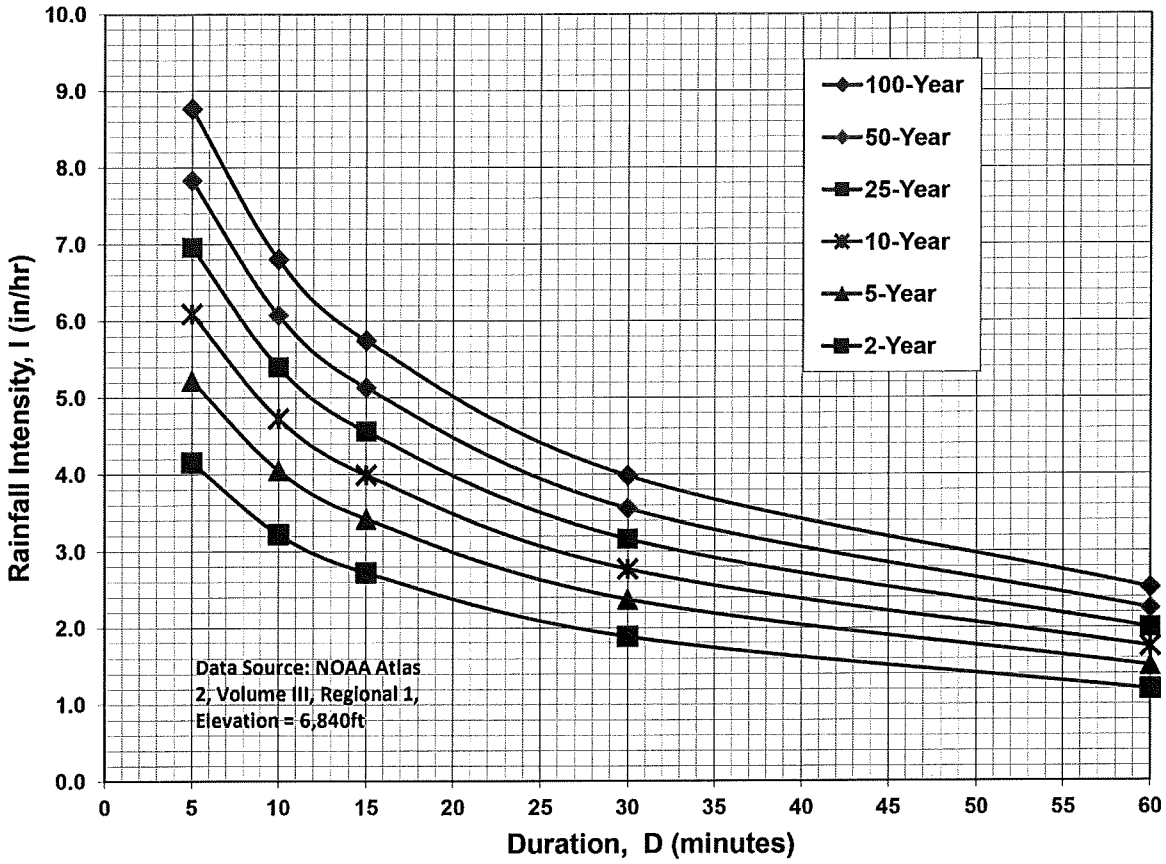
3.2.4 Minimum Time of Concentration

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

3.2.5 Post-Development Time of Concentration

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

Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency



IDF Equations

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

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

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

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

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

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

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

PRE-DEVELOPMENT RATIONAL ANALYSIS

SUMMARY

WATERVIEW NORTH - EXISTING
(RATIONAL METHOD Q=CIA)

	TOTAL FLOWS				AREA	WEIGHTED		OVERLAND				CHANNEL						Tc TOTAL	INTENSITY		COMMENTS
BASIN	Q(5)	Q(100)	CA(equiv.)		TOTAL	C(5)	C(100)	C(5)	Length	Slope	Ti	Length	Slope	Description	Convey	Velocity	Tt		I(5)	I(100)	
	(c.f.s.)	(c.f.s.)	5 YR	100 YR	(Ac)				(ft)	(ft)	(min)	(ft)	(%)	Code	Factor (K)	(fps)	(min)	(min)	(in/hr)	(in/hr)	
BJD-12a	8.3	60.6	4.34	19.00	54.28	0.08	0.35	0.08	300	3.7%	21.5	1,784	3.5%	3	7	1.3	22.7	44.2	1.9	3.2	
BJD-12b	2.0	14.8	0.76	3.34	9.54	0.08	0.35	0.08	295	2.8%	23.3	377	6.2%	3	7	1.7	3.6	26.9	2.6	4.4	
BJD-12c	2.8	20.5	1.46	6.38	18.23	0.08	0.35	0.08	300	3.3%	22.3	1,104	1.5%	3	7	0.9	21.5	43.7	1.9	3.2	
BJDEX-14	1.9	13.7	0.49	2.16	6.16	0.08	0.35	0.08	112	9.8%	9.5	377	9.1%	3	7	2.1	3.0	12.5	3.8	6.4	
JCD-OS1A	5.2	38.1	2.88	12.60	36.00	0.08	0.35	0.08	247	4.0%	19.0	2,545	4.6%	3	7	1.5	28.3	47.2	1.8	3.0	
JCD-OS1B	4.5	32.9	1.66	7.25	20.70	0.08	0.35	0.08	200	6.8%	14.3	1,167	5.8%	3	7	1.7	11.5	25.9	2.7	4.5	
JCD-EX3.1	9.4	69.1	5.49	24.01	68.60	0.08	0.35	0.08	300	8.3%	16.4	2,633	3.5%	3	7	1.3	33.5	49.9	1.7	2.9	
JCD-EX3.2	3.0	22.2	1.06	4.62	13.21	0.08	0.35	0.08	244	9.0%	14.4	958	6.6%	3	7	1.8	8.9	23.3	2.9	4.8	
JCD-EX3.3	2.6	19.1	0.80	3.50	10.00	0.08	0.35	0.08	297	11.8%	14.6	398	7.5%	3	7	1.9	3.5	18.0	3.2	5.4	
Design Points																					
A	**2.6**	**19.1**	0.80	3.51	10.00	0.08	0.35	0.08	297	11.8%	14.6	398	7.5%	3	7	1.9	3.5	18.0	3.2	5.4	Basin JCD-EX.3.3
BJD-12b	2.0	14.8	0.76	3.34	9.54	0.08	0.35	0.08	295	2.8%	23.3	377	6.2%	3	7	1.7	3.6	26.9	2.6	4.4	
BJD-12c	2.8	20.5	1.46	6.38	18.23	0.08	0.35	0.08	300	3.3%	22.3	1,104	1.5%	3	7	0.9	21.5	43.7	1.9	3.2	
BJD-K	**4.3**	**31.2**	2.22	9.72	27.77	0.08	0.35	0.08	300	3.3%	22.3	1,104	1.5%	3	7	0.9	21.5	43.7	1.9	3.2	Basins BJD-12b & BJD-12c
JCD-D	**10.4**	**76.2**	10.02	43.86	125.30	0.08	0.35	0.08	247	4.0%	19.0	4,881	3.8%	3	7	1.4	59.6	78.6	1.0	1.7	JCD-D WITHOUT JCD-EX3.2
JCD-EX3.1	9.4	69.1	5.49	24.01	68.60	0.08	0.35	0.08	300	8.3%	16.4	2,633	3.5%	3	7	1.3	33.5	49.9	1.7	2.9	
JCD-EX3.2	3.0	22.2	1.06	4.62	13.21	0.08	0.35	0.08	244	9.0%	14.4	958	6.6%	3	7	1.8	8.9	23.3	2.9	4.8	
JCD-OS1.A	5.2	38.1	2.88	12.60	36.00	0.08	0.35	0.08	247	4.0%	19.0	2,545	4.6%	3	7	1.5	28.3	47.2	1.8	3.0	
JCD-OS1.B	4.6	33.6	1.66	7.25	20.70	0.08	0.35	0.08	200	8.5%	13.3	1,167	5.8%	3	7	1.7	11.5	24.8	2.8	4.6	BASINS JCD-EX3.1, JCD-EX3.2,
JCD-D	**11.5**	**84.2**	11.08	48.48	138.51	0.08	0.35	0.08	247	4.0%	19.0	4,881	3.8%	3	7	1.4	59.6	78.6	1.0	1.7	JCD-OS1.A, & JCD-OS1.B

UDFCD Table 6-2 NRCS Conveyance Factors, K		
Code	Description	K
1	Heavy meadow	2.5
2	Tillage/field	5
3	Short pasture and lawns	7
4	Nearly bare ground	10
5	Grassed waterway	15
6	Paved areas and shallow paved swales	20

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

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

Computed $t_c = t_i + t_t$

IDF Equations

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

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

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

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

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

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

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

PRE-DEVELOPMENT WEIGHTED CURVE NUMBER & RUNOFF COEFFICIENT CALCULATIONS

Waterview North

BASIN ID	Total Area (Ac.)	HSG A/B	% IMPERV	WEIGHTED RESULTANT VALUES CN	C_5	C_{100}	ca-equivalent CA_5	CA_{100}	Initial Abstraction(Ia)
BJD-12a	*54.28*	*A*	*0.0*	28.0	0.08	0.35	4.3424	19.00	2.571428571
BJD-12b	*9.54*	*A*	*0.0*	28.0	0.08	0.35	0.7632	3.34	2.571428571
BJD-12c	*18.23*	*A/B*	*0.0*	46	0.08	0.35	1.4584	6.38	1.173913043
BJDEX-14	*6.16*	*B*	*0.0*	46.0	0.08	0.35	0.4928	2.16	1.173913043
JCD-OS1A	*36.00*	*A*	*0.0*	28.0	0.08	0.35	2.88	12.60	2.571428571
JCD-OS1B	*20.70*	*A/B*	*0.0*	34.3	0.08	0.35	1.656	7.25	1.915451895
JCDEX-3.1	*68.60*	*A/B*	*0.0*	40.6	0.08	0.35	5.488	24.01	1.463054187
JCDEX-3.2	*13.21*	*B*	*0.0*	46.0	0.08	0.35	1.0568	4.62	1.173913043
JCDEX-3.3	*10.00*	*B*	*0.0*	46.0	0.08	0.35	0.8	3.50	1.173913043

Note: Antecedent Runoff Condition = 1, Runoff Coefficients refenced from Table 6-6, CNs referenced from Table 6-9 of the DCM.

Land Use ID	% Imp.	5-yr (C) HSG A & B	100-yr (C) HSG A & B	CN HSG A	CN HSG B
*Brush/Weed/Grass	0	0.08	0.35	28	46
INDUSTRIAL	80	0.59	0.7	81	88
COMMERCIAL	95	0.81	0.88	89	92
**RESIDENTIAL	80	0.6	0.68	82	90

* Offsite Basin land use is Pasture/Meadow For the Rational Analysis and Brush- brush weed grass for the UH Analysis - unless noted otherwise.

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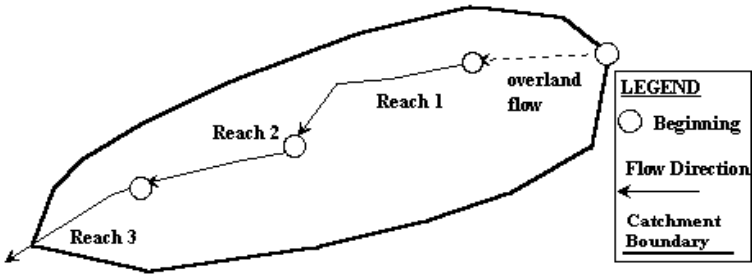
Length-Weighted Slope Calculations

Version 2.00 released May 2017

Designer: *Chad Binder*
Company: *Dakota Springs Engineering*
Date: *8/14/2020*
Project: *Waterview North*
Location: *NE Corner at Powers Blvd & Bradley Rd.*



Subcatchment Name	Percent Imperviousness (%)
BJD-12a	*0*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)
OVERLAND FLOW	*300.00*	*6054.00*	*6043.00*	*0.037*
Total Overland Length (ft)	**300.00**	**Length-Weighted Slope (ft/ft)**		**0.037**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)
SC1	*789.00*	*6043.00*	*6003.00*	*0.051*
SC2	*995.00*	*6003.00*	*5981.00*	*0.022*
Total Channelized Length (ft)	**1784.00**	**Length-Weighted Slope (ft/ft)**		**0.035**

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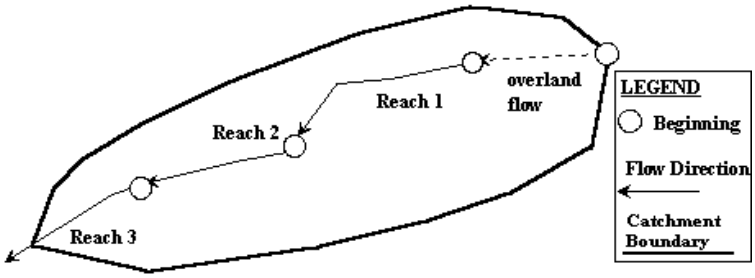

Subcatchment Name	Percent Imperviousness (%)
BJD-12b	*0*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)
OVERLAND FLOW	*295.00*	*6018.30*	*6010.00*	*0.028*

Total Overland Length (ft)	295.00	Length-Weighted Slope (ft/ft)	0.028

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)
SC1	*355.00*	*6010.00*	*5988.00*	*0.062*

Total Channelized Length (ft)	355.00	Length-Weighted Slope (ft/ft)	0.062

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Length-Weighted Slope Calculations

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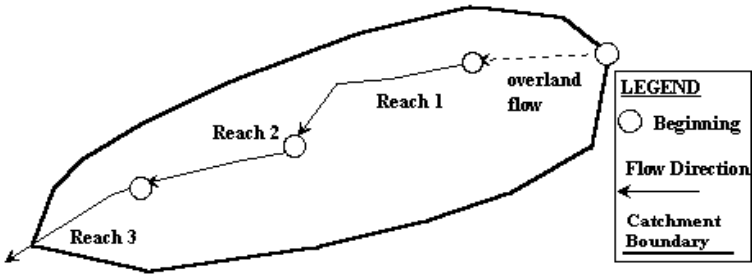

Subcatchment Name	Percent Imperviousness (%)
BJD-12c	*0*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)
OVERLAND FLOW	*300.00*	*6000.00*	*5990.25*	*0.033*
Total Overland Length (ft)	**300.00**	**Length-Weighted Slope (ft/ft)**		**0.033**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)
SC1	*656.00*	*5990.25*	*5975.90*	*0.022*
SC2	*448.00*	*5975.90*	*5973.75*	*0.005*
Total Channelized Length (ft)	**1104.00**	**Length-Weighted Slope (ft/ft)**		**0.015**

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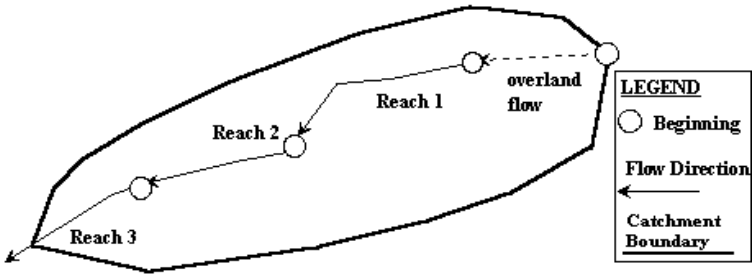

Subcatchment Name	Percent Imperviousness (%)
BJDEX-14	*0*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)
OVERLAND FLOW	*112.00*			*0.098*
Total Overland Length (ft)	**112.00**		**Length-Weighted Slope (ft/ft)**	**0.098**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)
SC1	*377.00*			*0.091*
Total Channelized Length (ft)	**377.00**		**Length-Weighted Slope (ft/ft)**	**0.091**

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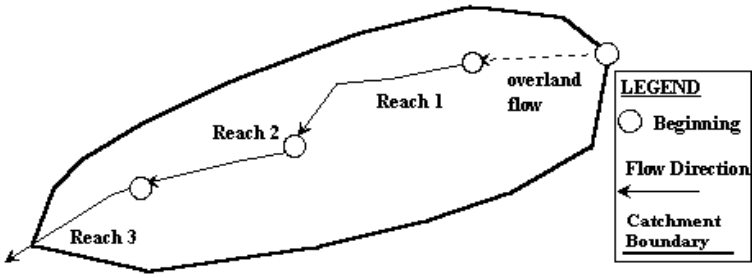

Subcatchment Name	Percent Imperviousness (%)
JCD-EX3.1	*0*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)
OVERLAND FLOW	*300.00*	*5996.00*	*5971.00*	*0.083*

Total Overland Length (ft)	300.00	Length-Weighted Slope (ft/ft)	0.083

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)
SC1	*899.00*	*5971.50*	*5930.50*	*0.046*
SC2	*1734.00*	*5930.50*	*5880.00*	*0.029*

Total Channelized Length (ft)	2633.00	Length-Weighted Slope (ft/ft)	0.035

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Length-Weighted Slope Calculations

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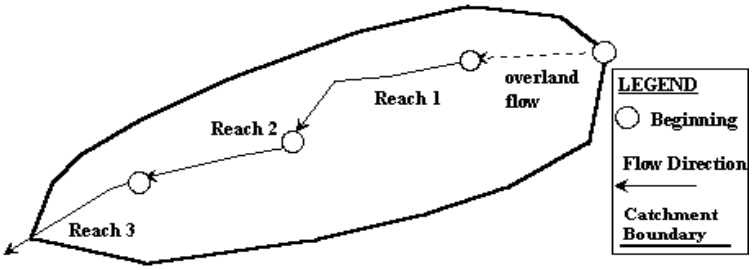

Subcatchment Name	Percent Imperviousness (%)
JCDEX3.2	*0*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)
OVERLAND FLOW	*244.00*	*5994.00*	*5972.00*	*0.090*
Total Overland Length (ft)	**244.00**		**Length-Weighted Slope (ft/ft)**	**0.090**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)
SC1	*985.00*	*5972.00*	*5908.00*	*0.065*
Total Channelized Length (ft)	**985.00**		**Length-Weighted Slope (ft/ft)**	**0.065**

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Length-Weighted Slope Calculations

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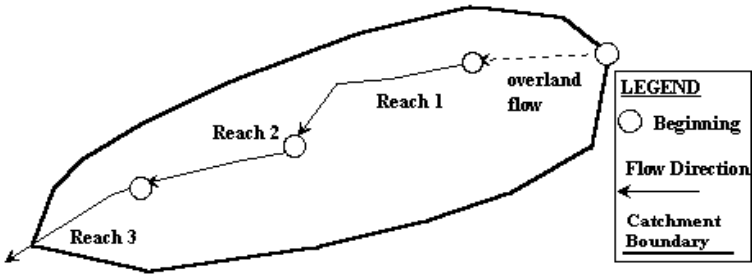

Subcatchment Name	Percent Imperviousness (%)
JCD OS-1B	*0*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)
OVERLAND FLOW	*200.00*	*6013.50*	*6000.00*	*0.068*

Total Overland Length (ft)	200.00	Length-Weighted Slope (ft/ft)	0.068

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)
SC1	*1167.00*	*6000.00*	*5932.00*	*0.058*

Total Channelized Length (ft)	1167.00	Length-Weighted Slope (ft/ft)	0.058

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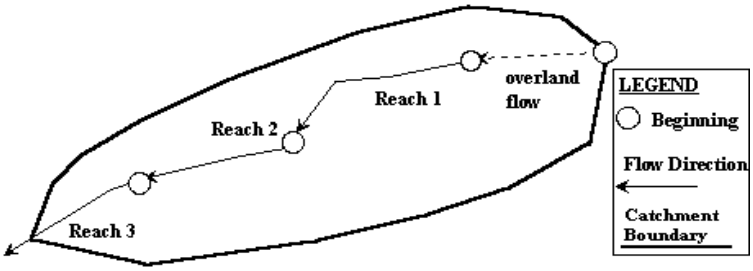
Length-Weighted Slope Calculations

Version 2.00 released May 2017

Designer: *Chad Binder*
Company: *Dakota Springs Engineering*
Date: *8/14/2020*
Project: *Waterview North*
Location: *NE Corner at Powers Blvd & Bradley Rd.*



Subcatchment Name	Percent Imperviousness (%)
JCD EX-3.3	*0*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)
OVERLAND FLOW	*297.00*	*5995.00*	*5960.00*	*0.118*
Total Overland Length (ft)	**297.00**		**Length-Weighted Slope (ft/ft)**	**0.118**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)
SC1	*398.00*	*5960.00*	*5930.00*	*0.075*
Total Channelized Length (ft)	**398.00**		**Length-Weighted Slope (ft/ft)**	**0.075**

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Length-Weighted Slope Calculations

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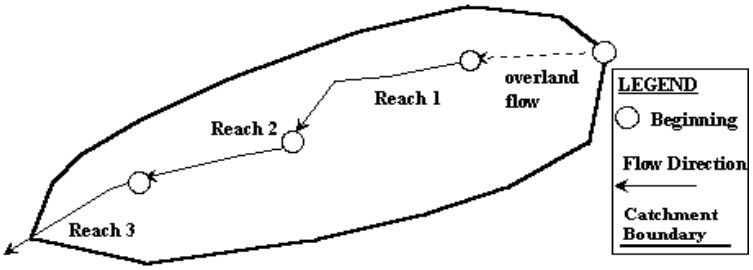
Location: *NE Corner at Powers Blvd & Bradley Rd.*



Subcatchment Name	Percent Imperviousness (%)
JCD OS-1A	*0*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)
OVERLAND FLOW	*247.00*	*6076.00*	*6066.00*	*0.040*

Total Overland Length (ft) **247.00** **Length-Weighted Slope (ft/ft)** **0.040**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)
SC1	*2545.00*	*6066.00*	*5950.00*	*0.046*

Total Channelized Length (ft) **2545.00** **Length-Weighted Slope (ft/ft)** **0.046**

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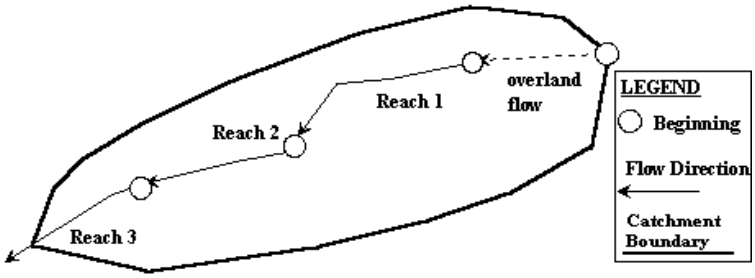
PRE DEVELOPMENT RATIONAL ANALYSIS

WEIGHTED Tc CALCS

Reach-Weighted Time of Concentration Calculations

Version 2.00 released May 2017

Designer: *Chad Binder*
Company: *Dakota Springs Engineering*
Date: *8/14/2020*
Project: *Waterview North*
Location: *NE Corner at Powers Blvd & Bradley Rd.*



Subcatchment Name	Percent Imperviousness (%)
BJD-12a	*0*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	Overland Flow Slope S_i (ft/ft)	5-yr Runoff Coefficient, C_5	Overland Flow Time t_i (min)
OVERLAND FLOW	*300.00*	*0.037*	*0.08*	*20.71*
Weighted Totals	**300.00**	**0.037**	**Total t_i (min)**	**20.71**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Time t_t (min)
SC-1	*789.00*	*0.051*	*7*	*8.32*
SC-2	*995.00*	*0.022*	*7*	*15.97*
Weighted Totals	**1784.00**	**0.035**	**Total t_t (min)**	**24.29**

Computed t_c (min)	**45.00**
Regional t_c (min)	**43.70**
Selected t_c (min)	**43.70**

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Reach-Weighted Time of Concentration Calculations

Version 2.00 released May 2017

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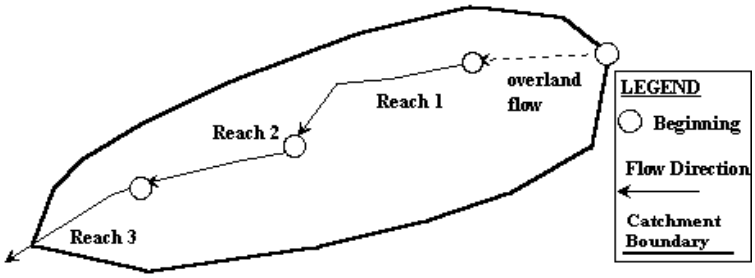
Company: *Dakota Springs Engineering*
Date: *8/14/2020*
Project: *Waterview North*
Location: *NE Corner at Powers Blvd & Bradley Rd.*



Subcatchment Name	Percent Imperviousness (%)
BJD-12b	*0*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	Overland Flow Slope S_i (ft/ft)	5-yr Runoff Coefficient, C_5	Overland Flow Time t_i (min)
OVERLAND FLOW	*295.00*	*0.028*	*0.02*	*23.84*
Weighted Totals	**295.00**	**0.028**	**Total t_i (min)**	**23.84**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Time t_t (min)
SC-1	*355.00*	*0.062*	*7*	*3.39*
Weighted Totals	**355.00**	**0.062**	**Total t_t (min)**	**3.39**

Computed t_c (min)	**27.24**
Regional t_c (min)	**28.64**
Selected t_c (min)	**27.24**

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Reach-Weighted Time of Concentration Calculations

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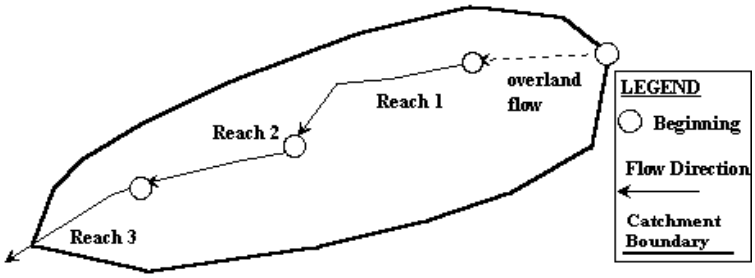
Company: *Dakota Springs Engineering*
Date: *8/14/2020*
Project: *Waterview North*
Location: *NE Corner at Powers Blvd & Bradley Rd.*



Subcatchment Name	Percent Imperviousness (%)
BJD-12c	*0*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	Overland Flow Slope S_i (ft/ft)	5-yr Runoff Coefficient, C_5	Overland Flow Time t_i (min)
OVERLAND FLOW	*300.00*	*0.330*	*0.08*	*10.08*
Weighted Totals	**300.00**	**0.330**	**Total t_i (min)**	**10.08**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Time t_t (min)
SC-1	*1104.00*	*0.015*	*7*	*21.46*
Weighted Totals	**1104.00**	**0.015**	**Total t_t (min)**	**21.46**

Computed t_c (min)	**31.54**
Regional t_c (min)	**42.69**
Selected t_c (min)	**31.54**

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Reach-Weighted Time of Concentration Calculations

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Date: *8/14/2020*
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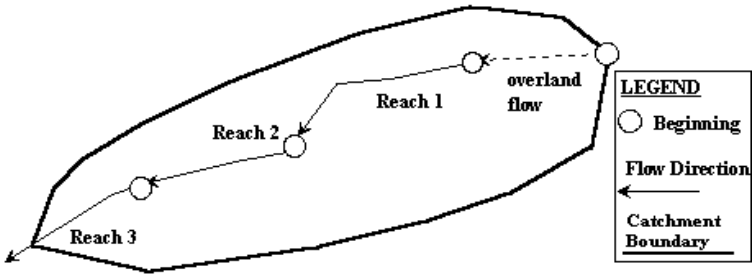
Location: *NE Corner at Powers Blvd & Bradley Rd.*



Subcatchment Name	Percent Imperviousness (%)
BJDEX14	*0*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	Overland Flow Slope S_i (ft/ft)	5-yr Runoff Coefficient, C_5	Overland Flow Time t_i (min)
OVERLAND FLOW	*112.00*	*0.098*	*0.08*	*9.18*
Weighted Totals	**112.00**	**0.098**	**Total t_i (min)**	**9.18**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Time t_t (min)
SC-1	*353.00*	*0.091*	*7*	*2.79*
Weighted Totals	**353.00**	**0.091**	**Total t_t (min)**	**2.79**

Computed t_c (min)	**11.96**
Regional t_c (min)	**28.17**
Selected t_c (min)	**11.96**

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Reach-Weighted Time of Concentration Calculations

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Company: *Dakota Springs Engineering*
Date: *8/14/2020*
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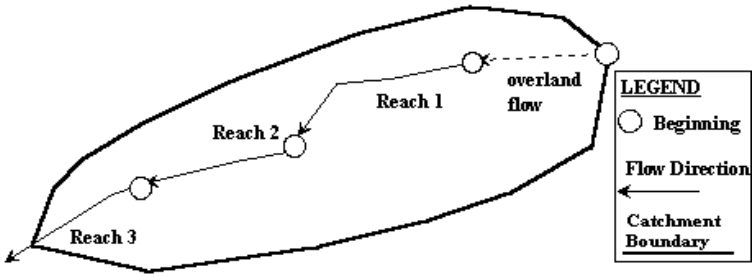
Location: *NE Corner at Powers Blvd & Bradley Rd.*



Subcatchment Name	Percent Imperviousness (%)
JCD OS-1A	*0*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	Overland Flow Slope S_i (ft/ft)	5-yr Runoff Coefficient, C_5	Overland Flow Time t_i (min)
OVERLAND FLOW	*247.00*	*0.040*	*0.02*	*19.39*
Weighted Totals	**247.00**	**0.040**	**Total t_i (min)**	**19.39**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Time t_t (min)
SC-1	*2545.00*	*0.045*	*7*	*28.56*
Weighted Totals	**2545.00**	**0.045**	**Total t_t (min)**	**28.56**

Computed t_c (min)	**47.96**
Regional t_c (min)	**48.22**
Selected t_c (min)	**47.96**

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Reach-Weighted Time of Concentration Calculations

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Date: *8/21/2020*
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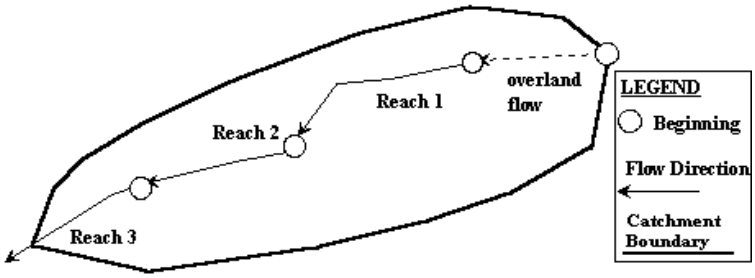
Location: *NE Corner at Powers Blvd & Bradley Rd.*



Subcatchment Name	Percent Imperviousness (%)
JCD OS-1B	*0*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	Overland Flow Slope S_i (ft/ft)	5-yr Runoff Coefficient, C_5	Overland Flow Time t_i (min)
OVERLAND FLOW	*200.00*	*0.068*	*0.08*	*13.84*
Weighted Totals	**200.00**	**0.068**	**Total t_i (min)**	**13.84**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Time t_t (min)
SC-1	*1167.00*	*0.058*	*7*	*11.54*
Weighted Totals	**1167.00**	**0.058**	**Total t_t (min)**	**11.54**

Computed t_c (min)	**25.37**
Regional t_c (min)	**34.97**
Selected t_c (min)	**25.37**

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Reach-Weighted Time of Concentration Calculations

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Date: *8/14/2020*
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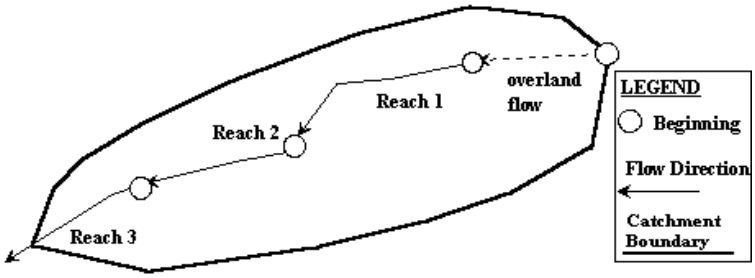

Subcatchment Name	Percent Imperviousness (%)
JCDEX3.1	*0*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	Overland Flow Slope S_i (ft/ft)	5-yr Runoff Coefficient, C_5	Overland Flow Time t_i (min)
OVERLAND FLOW	*300.00*	*0.083*	*0.08*	*15.87*
Weighted Totals	**300.00**	**0.083**	**Total t_i (min)**	**15.87**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Time t_t (min)
SC-1	*899.00*	*0.045*	*7*	*10.09*
SC-2	*1734.00*	*0.030*	*7*	*23.84*
Weighted Totals	**2633.00**	**0.035**	**Total t_t (min)**	**33.93**

Computed t_c (min)	**49.79**
Regional t_c (min)	**52.02**
Selected t_c (min)	**49.79**

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Reach-Weighted Time of Concentration Calculations

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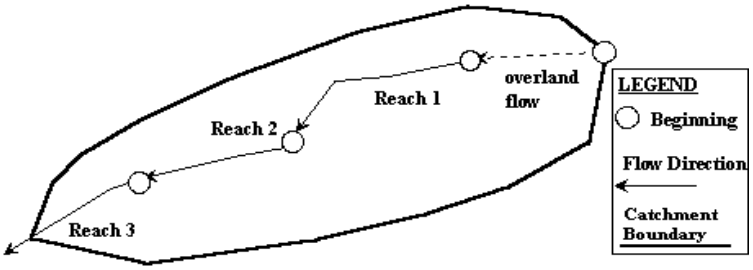

Subcatchment Name	Percent Imperviousness (%)
JCDEX-3.2	*0*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	Overland Flow Slope S_i (ft/ft)	5-yr Runoff Coefficient, C_5	Overland Flow Time t_i (min)
OVERLAND FLOW	*244.00*	*0.090*	*0.08*	*13.93*
Weighted Totals	**244.00**	**0.090**	**Total t_i (min)**	**13.93**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Time t_t (min)
SC-1	*958.00*	*0.066*	*7*	*8.88*
Weighted Totals	**958.00**	**0.066**	**Total t_t (min)**	**8.88**

Computed t_c (min)	**22.81**
Regional t_c (min)	**32.91**
Selected t_c (min)	**22.81**

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Reach-Weighted Time of Concentration Calculations

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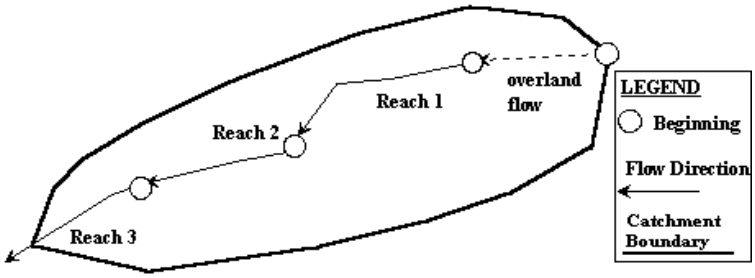

Subcatchment Name	Percent Imperviousness (%)
JCDEX3.3	*0*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	Overland Flow Slope S_i (ft/ft)	5-yr Runoff Coefficient, C_5	Overland Flow Time t_i (min)
OVERLAND FLOW	*297.00*	*0.118*	*0.08*	*14.06*
Weighted Totals	**297.00**	**0.118**	**Total t_i (min)**	**14.06**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Time t_t (min)
SC-1	*398.00*	*0.075*	*7*	*3.46*
Weighted Totals	**398.00**	**0.075**	**Total t_t (min)**	**3.46**

Computed t_c (min)	**17.52**
Regional t_c (min)	**28.69**
Selected t_c (min)	**17.52**

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POST DEVELOPMENT RATIONAL ANALYSIS

SUMMARY

WATERVIEW NORTH - POST DEVELOPMENT
(RATIONAL METHOD Q=CIA)

BASIN	TOTAL FLOWS				AREA TOTAL	WEIGHTED		OVERLAND				CHANNEL						Tc TOTAL	INTENSITY		COMMENTS
	Q(5)	Q(100)	CA(equiv.)			C(5)	C(100)	C(5)	Length	Slope	Ti	Length	Slope	Description Code	Convey Factor (K)	Velocity	Tt		I(5)	I(100)	
	(c.f.s.)	(c.f.s.)	5 YR	100 YR	(Ac)				(ft)	(ft)	(min)	(ft)	(%)			(fps)	(min)	(min)	(in/hr)	(in/hr)	
BJD-12a	8.3	60.6	4.34	19.00	54.28	0.08	0.35	0.08	300	3.7%	21.5	1,784	3.5%	3	7	1.3	22.7	44.2	1.9	3.2	Feeds offsite Depression
BJD-12b	2.0	14.8	0.76	3.34	9.54	0.08	0.35	0.08	295	2.8%	23.3	377	5.8%	3	7	1.7	3.7	27.1	2.6	4.4	Bypasses Pond BJD-K to DP-BJD-K
BJD-12c	37.2	74.1	10.76	12.76	18.23	0.59	0.70	0.59	100	2.5%	7.0	1,304	1.6%	6	20	2.5	8.6	15.6	3.5	5.8	Feeds Pond BJD-K
BJDEV-14	23.9	44.4	4.64	5.13	6.16	0.75	0.83	0.75	100	9.5%	3.1	366	8.5%	6	20	5.8	1.0	5.0	5.2	8.7	Conveys west and south to Big Johnson Res.
JCD-OS1A	5.2	38.1	2.88	12.60	36.00	0.08	0.35	0.08	247	4.0%	19.0	2,545	4.6%	3	7	1.5	28.3	47.2	1.8	3.0	Feeds Diversion Channel, Bypass to DP-JCD-D
JCD-OS1B	4.5	32.9	1.66	7.25	20.70	0.08	0.35	0.08	200	6.8%	14.3	1,167	5.8%	3	7	1.7	11.5	25.9	2.7	4.5	Feeds Diversion Channel, Bypass to DP-JCD-D
JCD-DEV3.1	137.2	272.6	41.16	48.71	68.60	0.60	0.71	0.60	100	7.5%	4.8	2,850	3.8%	6	20	3.9	12.2	17.0	3.3	5.6	Feeds Pond JCD-D
JCD-DEV3.2	35.6	67.8	7.93	8.98	13.21	0.60	0.68	0.60	100	10.9%	4.3	1,128	6.9%	6	20	5.3	3.6	7.8	4.5	7.5	Feeds Pond JCD-D
JCD-DEV3.3	38.2	70.9	7.60	8.40	10.00	0.76	0.84	0.76	100	6.7%	3.4	733	8.5%	6	20	5.8	2.1	5.5	5.0	8.4	Feeds Pond A
Design Points																					
Pond A	**38.2**	**70.9**	7.60	8.40	10.00	0.76	0.84	0.76	100	6.7%	3.4	733	8.5%	6	20	5.8	2.1	5.5	5.0	8.4	Pond A Tributary = JCD-3.3
DP A	**1**	**17**																			Pond A Qout (refer to pond calcs)
BJD-12b	2.0	14.8	0.76	3.34	9.54	0.08	0.35	0.08	295	2.8%	23.3	377	6.2%	3	7	1.7	3.6	26.9	2.6	4.4	Bypasses Pond BJD-K to DP-BJD-K
BJD-12c	37.2	74.1	10.76	12.76	18.23	0.59	0.70	0.59	100	2.5%	7.0	1,304	1.6%	6	20	2.5	8.6	15.6	3.5	5.8	Pond BJD-K Qin
POND BJD-K	1.0	9.0																			Pond BJD-K Qout (refer to pond calcs)
BJD-K	**2.0**	**14.8**																			equals BJD-12b peak flows
JCD-DEV3.1	137.2	272.6	41.16	48.71	68.60	0.60	0.71	0.60	100	7.5%	4.8	2,850	3.8%	6	20	3.9	12.2	17.0	3.3	5.6	
JCD-DEV3.2	35.6	67.8	7.93	8.98	13.21	0.60	0.68	0.60	100	10.9%	4.3	1,128	6.9%	6	20	5.3	3.6	7.8	4.5	7.5	
POND JCD-D	**164**	**320**	49.09	57.69	81.81	0.60	0.70	0.60	100	7.5%	4.8	2,850	3.8%	6	20	3.9	12.2	17.0	3.3	5.6	POND JCD-D Qin
JCD-OS1.A	5.2	38.1	2.88	12.60	36.00	0.08	0.35	0.08	247	4.0%	19.0	2,545	4.6%	3	7	1.5	28.3	47.2	1.8	3.0	Bypass Pond JCD-D to DP-JCD-D
JCD-OS1.B	4.6	33.6	1.66	7.25	20.70	0.08	0.35	0.08	200	8.5%	13.3	1,167	5.8%	3	7	1.7	11.5	24.8	2.8	4.6	Bypass Pond JCD-D to DP-JCD-D
BYPASS	7.5	55.3	4.54	19.85	56.70	0.08	0.35	0.08	247	4.0%	19.0	5,600	3.6%	3	15	2.8	32.8	51.8	1.7	2.8	Combined Bypass Flows
JCD-D	**7.5**	**138.3**																			Pond Discharge @ 0.863 Hrs: Q_{100}~83 cfs Q_5=0cfs

UDFCD Table 6-2 NRCS Conveyance Factors, K		
Code	Description	K
1	Heavy meadow	2.5
2	Tillage/field	5
3	Short pasture and lawns	7
4	Nearly bare ground	10
5	Grassed waterway	15
6	Paved areas and shallow paved swales	20

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

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

Computed $t_c = t_i + t_t$

IDF Equations

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

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

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

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

I_5 = -1.50 ln(D) + 7.583

I_2 = -1.19 ln(D) + 6.035

Note: Values calculated by

POST DEVELOPMENT WEIGHTED CURVE NUMBER & RUNOFF COEFFICIENT CALCULATIONS

Waterview North

BASIN ID	Total Area (Ac.)	HSG A/B	% IMPERV	DESIGNATED LAND USE (% OF BASIN)			WEIGHTED RESULTANT VALUES			ca-equivalent		Initial Abstraction(Ia)
				I-2	COMMERCIAL	RESIDENTIAL	CN	C_5	C_{100}	CA_5	CA_{100}	
BJD-12a	*54.28*	*A*	*0.0*									
							68.0	0.08	0.35	4.3424	19.00	0.470588235
BJD-12b	*9.54*	*A*	*0.0*									
							68.0	0.08	0.35	0.7632	3.34	0.470588235
BJD-12c	*18.23*	*A/B*	*80.0*	18.23								
				1			88	0.59	0.7	10.7557	12.76	0.136363636
BJDEV-14	*6.16*	*B*	*91.1*	1.61	4.55							
				0.26	0.74		91.0	0.75	0.83	4.6354	5.13	0.098901099
JCD-OS1A	*36.00*	*A*	*0.0*									
							68.0	0.08	0.35	2.88	12.60	0.470588235
JCD-OS1B	*20.70*	*A/B*	*0.0*									
							71.9	0.08	0.35	1.656	7.25	0.391788448
JCDEV-3.1	*68.60*	*A/B*	*82.2*	8.36	6.86	53.98						
				0.12	0.10	0.79	90.7	0.6	0.71	42.877	48.60	0.102008032
JCDEV-3.2	*13.21*	*B*	*80.0*			13.21						
						1.00	90.0	0.60	0.68	7.926	8.98	0.111111111
JCDEV-3.3	*10.00*	*B*	*91.7*		7.77	2.23						
					0.78	0.22	91.6	0.76	0.84	7.6317	8.35	0.092251567

Note: Antecedent Runoff Condition = 2, Runoff Coefficients refenced from Table 6-6, CNs referenced from Table 6-10 of the DCM.

Land Use ID	% Imp.	5-yr (C) HSG A & B	100-yr (C) HSG A & B	CN HSG A	CN HSG B
*Brush/Weed/Grass	0	0.08	0.35	68	79
INDUSTRIAL	80	0.59	0.7	81	88
COMMERCIAL	95	0.81	0.88	89	92
**RESIDENTIAL	80	0.6	0.68	82	90

* Offsite Basin land use is Pasture/Meadow For the Rational Analysis and Brush- brush weed grass for the UH Analysis - unless noted otherwise.

** Runoff Coefficients for residential were extrapolated from values shown on Table 6.6(8 units per acre) of the DCM to match proposed density (12 units per acre).

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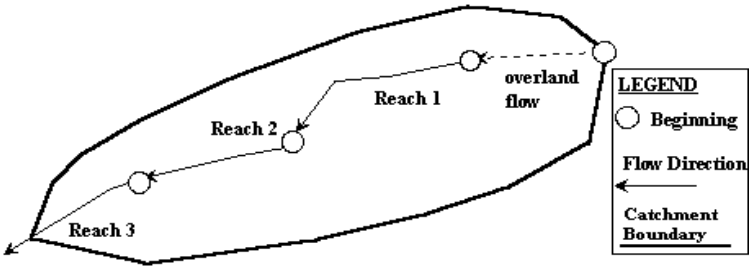
POST DEVELOPMENT RATIONAL ANALYSIS

WEIGHTED SLOPE CALCS

Length-Weighted Slope Calculations

Version 2.00 released May 2017

Designer: *Chad Binder*
Company: *Dakota Springs Engineering*
Date: *8/18/2020*
Project: *Waterview North*
Location: *NE Corner at Powers Blvd & Bradley Rd.*



Subcatchment Name	Percent Imperviousness (%)
BJD-12a	*0*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)
OVERLAND FLOW	*300.00*	*6054.00*	*6043.00*	*0.037*

Total Overland Length (ft) **300.00** **Length-Weighted Slope (ft/ft)** **0.037**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)
SC1	*789.00*	*6043.00*	*6003.00*	*0.051*
SC2	*995.00*	*6003.00*	*5981.00*	*0.022*

Total Channelized Length (ft) **1784.00** **Length-Weighted Slope (ft/ft)** **0.035**

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Length-Weighted Slope Calculations

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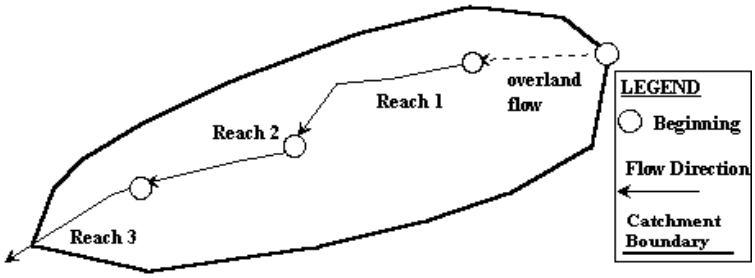
Date: *8/18/2020*
Project: *Waterview North*
Location: *NE Corner at Powers Blvd & Bradley Rd.*



Subcatchment Name	Percent Imperviousness (%)
BJD-12b	*0*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)
OVERLAND FLOW	*295.00*	*6018.30*	*6010.00*	*0.028*

Total Overland Length (ft) **295.00** **Length-Weighted Slope (ft/ft)** **0.028**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)
SC1	*355.00*	*6010.00*	*5988.00*	*0.062*

Total Channelized Length (ft) **355.00** **Length-Weighted Slope (ft/ft)** **0.062**

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Length-Weighted Slope Calculations

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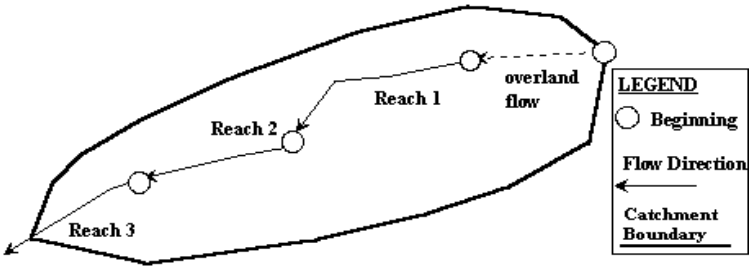
Date: *8/18/2020*
Project: *Waterview North*
Location: *NE Corner at Powers Blvd & Bradley Rd.*



Subcatchment Name	Percent Imperviousness (%)
BJD-12c	*80*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)
OVERLAND FLOW	*100.00*	*5999.50*	*5997.00*	*0.025*
Total Overland Length (ft)	**100.00**		**Length-Weighted Slope (ft/ft)**	**0.025**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)
SC1	*856.20*	*5997.00*	*5975.90*	*0.025*
sc2	*448.00*	*5975.90*	*5973.90*	*0.004*
Total Channelized Length (ft)	**1304.20**		**Length-Weighted Slope (ft/ft)**	**0.018**

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Length-Weighted Slope Calculations

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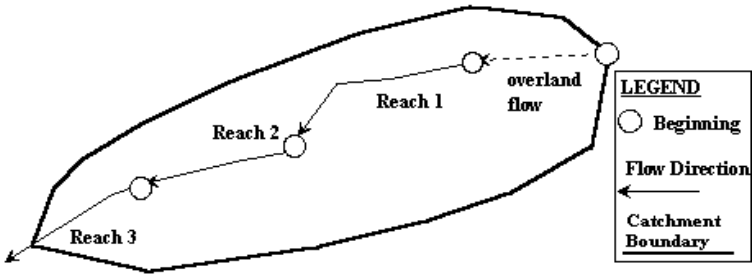
Company: *Dakota Springs Engineering*
Date: *8/18/2020*
Project: *Waterview North*
Location: *NE Corner at Powers Blvd & Bradley Rd.*



Subcatchment Name	Percent Imperviousness (%)
BJDEV-14	*91.1*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)
OVERLAND FLOW	*100.00*	*6002.50*	*5993.00*	*0.095*
Total Overland Length (ft)	**100.00**		**Length-Weighted Slope (ft/ft)**	**0.095**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)
SC1	*365.50*	*5993.00*	*5962.00*	*0.085*
Total Channelized Length (ft)	**365.50**		**Length-Weighted Slope (ft/ft)**	**0.085**

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Length-Weighted Slope Calculations

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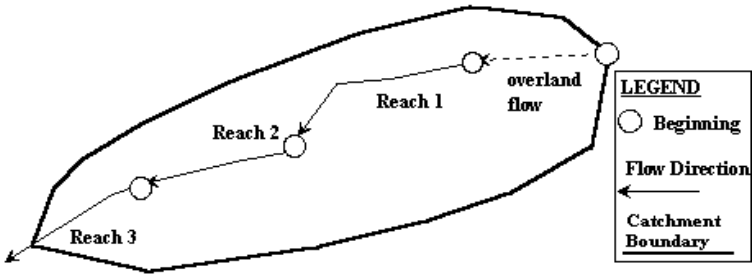
Company: *Dakota Springs Engineering*
Date: *8/18/2020*
Project: *Waterview North*
Location: *NE Corner at Powers Blvd & Bradley Rd.*



Subcatchment Name	Percent Imperviousness (%)
JCDEV-3.1	*82.2*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)
OVERLAND FLOW	*100.00*	*5996.00*	*5988.50*	*0.075*
Total Overland Length (ft)	**100.00**		**Length-Weighted Slope (ft/ft)**	**0.075**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)
SC1	*2850.00*	*5988.50*	*5879.30*	*0.038*
Total Channelized Length (ft)	**2850.00**		**Length-Weighted Slope (ft/ft)**	**0.038**

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Length-Weighted Slope Calculations

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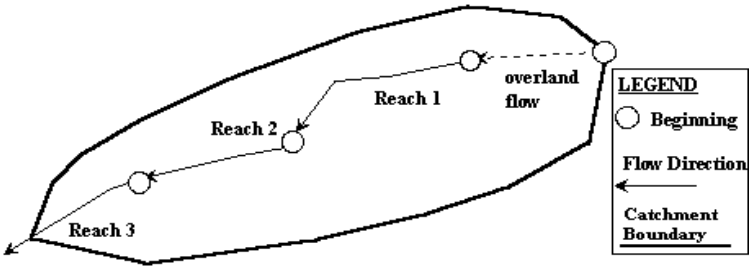
Date: *8/18/2020*
Project: *Waterview North*
Location: *NE Corner at Powers Blvd & Bradley Rd.*



Subcatchment Name	Percent Imperviousness (%)
JCDEV-3.2	*80*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)
OVERLAND FLOW	*100.00*	*5996.20*	*5985.30*	*0.109*

Total Overland Length (ft) **100.00** **Length-Weighted Slope (ft/ft)** **0.109**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)
SC1	*1128.00*	*5985.30*	*5907.00*	*0.069*

Total Channelized Length (ft) **1128.00** **Length-Weighted Slope (ft/ft)** **0.069**

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Length-Weighted Slope Calculations

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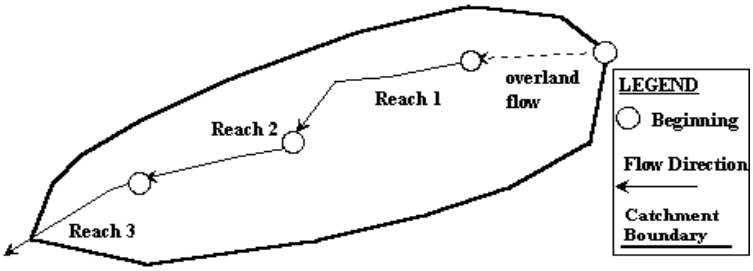
Date: *8/24/2020*
Project: *Waterview North*
Location: *NE Corner at Powers Blvd & Bradley Rd.*



Subcatchment Name	Percent Imperviousness (%)
JCDEV-3.3	*91.7*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)
OVERLAND FLOW	*100.00*	*5997.00*	*5990.30*	*0.067*
Total Overland Length (ft)	**100.00**		**Length-Weighted Slope (ft/ft)**	**0.067**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)
SC1	*409.20*	*5990.30*	*5952.75*	*0.092*
SC1	*323.40*	*5952.75*	*5928.00*	*0.077*
Total Channelized Length (ft)	**732.60**		**Length-Weighted Slope (ft/ft)**	**0.085**

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Length-Weighted Slope Calculations

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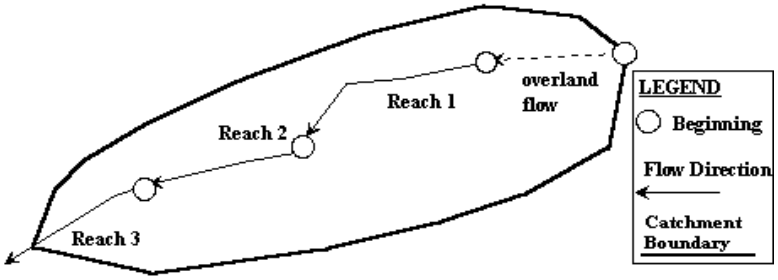

Subcatchment Name	Percent Imperviousness (%)
JCD-OS1A	5

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)
OVERLAND FLOW	247.00	6076.00	6066.00	0.040

Total Overland Length (ft)	247.00	Length-Weighted Slope (ft/ft)	0.040

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)
SC1	2545.00	6066.00	5950.00	0.046

Total Channelized Length (ft)	2545.00	Length-Weighted Slope (ft/ft)	0.046

Length-Weighted Slope Calculations

Version 2.00 released May 2017

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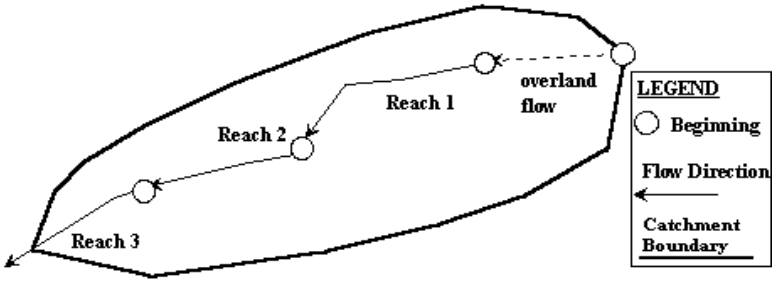
Company: Dakota Springs Engineering
Date: 11/3/2020
Project: Waterview North
Location: NE Corner at Powers Blvd & Bradley Rd.



Subcatchment Name	Percent Imperviousness (%)
BYPASS FLOWS TO JCD-D	0

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)
OVERLAND FLOW	247.00	6076.00	6066.00	0.040
Total Overland Length (ft)	**247.00**		**Length-Weighted Slope (ft/ft)**	**0.040**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)
SC1	2545.00	6076.00	5959.00	0.046
SC2	3055.00	5959.00	5874.00	0.028
Total Channelized Length (ft)	**5600.00**		**Length-Weighted Slope (ft/ft)**	**0.036**

Length-Weighted Slope Calculations

Version 2.00 released May 2017

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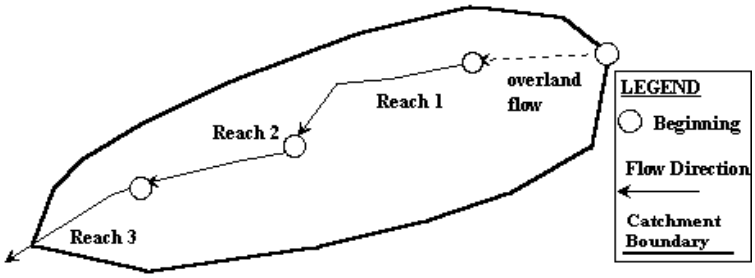
Company: *Dakota Springs Engineering*
Date: *8/18/2020*
Project: *Waterview North*
Location: *NE Corner at Powers Blvd & Bradley Rd.*



Subcatchment Name	Percent Imperviousness (%)
JCD-OS1B	*0*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Overland Flow Slope S_i (ft/ft)
OVERLAND FLOW	*200.00*	*6013.50*	*6000.00*	*0.068*
Total Overland Length (ft)	**200.00**	**Length-Weighted Slope (ft/ft)**		**0.068**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	U/S Elevation (ft) (Optional)	D/S Elevation (ft) (Optional)	Channelized Flow Slope S_t (ft/ft)
SC1	*1167.00*	*6000.00*	*5932.00*	*0.058*
Total Channelized Length (ft)	**1167.00**	**Length-Weighted Slope (ft/ft)**		**0.058**

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POST DEVELOPMENT RATIONAL ANALYSIS

WEIGHTED Tc CALCS

Reach-Weighted Time of Concentration Calculations

Version 2.00 released May 2017

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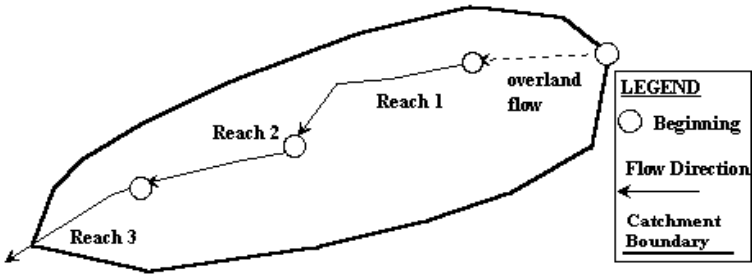
Date: *8/18/2020*
Project: *Waterview North*
Location: *NE Corner at Powers Blvd & Bradley Rd.*



Subcatchment Name	Percent Imperviousness (%)
BJD-12a	*0*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	Overland Flow Slope S_i (ft/ft)	5-yr Runoff Coefficient, C_5	Overland Flow Time t_i (min)
OVERLAND FLOW	*300.00*	*0.037*	*0.08*	*20.71*
Weighted Totals	**300.00**	**0.037**	**Total t_i (min)**	**20.71**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Time t_t (min)
SC-1	*789.00*	*0.049*	*7*	*8.49*
SC-2	*995.00*	*0.022*	*7*	*15.97*
Weighted Totals	**1784.00**	**0.034**	**Total t_t (min)**	**24.46**

Computed t_c (min)	**45.17**
Regional t_c (min)	**43.93**
Selected t_c (min)	**43.93**

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Reach-Weighted Time of Concentration Calculations

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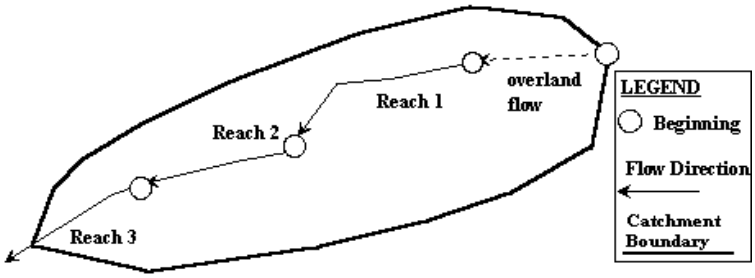
Date: *8/18/2020*
Project: *Waterview North*
Location: *NE Corner at Powers Blvd & Bradley Rd.*



Subcatchment Name	Percent Imperviousness (%)
BJD-12b	*0*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	Overland Flow Slope S_i (ft/ft)	5-yr Runoff Coefficient, C_5	Overland Flow Time t_i (min)
OVERLAND FLOW	*295.00*	*0.028*	*0.08*	*22.52*
Weighted Totals	**295.00**	**0.028**	**Total t_i (min)**	**22.52**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Time t_t (min)
SC-1	*355.00*	*0.062*	*7*	*3.39*
Weighted Totals	**355.00**	**0.062**	**Total t_t (min)**	**3.39**

Computed t_c (min)	**25.91**
Regional t_c (min)	**28.64**
Selected t_c (min)	**25.91**

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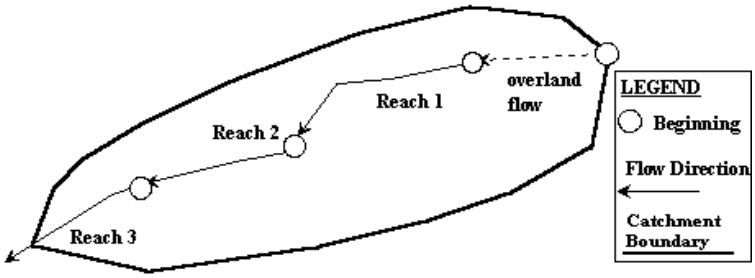
Reach-Weighted Time of Concentration Calculations

Version 2.00 released May 2017

Designer: *Chad Binder*
Company: *Dakota Springs Engineering*
Date: *8/18/2020*
Project: *Waterview North*
Location: *NE Corner at Powers Blvd & Bradley Rd.*



Subcatchment Name	Percent Imperviousness (%)
BJD-12c	*80*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	Overland Flow Slope S_i (ft/ft)	5-yr Runoff Coefficient, C_5	Overland Flow Time t_i (min)
OVERLAND FLOW	*100.00*	*0.025*	*0.59*	*6.81*
Weighted Totals	**100.00**	**0.025**	**Total t_i (min)**	**6.81**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Time t_t (min)
SC-1	*856.20*	*0.022*	*20*	*4.81*
SC-2	*448.00*	*0.004*	*10*	*11.81*
Weighted Totals	**1304.20**	**0.016**	**Total t_t (min)**	**16.62**

Computed t_c (min)	**23.42**
Regional t_c (min)	**20.96**
Selected t_c (min)	**20.96**

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Reach-Weighted Time of Concentration Calculations

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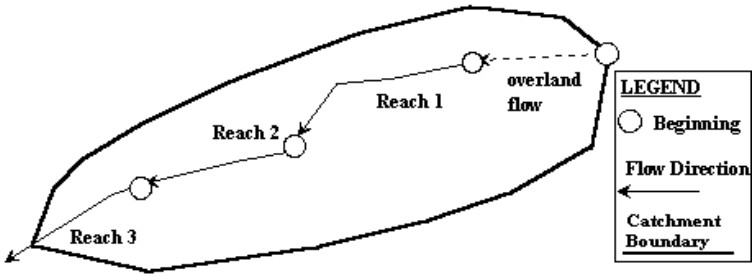
Date: *8/18/2020*
Project: *Waterview North*
Location: *NE Corner at Powers Blvd & Bradley Rd.*



Subcatchment Name	Percent Imperviousness (%)
BJDEV-14	*91.1*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	Overland Flow Slope S_i (ft/ft)	5-yr Runoff Coefficient, C_5	Overland Flow Time t_i (min)
OVERLAND FLOW	*100.00*	*0.095*	*0.75*	*3.01*
Weighted Totals	**100.00**	**0.095**	**Total t_i (min)**	**3.01**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Time t_t (min)
SC-1	*365.50*	*0.085*	*20*	*1.04*
Weighted Totals	**365.50**	**0.085**	**Total t_t (min)**	**1.04**

Computed t_c (min)	**4.05**
Regional t_c (min)	**11.47**
Selected t_c (min)	**5.00**

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Reach-Weighted Time of Concentration Calculations

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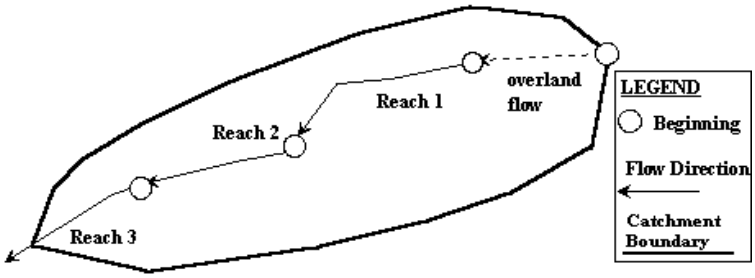

Subcatchment Name	Percent Imperviousness (%)
JCDEV3.1	*82.2*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	Overland Flow Slope S_i (ft/ft)	5-yr Runoff Coefficient, C_5	Overland Flow Time t_i (min)
OVERLAND FLOW	*100.00*	*0.075*	*0.60*	*4.64*
Weighted Totals	**100.00**	**0.075**	**Total t_i (min)**	**4.64**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Time t_t (min)
SC-1	*2850.00*	*0.038*	*20*	*12.18*
Weighted Totals	**2850.00**	**0.038**	**Total t_t (min)**	**12.18**

Computed t_c (min)	**16.83**
Regional t_c (min)	**23.91**
Selected t_c (min)	**16.83**

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Reach-Weighted Time of Concentration Calculations

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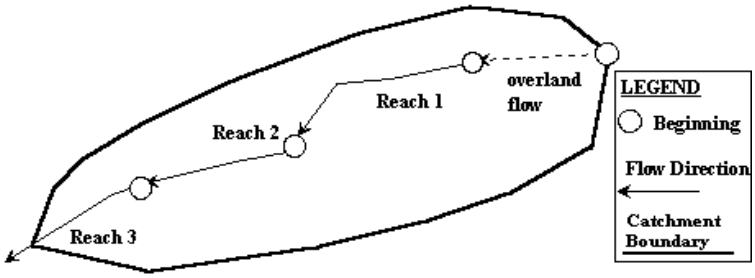
Date: *8/18/2020*
Project: *Waterview North*
Location: *NE Corner at Powers Blvd & Bradley Rd.*



Subcatchment Name	Percent Imperviousness (%)
JCDEV3.2	*80*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	Overland Flow Slope S_i (ft/ft)	5-yr Runoff Coefficient, C_5	Overland Flow Time t_i (min)
OVERLAND FLOW	*100.00*	*0.109*	*0.60*	*4.10*
Weighted Totals	**100.00**	**0.109**	**Total t_i (min)**	**4.10**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Time t_t (min)
SC-1	*1128.00*	*0.069*	*20*	*3.58*
Weighted Totals	**1128.00**	**0.069**	**Total t_t (min)**	**3.58**

Computed t_c (min)	**7.68**
Regional t_c (min)	**15.94**
Selected t_c (min)	**7.68**

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Reach-Weighted Time of Concentration Calculations

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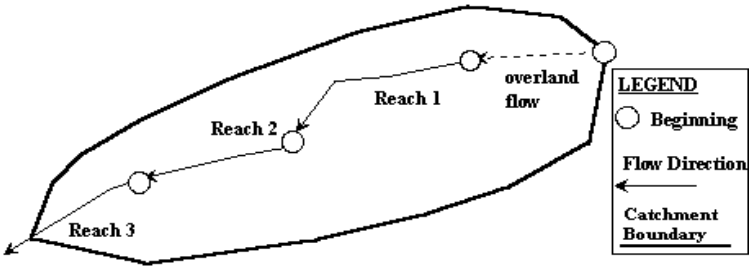
Date: *8/24/2020*
Project: *Waterview North*
Location: *NE Corner at Powers Blvd & Bradley Rd.*



Subcatchment Name	Percent Imperviousness (%)
JCDEV3.3	*91.7*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	Overland Flow Slope S_i (ft/ft)	5-yr Runoff Coefficient, C_5	Overland Flow Time t_i (min)
OVERLAND FLOW	*100.00*	*0.067*	*0.76*	*3.28*
Weighted Totals	**100.00**	**0.067**	**Total t_i (min)**	**3.28**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Time t_t (min)
SC-1	*732.60*	*0.085*	*20*	*2.09*
Weighted Totals	**732.60**	**0.085**	**Total t_t (min)**	**2.09**

Computed t_c (min)	**5.37**
Regional t_c (min)	**12.33**
Selected t_c (min)	**5.37**

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Reach-Weighted Time of Concentration Calculations

Version 2.00 released May 2017

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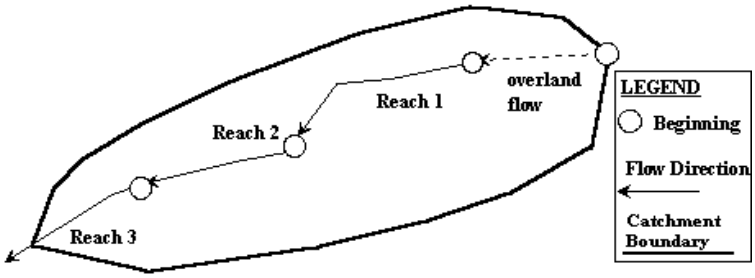
Company: *Dakota Springs Engineering*
Date: *8/18/2020*
Project: *Waterview North*
Location: *NE Corner at Powers Blvd & Bradley Rd.*



Subcatchment Name	Percent Imperviousness (%)
JCD-OS1A	*0*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	Overland Flow Slope S_i (ft/ft)	5-yr Runoff Coefficient, C_5	Overland Flow Time t_i (min)
OVERLAND FLOW	*247.00*	*0.040*	*0.08*	*18.32*
Weighted Totals	**247.00**	**0.040**	**Total t_i (min)**	**18.32**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Time t_t (min)
SC-1	*2545.00*	*0.046*	*7*	*28.25*
Weighted Totals	**2545.00**	**0.046**	**Total t_t (min)**	**28.25**

Computed t_c (min)	**46.57**
Regional t_c (min)	**47.97**
Selected t_c (min)	**46.57**

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Reach-Weighted Time of Concentration Calculations

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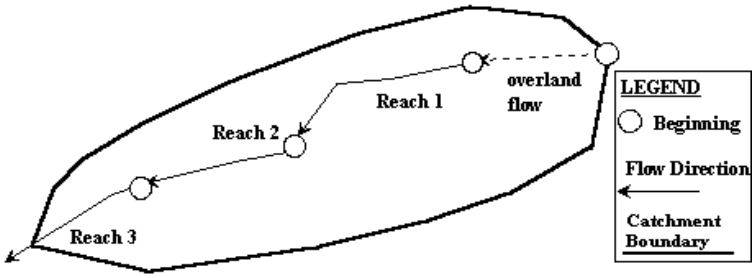
Date: *8/18/2020*
Project: *Waterview North*
Location: *NE Corner at Powers Blvd & Bradley Rd.*



Subcatchment Name	Percent Imperviousness (%)
JCD-OS1B	*0*

OVERLAND FLOW

Reach ID	Overland Flow Length L_i (ft)	Overland Flow Slope S_i (ft/ft)	5-yr Runoff Coefficient, C_5	Overland Flow Time t_i (min)
OVERLAND FLOW	*200.00*	*0.068*	*0.08*	*13.84*
Weighted Totals	**200.00**	**0.068**	**Total t_i (min)**	**13.84**

CHANNELIZED FLOW

Reach ID	Channelized Flow Length L_t (ft)	Channelized Flow Slope S_t (ft/ft)	NRCS Conveyance Factor K	Channelized Flow Time t_t (min)
SC-1	*1167.00*	*0.058*	*7*	*11.54*
Weighted Totals	**1167.00**	**0.058**	**Total t_t (min)**	**11.54**

Computed t_c (min)	**25.37**
Regional t_c (min)	**34.97**
Selected t_c (min)	**25.37**

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APPENDIX C

DETENTION CALCULATIONS

WATER QUALITY CALCULATIONS

EX. OFFSITE POND

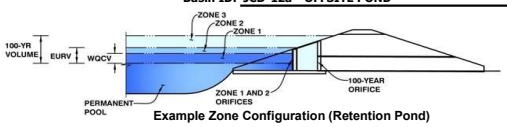
FED BY OFFSITE BASIN BJD-12A

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.02 (February 2020)

Project: **Waterview North**

Basin ID: **JCD-12a - OFFSITE POND**



Example Zone Configuration (Retention Pond)

Watershed Information

			Flood Control Only
Selected BMP Type =	**No BMP**		
Watershed Area =	57.11	acres	
Watershed Length =	2,331	ft	
Watershed Length to Centroid =	1,307	ft	
Watershed Slope =	0.026	ft/ft	
Watershed Imperviousness =	5.00%	percent	
Percentage Hydrologic Soil Group A =	100.0%	percent	
Percentage Hydrologic Soil Group B =	0.0%	percent	
Percentage Hydrologic Soil Groups C/D =	0.0%	percent	
Target WQCV Drain Time =	N/A	hours	
Location for 1-hr Rainfall Depths =	User Input		

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.172	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.173	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.085	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.155	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.215	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.907	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	1.652	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	2.685	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	5.047	acre-feet		inches
Approximate 2-yr Detention Volume =	0.100	acre-feet		
Approximate 5-yr Detention Volume =	0.140	acre-feet		
Approximate 10-yr Detention Volume =	0.191	acre-feet		
Approximate 25-yr Detention Volume =	0.270	acre-feet		
Approximate 50-yr Detention Volume =	0.440	acre-feet		
Approximate 100-yr Detention Volume =	0.906	acre-feet		

Define Zones and Basin Geometry

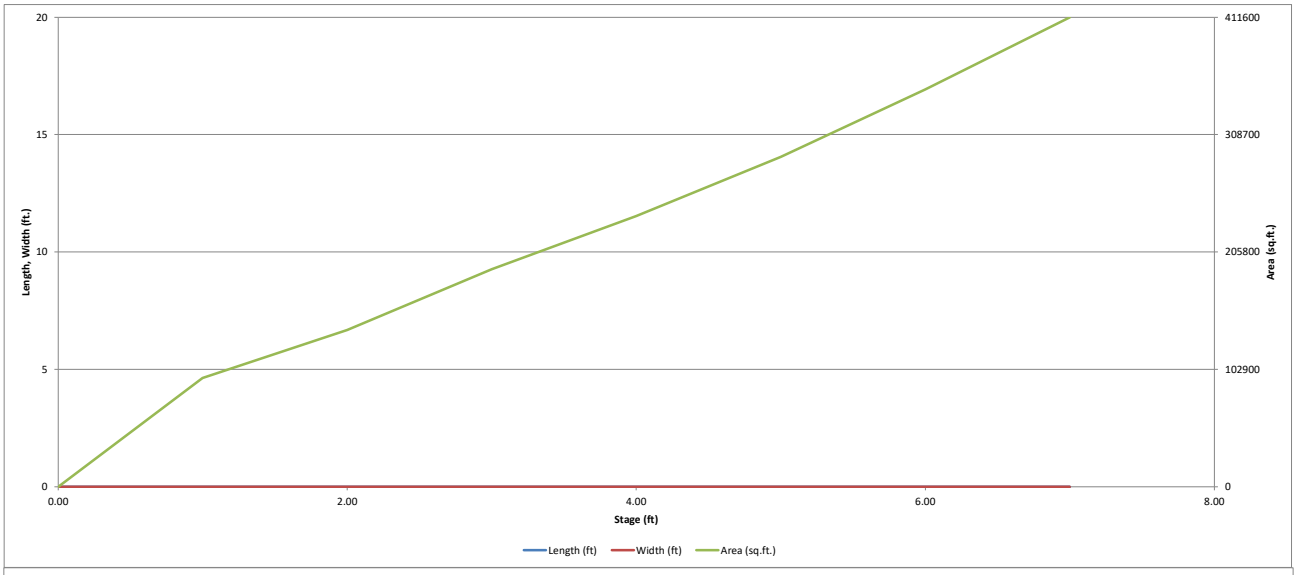
Select Zone 1 Storage Volume (Required) =		acre-feet
Select Zone 2 Storage Volume (Optional) =		acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =		acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention 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

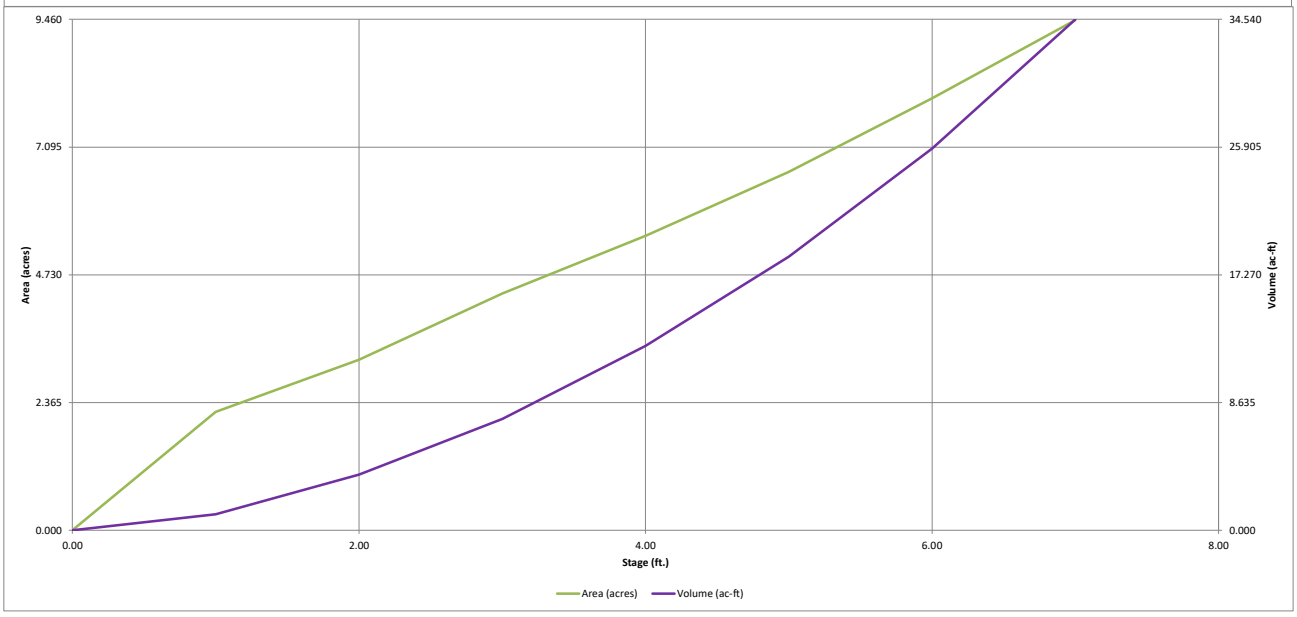
Depth Increment = 1.00 ft

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	--	--	--	0	0.000		
	--	1.00	--	--	--	95,389	2.190	47,691	1.095
	--	2.00	--	--	--	137,419	3.155	164,095	3.767
	--	3.00	--	--	--	190,906	4.383	328,257	7.536
	--	4.00	--	--	--	237,452	5.451	542,436	12.453
	--	5.00	--	--	--	289,141	6.638	805,733	18.497
	--	6.00	--	--	--	348,285	7.996	1,124,446	25.814
	--	7.00	--	--	--	411,513	9.447	1,504,345	34.535
	--		--	--	--				
	--		--	--	--				
	--		--	--	--			

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.02 (February 2020)





POND DESIGN & ANALYSIS

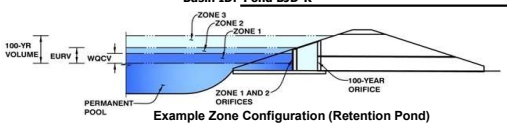
Proposed Pond BJD-K

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.02 (February 2020)

Project: Waterview North

Basin ID: Pond BJD-K



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	18.23	acres
Watershed Length =	1,403	ft
Watershed Length to Centroid =	778	ft
Watershed Slope =	0.018	ft/ft
Watershed Imperviousness =	80.00%	percent
Percentage Hydrologic Soil Group A =	17.3%	percent
Percentage Hydrologic Soil Group B =	82.7%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

		Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.499 acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	1.671 acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	1.422 acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	1.882 acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	2.257 acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	2.690 acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	3.084 acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	3.543 acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	4.535 acre-feet		inches
Approximate 2-yr Detention Volume =	1.279 acre-feet		
Approximate 5-yr Detention Volume =	1.681 acre-feet		
Approximate 10-yr Detention Volume =	2.073 acre-feet		
Approximate 25-yr Detention Volume =	2.261 acre-feet		
Approximate 50-yr Detention Volume =	2.371 acre-feet		
Approximate 100-yr Detention Volume =	2.509 acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.499	acre-feet
Zone 2 Volume (EURV - Zone 1) =	1.172	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.838	acre-feet
Total Detention Basin Volume =	2.509	acre-feet
Initial Surcharge Volume (ISV) =	65	ft^3
Initial Surcharge Depth (ISD) =	0.40	ft
Total Available Detention Depth (H_{total}) =	6.50	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.005	ft/ft
Slopes of Main Basin Sides (S_{main}) =	3	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2	

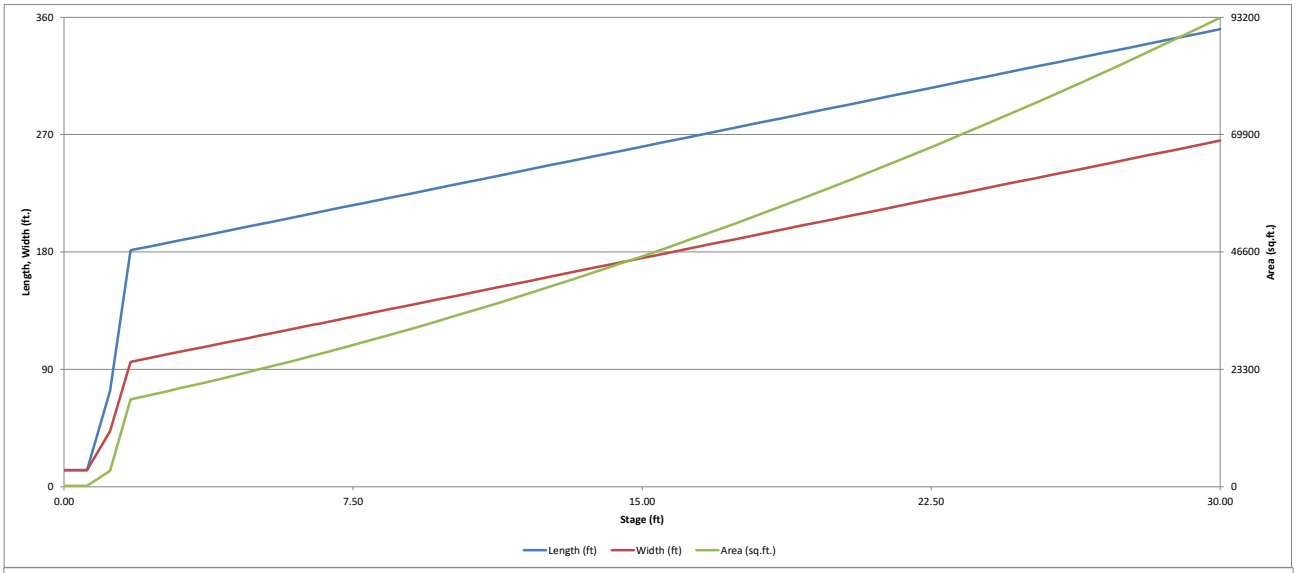
Initial Surcharge Area (A_{ISV}) =	163	ft^2
Surcharge Volume Length (L_{ISV}) =	12.8	ft
Surcharge Volume Width (W_{ISV}) =	12.8	ft
Depth of Basin Floor (H_{FLOOR}) =	0.83	ft
Length of Basin Floor (L_{FLOOR}) =	181.3	ft
Width of Basin Floor (W_{FLOOR}) =	95.8	ft
Area of Basin Floor (A_{FLOOR}) =	17,358	ft^2
Volume of Basin Floor (V_{FLOOR}) =	5,313	ft^3
Depth of Main Basin (H_{MAIN}) =	4.77	ft
Length of Main Basin (L_{MAIN}) =	209.9	ft
Width of Main Basin (W_{MAIN}) =	124.4	ft
Area of Main Basin (A_{MAIN}) =	26,105	ft^2
Volume of Main Basin (V_{MAIN}) =	102,953	ft^3
Calculated Total Basin Volume (V_{total}) =	**2.489**	acre-feet

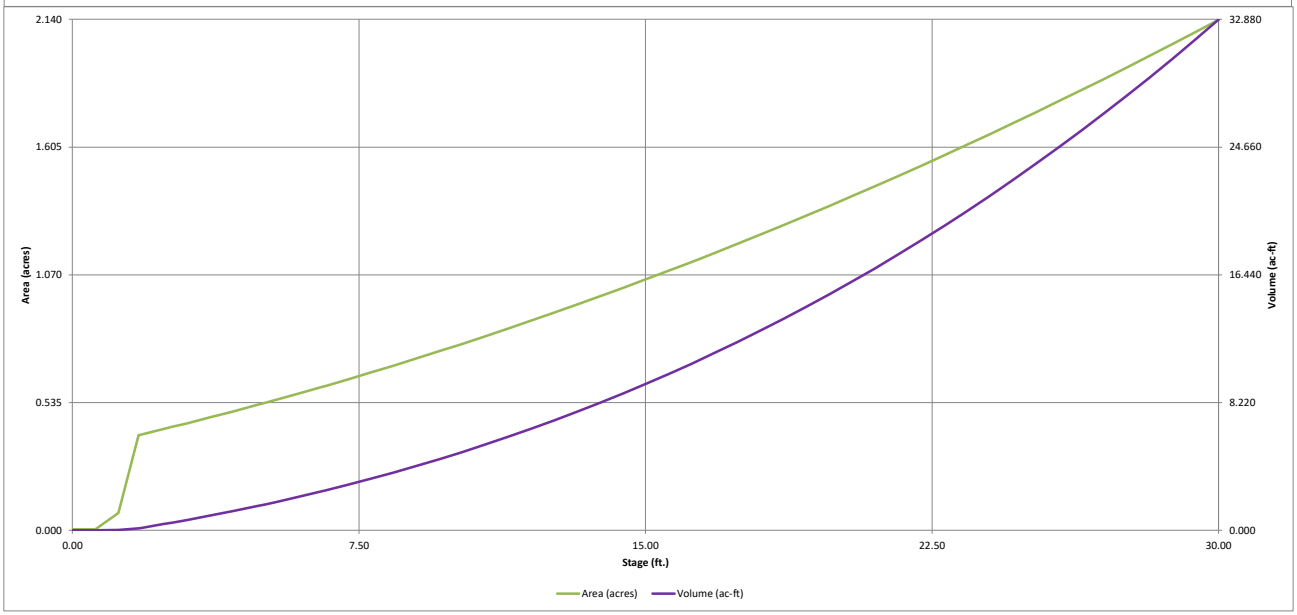
Depth Increment = 0.60 ft

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		12.8	12.8	163		0.004		
ISV	0.40		12.8	12.8	163		0.004	65	0.00150
	0.60		12.8	12.8	163		0.004	98	0.00224
	1.20		73.7	42.8	3,150		0.072	552	0.01268
Floor	1.73		181.3	95.8	17,358		0.398	5,483	0.12588
	1.80		181.7	96.2	17,474		0.401	6,702	0.15387
	2.40		185.3	99.8	18,488		0.424	17,490	0.40151
Zone 1 (WQCV)	2.63		186.7	101.2	18,883		0.433	21,787	0.50017
	3.00		188.9	103.4	19,527		0.448	28,893	0.66329
	3.60		192.5	107.0	20,592		0.473	40,927	0.93956
	4.20		196.1	110.6	21,683		0.498	53,608	1.23068
	4.80		199.7	114.2	22,800		0.523	66,952	1.53701
Zone 2 (EURV)	5.06		201.2	115.7	23,292		0.535	72,944	1.67456
	5.40		203.3	117.8	23,943		0.550	80,974	1.85890
	6.00		206.9	121.4	25,112		0.576	95,689	2.19671
Zone 3 (100-year)	6.53		210.1	124.6	26,166		0.601	109,276	2.50863
	6.60		210.5	125.0	26,306		0.604	111,113	2.55079
	7.20		214.1	128.6	27,527		0.632	127,261	2.92152
	7.80		217.7	132.2	28,773		0.661	144,150	3.30923
	8.40		221.3	135.8	30,046		0.690	161,795	3.71429
	9.00		224.9	139.4	31,344		0.720	180,210	4.13706
	9.60		228.5	143.0	32,669		0.750	199,413	4.57789
	10.20		232.1	146.6	34,019		0.781	219,418	5.03714
	10.80		235.7	150.2	35,395		0.813	240,241	5.51516
	11.40		239.3	153.8	36,797		0.845	261,897	6.01232
	12.00		242.9	157.4	38,225		0.878	284,402	6.52897
4.12	12.60		246.5	161.0	39,679		0.911	307,772	7.06547
	13.20		250.1	164.6	41,159		0.945	332,022	7.62217
	13.80		253.7	168.2	42,664		0.979	357,167	8.19944
	14.40		257.3	171.8	44,196		1.015	383,224	8.79762
	15.00		260.9	175.4	45,754		1.050	410,208	9.41708
	15.60		264.5	179.0	47,337		1.087	438,134	10.05817
	16.20		268.1	182.6	48,947		1.124	467,018	10.72125
	16.80		271.7	186.2	50,582		1.161	496,875	11.40668
	17.40		275.3	189.8	52,243		1.199	527,721	12.11481
	18.00		278.9	193.4	53,930		1.238	559,572	12.84600
	18.60		282.5	197.0	55,643		1.277	592,443	13.60061
	19.20		286.1	200.6	57,382		1.317	626,349	14.37900
	19.80		289.7	204.2	59,147		1.358	661,307	15.18151
	20.40		293.3	207.8	60,938		1.399	697,331	16.00852
	21.00		296.9	211.4	62,755		1.441	734,438	16.86037
	21.60		300.5	215.0	64,598		1.483	772,642	17.73743
	22.20		304.1	218.6	66,466		1.526	811,960	18.64004
	22.80		307.7	222.2	68,361		1.569	852,407	19.56857
	23.40		311.3	225.8	70,281		1.613	893,998	20.52338
	24.00		314.9	229.4	72,228		1.658	936,750	21.50482
	24.60		318.5	233.0	74,200		1.703	980,677	22.51324
	25.20		322.1	236.6	76,198		1.749	1,025,795	23.54901
	25.80		325.7	240.2	78,222		1.796	1,072,120	24.61248
	26.40		329.3	243.8	80,272		1.843	1,119,667	25.70402
	27.00		332.9	247.4	82,348		1.890	1,168,452	26.82396
	27.60		336.5	251.0	84,450		1.939	1,218,490	27.97269
	28.20		340.1	254.6	86,578		1.988	1,269,797	29.15054
	28.80		343.7	258.2	88,732		2.037	1,322,389	30.35788
	29.40		347.3	261.8	90,911		2.087	1,376,281	31.59506
	30.00		350.9	265.4	93,117		2.138	1,431,488	32.86244

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.02 (February 2020)



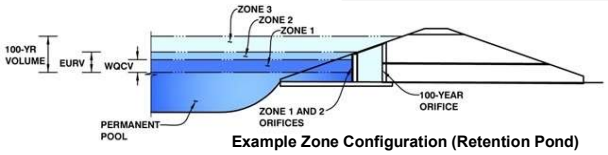


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.02 (February 2020)

Project: **Waterview North**

Basin ID: **Pond BJD-K**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.63	0.499	Orifice Plate
Zone 2 (EURV)	5.06	1.172	Orifice Plate
Zone 3 (100-year)	6.53	0.838	Weir&Pipe (Restrict)
Total (all zones)		2.509	

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

Calculated Parameters for Underdrain

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)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	5.00	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	N/A	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	inches	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	2.00	3.00	3.75				
Orifice Area (sq. inches)	2.20	6.00	6.00	6.00				

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	6.53	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	7.78	N/A	feet
Overflow Weir Front Edge Length =	8.00	N/A	feet	Overflow Weir Slope Length =	5.15	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	46.99	N/A	
Horiz. Length of Weir Sides =	5.00	N/A	feet	Overflow Grate Open Area w/o Debris =	28.86	N/A	ft^2
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area	Overflow Grate Open Area w/ Debris =	28.86	N/A	ft^2
Debris Clogging % =	0%	N/A	%				

Calculated Parameters for Overflow Weir

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

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.00	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	0.61	N/A	ft^2
Outlet Pipe Diameter =	24.00	N/A	inches	Outlet Orifice Centroid =	0.29	N/A	feet
Restrictor Plate Height Above Pipe Invert =	6.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.05	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	8.52	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.91	feet
Spillway Crest Length =	18.00	feet	Stage at Top of Freeboard =	10.43	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	0.79	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	5.22	acre-ft

Calculated Parameters for Spillway

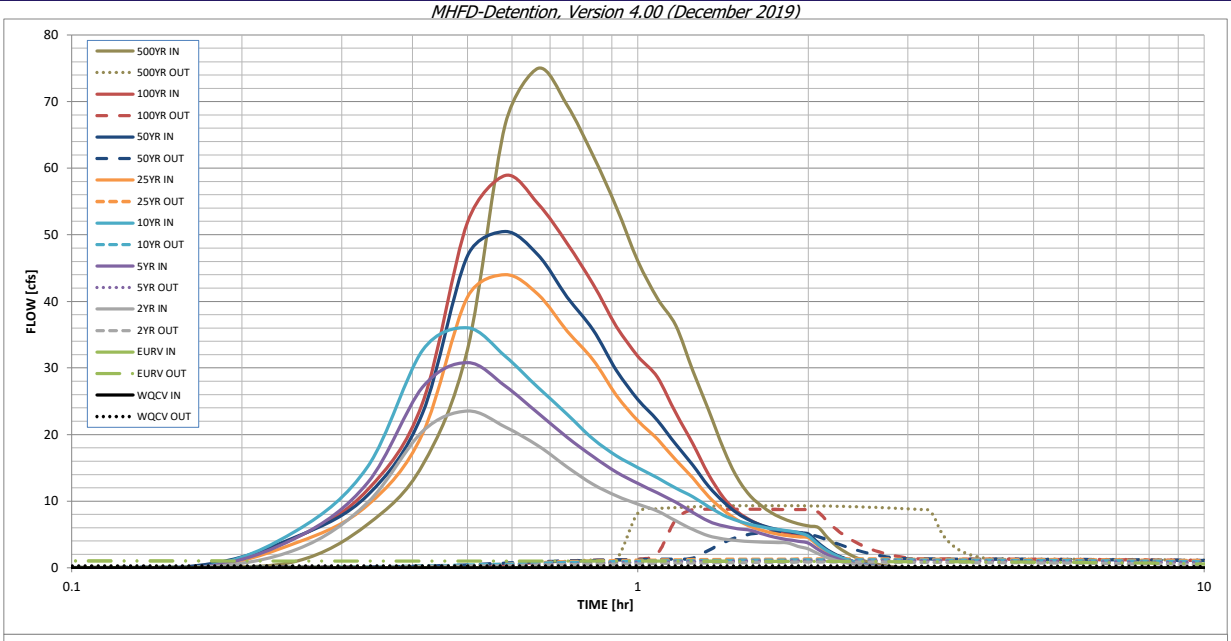
Routed Hydrograph Results

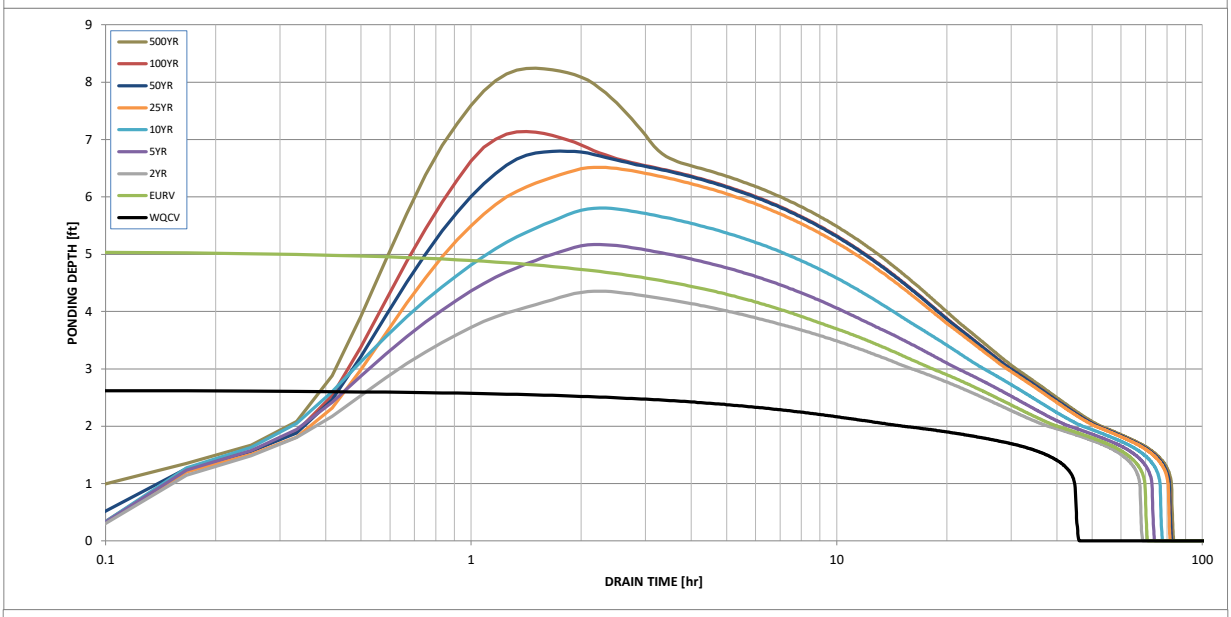
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

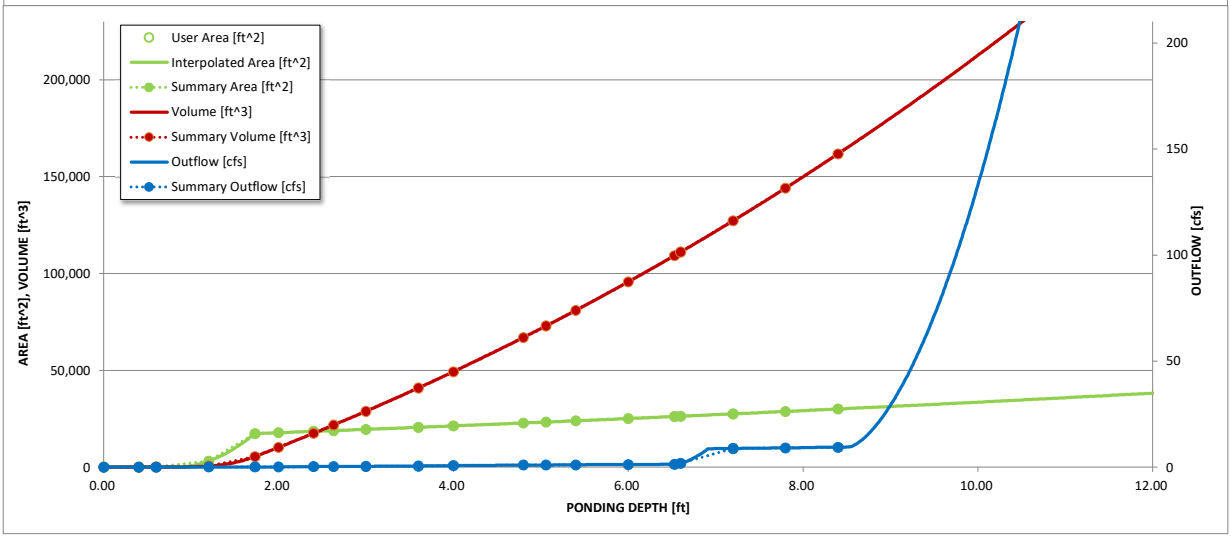
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.499	1.671	1.422	1.882	2.257	2.690	3.084	3.543	4.535
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	1.422	1.882	2.257	2.690	3.084	3.543	4.535
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.6	3.7	6.0	11.7	15.1	19.7	27.9
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.03	0.20	0.33	0.64	0.83	1.08	1.53
Peak Inflow Q (cfs) =	N/A	N/A	23.5	30.8	36.0	44.0	50.5	58.9	75.0
Peak Outflow Q (cfs) =	0.3	1.0	0.9	1.1	1.2	1.3	5.4	8.8	9.3
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.3	0.2	0.1	0.4	0.4	0.3
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Plate	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	0.1	0.3	0.3
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) =	43	63	62	65	68	70	69	68	65
Time to Drain 99% of Inflow Volume (hours) =	**45**	68	66	71	74	77	77	77	76
Maximum Ponding Depth (ft) =	2.63	5.06	4.35	5.17	5.81	6.52	6.80	7.14	8.24
Area at Maximum Ponding Depth (acres) =	0.43	0.53	0.50	0.54	0.57	0.60	0.61	0.63	0.68
Maximum Volume Stored (acre-ft) =	0.500	1.675	1.306	1.734	2.082	2.497	2.666	2.877	3.605

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: *Pond BJD-K Outlfow hydrographs*

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.03	1.01
	0:15:00	0.00	0.00	2.79	4.55	5.63	3.77	4.69	4.59	6.52
	0:20:00	0.00	0.00	9.77	12.77	15.19	9.41	10.92	11.72	15.36
	0:25:00	0.00	0.00	20.46	27.07	32.62	20.07	23.17	24.69	32.78
	0:30:00	0.00	0.00	23.52	30.82	36.02	40.66	46.85	51.89	66.59
	0:35:00	0.00	0.00	21.11	27.28	31.74	44.01	50.48	58.91	75.01
	0:40:00	0.00	0.00	18.32	23.21	27.04	41.01	46.93	54.64	69.46
	0:45:00	0.00	0.00	15.12	19.59	23.06	35.54	40.67	48.72	61.92
	0:50:00	0.00	0.00	12.55	16.70	19.35	31.24	35.74	42.62	54.13
	0:55:00	0.00	0.00	10.79	14.34	16.81	25.89	29.63	36.24	46.07
	1:00:00	0.00	0.00	9.57	12.66	15.05	22.08	25.29	31.77	40.42
	1:05:00	0.00	0.00	8.51	11.22	13.48	19.30	22.12	28.59	36.37
	1:10:00	0.00	0.00	7.04	9.85	11.97	16.19	18.54	23.24	29.59
	1:15:00	0.00	0.00	5.74	8.32	10.66	13.47	15.40	18.62	23.74
	1:20:00	0.00	0.00	4.81	6.99	9.18	10.70	12.23	14.02	17.85
	1:25:00	0.00	0.00	4.32	6.27	7.90	8.64	9.88	10.53	13.43
	1:30:00	0.00	0.00	4.07	5.88	7.06	7.15	8.16	8.41	10.72
	1:35:00	0.00	0.00	3.93	5.61	6.49	6.18	7.03	7.11	9.07
	1:40:00	0.00	0.00	3.85	5.03	6.07	5.55	6.29	6.23	7.94
	1:45:00	0.00	0.00	3.78	4.57	5.78	5.11	5.79	5.63	7.17
	1:50:00	0.00	0.00	3.73	4.25	5.58	4.83	5.46	5.22	6.64
	1:55:00	0.00	0.00	3.23	4.00	5.28	4.63	5.22	4.93	6.26
	2:00:00	0.00	0.00	2.83	3.70	4.77	4.50	5.07	4.76	6.06
	2:05:00	0.00	0.00	2.09	2.72	3.48	3.31	3.73	3.52	4.47
	2:10:00	0.00	0.00	1.49	1.94	2.47	2.36	2.65	2.51	3.19
	2:15:00	0.00	0.00	1.06	1.37	1.75	1.68	1.89	1.80	2.28
	2:20:00	0.00	0.00	0.74	0.95	1.23	1.18	1.32	1.27	1.61
	2:25:00	0.00	0.00	0.50	0.63	0.84	0.80	0.90	0.87	1.10
	2:30:00	0.00	0.00	0.33	0.43	0.57	0.55	0.62	0.60	0.76
	2:35:00	0.00	0.00	0.20	0.28	0.36	0.36	0.41	0.39	0.49
	2:40:00	0.00	0.00	0.11	0.16	0.20	0.21	0.24	0.23	0.29
	2:45:00	0.00	0.00	0.04	0.07	0.09	0.10	0.11	0.11	0.14
	2:50:00	0.00	0.00	0.01	0.02	0.03	0.03	0.03	0.03	0.04
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.02 (February 2020)

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]
Top of Micrpool	0.00	163	0.004	0	0.000	0.00
ISV	0.40	163	0.004	65	0.001	0.05
	0.60	163	0.004	98	0.002	0.06
	1.20	3,150	0.072	552	0.013	0.08
Floor	1.73	17,358	0.398	5,483	0.126	0.10
	2.00	17,809	0.409	10,231	0.235	0.10
	2.40	18,488	0.424	17,490	0.402	0.24
Zone 1	2.63	18,883	0.433	21,787	0.500	0.28
	3.00	19,527	0.448	28,893	0.663	0.33
	3.60	20,592	0.473	40,927	0.940	0.55
	4.00	21,316	0.489	49,309	1.132	0.73
	4.80	22,800	0.523	66,952	1.537	0.97
Zone 2	5.06	23,292	0.535	72,944	1.675	1.03
	5.40	23,943	0.550	80,974	1.859	1.11
	6.00	25,112	0.576	95,689	2.197	1.23
Zone 3	6.53	26,166	0.601	109,276	2.509	1.33
	6.60	26,306	0.604	111,113	2.551	1.84
	7.20	27,527	0.632	127,261	2.922	8.82
	7.80	28,773	0.661	144,150	3.309	9.12
	8.40	30,046	0.690	161,795	3.714	9.40

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).

POND DESIGN & ANALYSIS

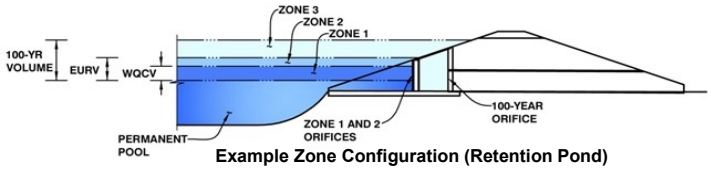
Proposed Pond A

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.02 (February 2020)

Project: **Waterview North**

Basin ID: **Proposed Pond A**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	10.00	acres
Watershed Length =	833	ft
Watershed Length to Centroid =	335	ft
Watershed Slope =	0.083	ft/ft
Watershed Imperviousness =	91.70%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

Steep Slope > 0.06 ft/ft

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.347	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	1.029	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.818	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	1.062	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	1.260	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	1.465	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	1.666	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	1.887	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	2.386	acre-feet		inches
Approximate 2-yr Detention Volume =	0.827	acre-feet		
Approximate 5-yr Detention Volume =	1.077	acre-feet		
Approximate 10-yr Detention Volume =	1.317	acre-feet		
Approximate 25-yr Detention Volume =	1.411	acre-feet		
Approximate 50-yr Detention Volume =	1.464	acre-feet		
Approximate 100-yr Detention Volume =	1.517	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.347	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.682	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.488	acre-feet
Total Detention Basin Volume =	1.517	acre-feet
Initial Surcharge Volume (ISV) =	60	ft^3
Initial Surcharge Depth (ISD) =	0.33	ft
Total Available Detention Depth (H_{total}) =	7.00	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.005	ft/ft
Slopes of Main Basin Sides (S_{main}) =	3	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	2.5	

Initial Surcharge Area (A_{ISV}) =	182	ft^2
Surcharge Volume Length (L_{ISV}) =	13.5	ft
Surcharge Volume Width (W_{ISV}) =	13.5	ft
Depth of Basin Floor (H_{FLOOR}) =	0.58	ft
Length of Basin Floor (L_{FLOOR}) =	131.2	ft
Width of Basin Floor (W_{FLOOR}) =	59.9	ft
Area of Basin Floor (A_{FLOOR}) =	7,858	ft^2
Volume of Basin Floor (V_{FLOOR}) =	1,786	ft^3
Depth of Main Basin (H_{MAIN}) =	5.59	ft
Length of Main Basin (L_{MAIN}) =	164.8	ft
Width of Main Basin (W_{MAIN}) =	93.4	ft
Area of Main Basin (A_{MAIN}) =	15,393	ft^2
Volume of Main Basin (V_{MAIN}) =	63,818	ft^3
Calculated Total Basin Volume (V_{total}) =	**1.510**	acre-feet

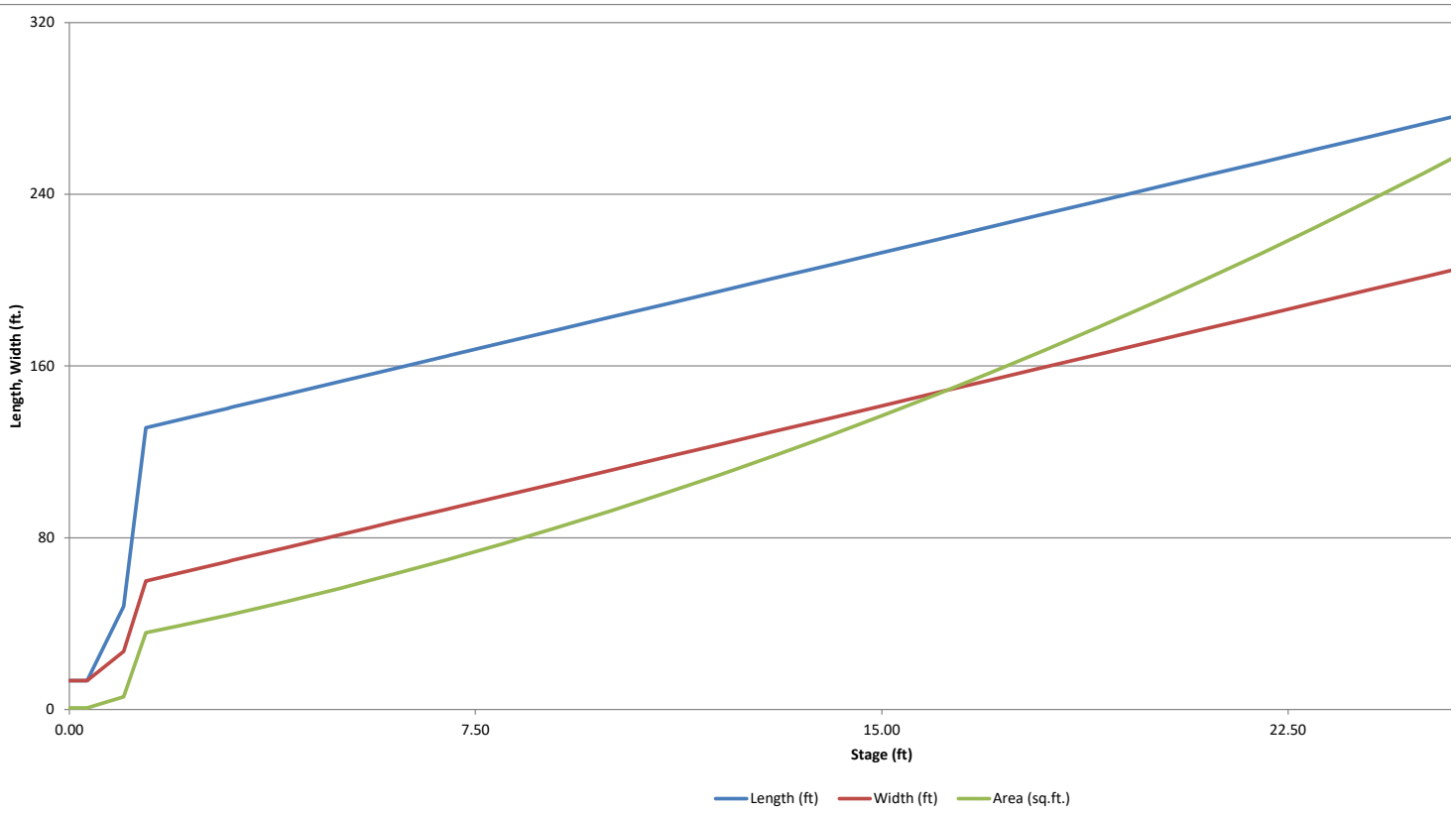
Depth Increment = 1.00 ft

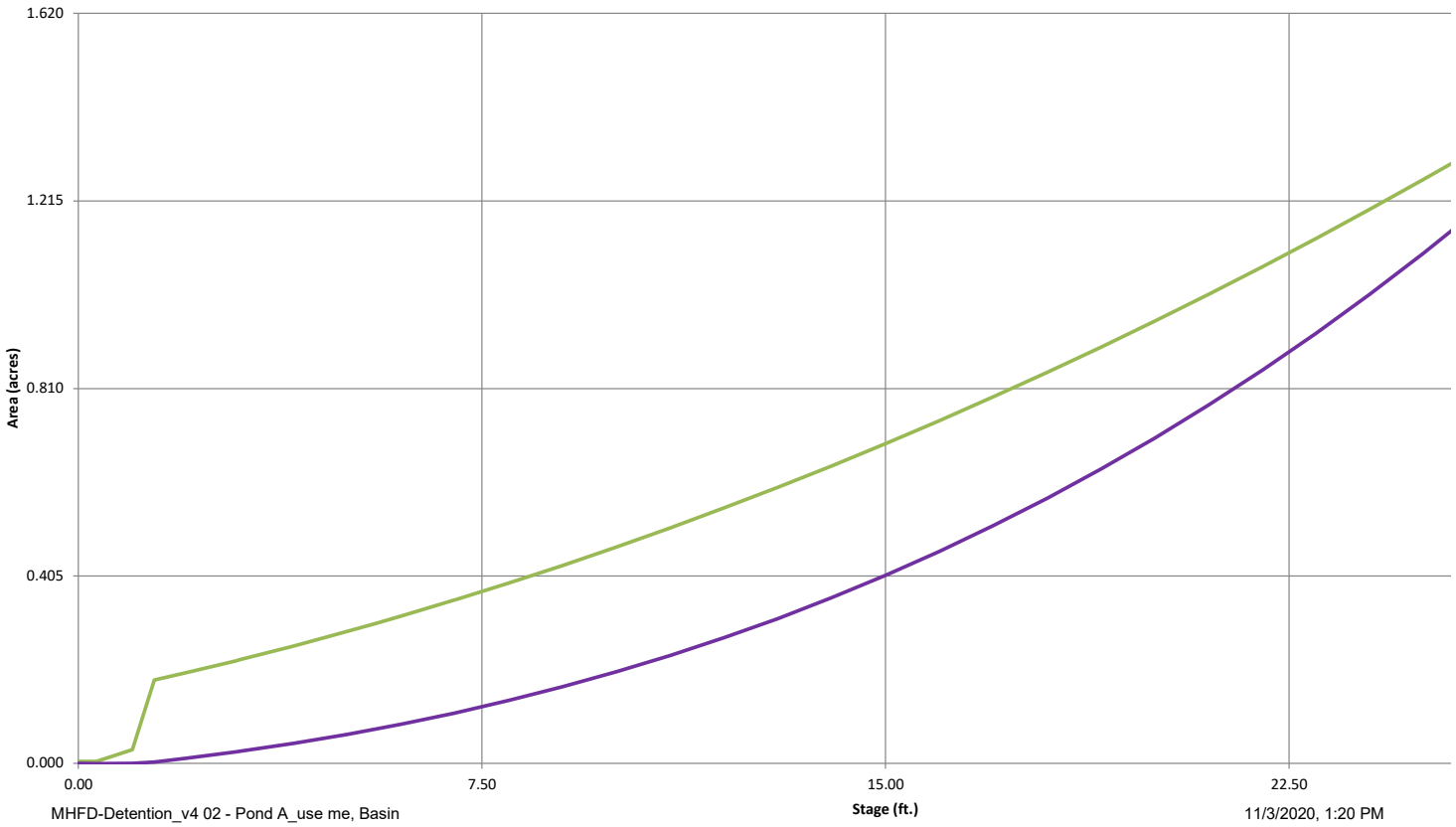
Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)
Top of Micropool	0.00		13.5	13.5	182	
ISV	0.33		13.5	13.5	182	
	1.00		48.0	27.1	1,300	
Floor	1.41		131.2	59.9	7,858	
	2.00		134.8	63.4	8,547	
Zone 1 (WQCV)	2.92		140.3	68.9	9,672	
	3.00		140.8	69.4	9,772	
	4.00		146.8	75.4	11,070	
	5.00		152.8	81.4	12,439	
Zone 2 (EURV)	5.53		155.9	84.6	13,193	
	6.00		158.8	87.4	13,880	
	7.00		164.8	93.4	15,393	
Zone 3 (100-year)	7.02		164.9	93.5	15,424	
	8.00		170.8	99.4	16,978	
	9.00		176.8	105.4	18,635	
	10.00		182.8	111.4	20,364	
	11.00		188.8	117.4	22,165	
	12.00		194.8	123.4	24,039	
	13.00		200.8	129.4	25,984	
	14.00		206.8	135.4	28,001	
	15.00		212.8	141.4	30,090	
	16.00		218.8	147.4	32,251	
	17.00		224.8	153.4	34,484	
	18.00		230.8	159.4	36,789	
	19.00		236.8	165.4	39,166	
	20.00		242.8	171.4	41,616	
	21.00		248.8	177.4	44,137	
	22.00		254.8	183.4	46,730	
	23.00		260.8	189.4	49,395	
	24.00		266.8	195.4	52,132	
	25.00		272.8	201.4	54,941	
	26.00		278.8	207.4	57,822	
	27.00		284.8	213.4	60,775	
	28.00		290.8	219.4	63,801	
	29.00		296.8	225.4	66,898	
	30.00		302.8	231.4	70,067	

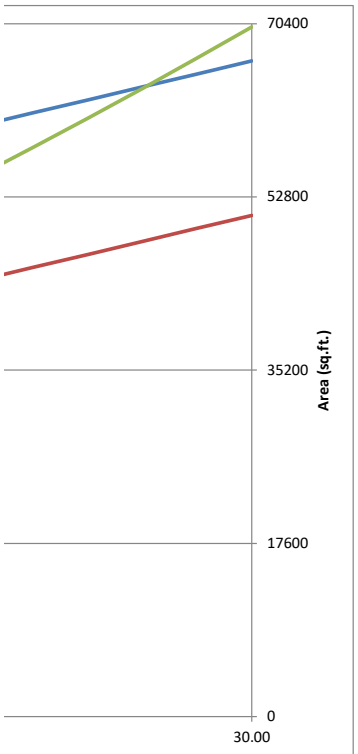
Area (acre)	Volume (ft^3)	Volume (ac-ft)
0.004		
0.004	60	0.001
0.030	264	0.006
0.180	1,954	0.045
0.196	6,793	0.156
0.222	15,169	0.348
0.224	15,947	0.366
0.254	26,362	0.605
0.286	38,110	0.875
0.303	44,901	1.031
0.319	51,263	1.177
0.353	65,893	1.513
0.354	66,201	1.520
0.390	82,073	1.884
0.428	99,873	2.293
0.467	119,367	2.740
0.509	140,626	3.228
0.552	163,722	3.759
0.597	188,727	4.333
0.643	215,713	4.952
0.691	244,753	5.619
0.740	275,917	6.334
0.792	309,279	7.100
0.845	344,910	7.918
0.899	382,881	8.790
0.955	423,266	9.717
1.013	466,137	10.701
1.073	511,564	11.744
1.134	559,620	12.847
1.197	610,378	14.012
1.261	663,908	15.241
1.327	720,284	16.535
1.395	779,577	17.897
1.465	841,859	19.326
1.536	907,202	20.826
1.609	975,679	22.398

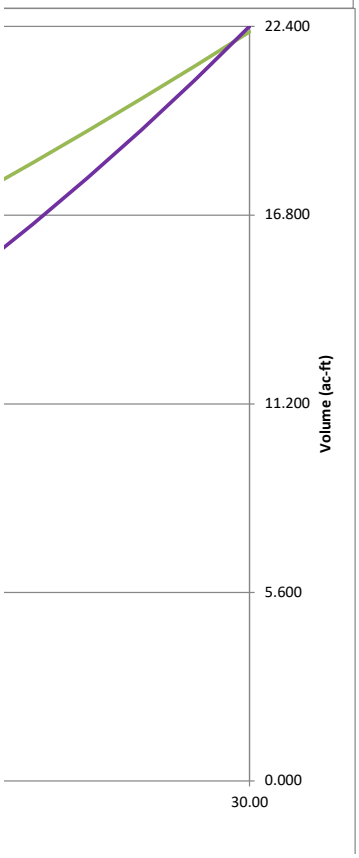
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.02 (February 2020)






70400
52800
35200
17600
0
Area (sq.ft.)
30.00

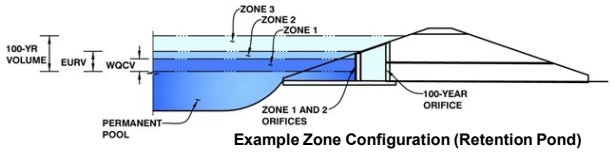

22.400
16.800
11.200
5.600
0.000
Volume (ac-ft)
30.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.02 (February 2020)

Project: Waterview North

Basin ID: Proposed Pond A



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.92	0.347	Orifice Plate
Zone 2 (EURV)	5.53	0.682	Orifice Plate
Zone 3 (100-year)	7.02	0.488	Weir&Pipe (Restrict)
Total (all zones)		1.517	

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

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

Underdrain Orifice Diameter = inches

Calculated Parameters for Underdrain

Underdrain Orifice Area = ft^2

Underdrain Orifice Centroid = feet

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

Invert of Lowest Orifice = 0.00 ft (relative to basin bottom at Stage = 0 ft)

Depth at top of Zone using Orifice Plate = 5.30 ft (relative to basin bottom at Stage = 0 ft)

Orifice Plate: Orifice Vertical Spacing = N/A inches

Orifice Plate: Orifice Area per Row = N/A 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 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.50	2.25	3.00	4.00			
Orifice Area (sq. inches)	1.45	1.80	2.00	3.00	4.00			

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orif

	Not Selected	Not Selected
Vertical Orifice Area =	N/A	N/A
Vertical Orifice Centroid =	N/A	N/A

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	5.30	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	8.00	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V
Horiz. Length of Weir Sides =	3.50	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	0%	N/A	%

Calculated Parameters for Overflow W

	Zone 3 Weir	Not Selected
Height of Grate Upper Edge, H_t =	6.18	N/A
Overflow Weir Slope Length =	3.61	N/A
Grate Open Area / 100-yr Orifice Area =	15.16	N/A
Overflow Grate Open Area w/o Debris =	20.20	N/A
Overflow Grate Open Area w/ Debris =	20.20	N/A

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 =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	12.70		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Pla

	Zone 3 Restrictor	Not Selected
Outlet Orifice Area =	1.33	N/A
Outlet Orifice Centroid =	0.59	N/A
Half-Central Angle of Restrictor Plate on Pipe =	1.99	N/A

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage= 6.20 ft (relative to basin bottom at Stage = 0 ft)

Spillway Crest Length = 16.00 feet

Spillway End Slopes = 3.00 H:V

Freeboard above Max Water Surface = 1.00 feet

Calculated Parameters for Spillway

Spillway Design Flow Depth= 0.89 feet

Stage at Top of Freeboard = 8.09 feet

Basin Area at Top of Freeboard = 0.39 acres

Basin Volume at Top of Freeboard = 1.92 acre-ft

Routed Hydrograph Results

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

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52
CUHP Runoff Volume (acre-ft) =	0.347	1.029	0.818	1.062	1.260	1.465	1.666	1.887
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.818	1.062	1.260	1.465	1.666	1.887
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.7	4.7	7.2	12.2	15.2	19.0
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A						
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.17	0.47	0.72	1.22	1.52	1.90
Peak Inflow Q (cfs) =	N/A	N/A	20.7	26.6	31.4	37.0	42.0	46.5
Peak Outflow Q (cfs) =	0.2	3.0	0.5	0.9	3.2	6.3	10.4	17.0
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	0.4	0.5	0.7	0.9
Structure Controlling Flow =	Plate	Overflow Weir 1	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1
Max Velocity through Grate 1 (fps) =	N/A	0.16	N/A	0.0	0.1	0.3	0.5	0.8
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	53	52	54	53	52	51	49
Time to Drain 99% of Inflow Volume (hours) =	**40**	58	55	59	59	59	58	58
Maximum Ponding Depth (ft) =	2.92	5.53	4.57	5.35	5.50	5.63	5.76	5.92
Area at Maximum Ponding Depth (acres) =	0.22	0.30	0.27	0.30	0.30	0.31	0.31	0.32
Maximum Volume Stored (acre-ft) =	0.348	1.031	0.752	0.974	1.019	1.058	1.098	1.151

ice

ft^2
feet

eir

feet
feet

ft^2
ft^2

ate

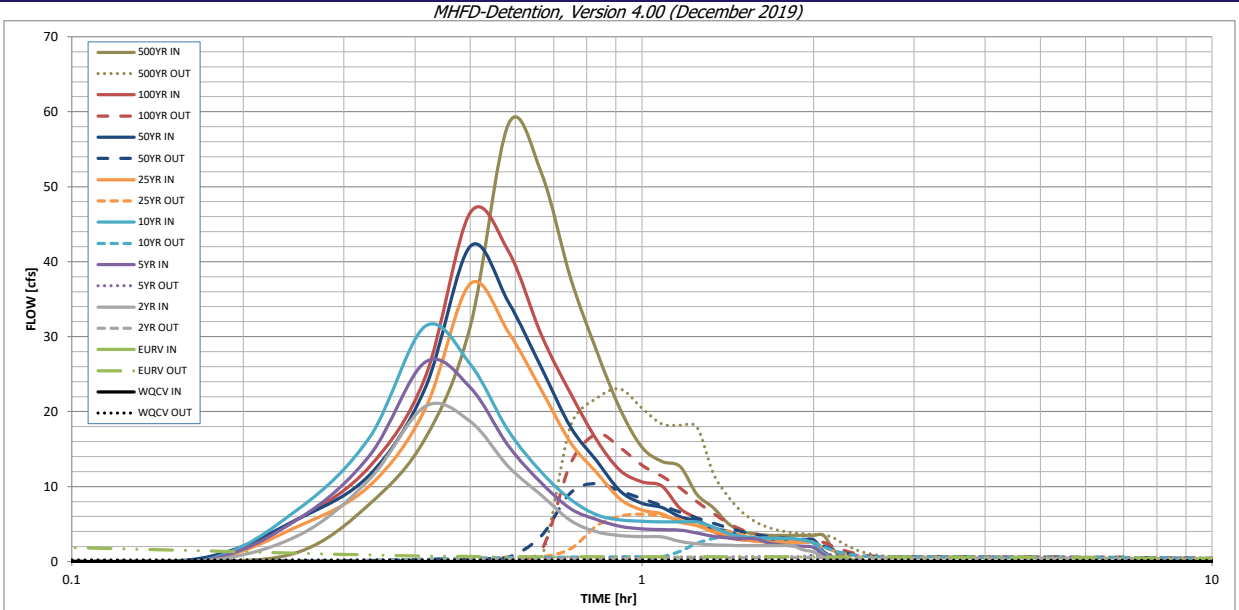
ft^2
feet
radians

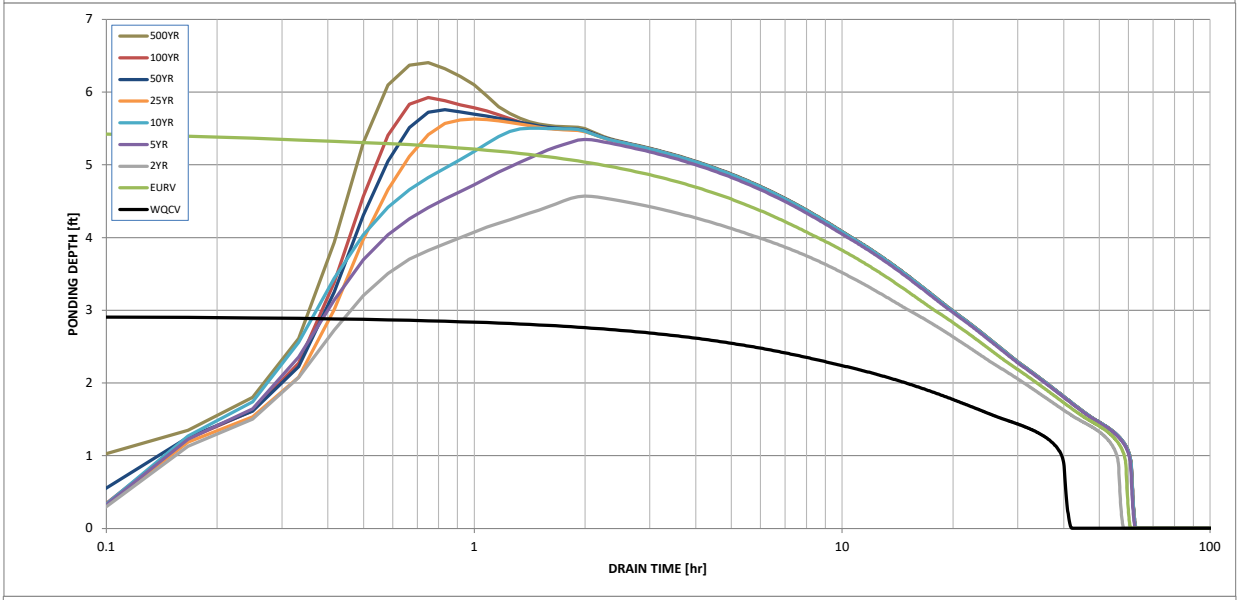
5).

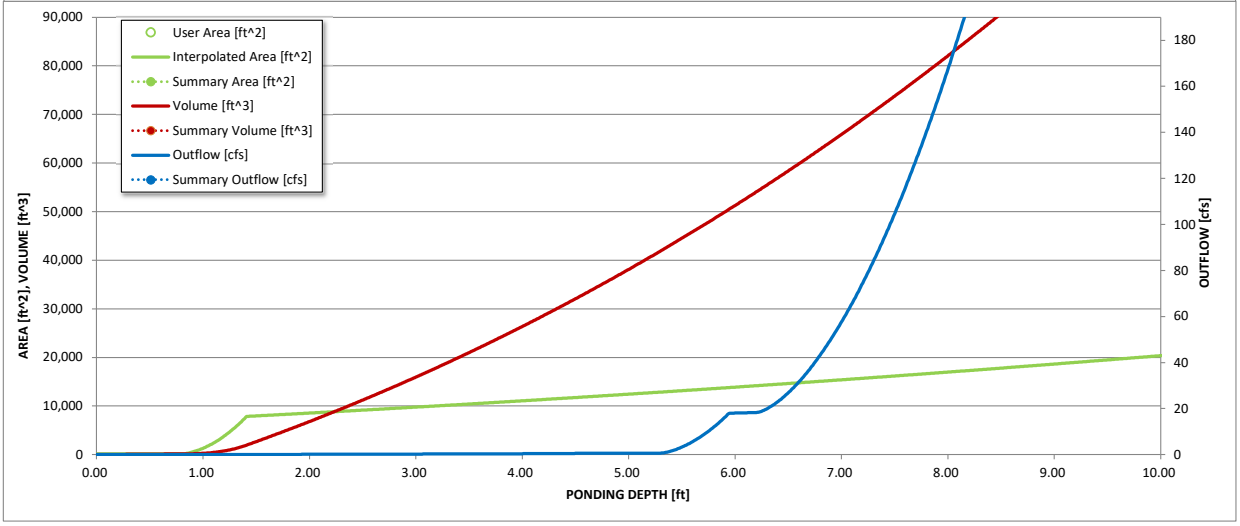
500 Year
3.14
2.386
2.386
26.5
2.65
58.4
23.0
0.9
Spillway
0.9
N/A
47
57
6.40
0.33
1.307

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.39	0.04	1.26
	0:15:00	0.00	0.00	3.51	5.71	7.05	4.73	5.73	5.73	7.72
	0:20:00	0.00	0.00	11.06	14.20	16.66	10.14	11.60	12.72	16.37
	0:25:00	0.00	0.00	20.69	26.59	31.35	20.31	23.11	24.56	31.32
	0:30:00	0.00	0.00	18.68	23.22	26.33	37.05	42.03	46.54	58.37
	0:35:00	0.00	0.00	12.65	15.39	17.42	30.57	34.59	41.36	51.78
	0:40:00	0.00	0.00	8.85	10.46	11.91	22.84	25.81	30.18	37.78
	0:45:00	0.00	0.00	5.45	7.02	8.27	15.84	17.90	22.39	28.02
	0:50:00	0.00	0.00	3.95	5.57	6.21	11.84	13.38	16.18	20.26
	0:55:00	0.00	0.00	3.47	4.69	5.57	8.31	9.40	12.13	15.22
	1:00:00	0.00	0.00	3.31	4.37	5.36	6.87	7.78	10.63	13.36
	1:05:00	0.00	0.00	3.28	4.25	5.29	6.37	7.22	10.08	12.67
	1:10:00	0.00	0.00	2.67	4.19	5.28	5.25	5.96	7.07	8.92
	1:15:00	0.00	0.00	2.37	3.79	5.28	4.79	5.43	5.70	7.21
	1:20:00	0.00	0.00	2.24	3.36	4.62	3.96	4.49	4.03	5.09
	1:25:00	0.00	0.00	2.16	3.16	3.75	3.56	4.03	3.19	4.03
	1:30:00	0.00	0.00	2.15	3.07	3.34	2.98	3.37	2.90	3.66
	1:35:00	0.00	0.00	2.15	3.03	3.14	2.70	3.06	2.78	3.50
	1:40:00	0.00	0.00	2.15	2.48	3.06	2.60	2.94	2.76	3.48
	1:45:00	0.00	0.00	2.15	2.22	3.05	2.55	2.89	2.76	3.48
	1:50:00	0.00	0.00	2.15	2.11	3.05	2.54	2.88	2.76	3.48
	1:55:00	0.00	0.00	1.56	2.04	2.86	2.54	2.88	2.76	3.48
	2:00:00	0.00	0.00	1.28	1.88	2.42	2.54	2.88	2.76	3.48
	2:05:00	0.00	0.00	0.57	0.85	1.09	1.15	1.31	1.25	1.58
	2:10:00	0.00	0.00	0.22	0.36	0.45	0.49	0.56	0.53	0.67
	2:15:00	0.00	0.00	0.08	0.14	0.16	0.19	0.22	0.21	0.26
	2:20:00	0.00	0.00	0.01	0.02	0.02	0.03	0.03	0.03	0.04
	2:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.02 (February 2020)

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]

POND DESIGN & ANALYSIS

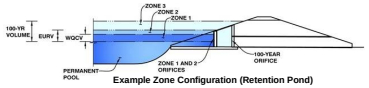
Proposed Pond JCD-D

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.02 (February 2020)

Project: Waterview North

Basin ID: Pond JCD-D



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB		
Watershed Area =	81.81	acres	
Watershed Length =	2,950	ft	
Watershed Length to Centroid =	1,574	ft	
Watershed Slope =	0.040	ft/ft	
Watershed Imperviousness =	81.80%	percent	
Percentage Hydrologic Soil Group A =	0.0%	percent	
Percentage Hydrologic Soil Group B =	100.0%	percent	
Percentage Hydrologic Soil Groups C/D =	0.0%	percent	
Target WQCV Drain Time =	40.0	hours	
Location for 1-hr Rainfall Depths =	User Input		

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	2.317	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	7.441	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	6.656	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	8.777	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	10.527	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	12.444	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	14.246	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	16.293	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	20.810	acre-feet		inches
Approximate 2-yr Detention Volume =	5.909	acre-feet		
Approximate 5-yr Detention Volume =	7.772	acre-feet		
Approximate 10-yr Detention Volume =	9.624	acre-feet		
Approximate 25-yr Detention Volume =	10.312	acre-feet		
Approximate 50-yr Detention Volume =	10.710	acre-feet		
Approximate 100-yr Detention Volume =	11.254	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	2.317	acre-feet
Zone 2 Volume (EURV - Zone 1) =	5.124	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	3.812	acre-feet
Total Detention Basin Volume =	11.254	acre-feet
Initial Surcharge Volume (ISV) =	303	ft^3
Initial Surcharge Depth (ISD) =	0.40	ft
Total Available Detention Depth (H_{total}) =	8.00	ft
Depth of Trickle Channel (H_{TC}) =	0.50	ft
Slope of Trickle Channel (S_{TC}) =	0.005	ft/ft
Slopes of Main Basin Sides (S_{main}) =	3	H:V
Basin Length-to-Width Ratio (R_{LW}) =	2	
Initial Surcharge Area (A_{ISV}) =	757	ft^2
Surcharge Volume Length (L_{ISV}) =	27.5	ft
Surcharge Volume Width (W_{ISV}) =	27.5	ft
Depth of Basin Floor (H_{FLOOR}) =	1.69	ft
Length of Basin Floor (L_{FLOOR}) =	370.6	ft
Width of Basin Floor (W_{FLOOR}) =	196.5	ft
Area of Basin Floor (A_{FLOOR}) =	72,824	ft^2
Volume of Basin Floor (V_{FLOOR}) =	45,633	ft^3
Depth of Main Basin (H_{MAIN}) =	5.41	ft
Length of Main Basin (L_{MAIN}) =	403.0	ft
Width of Main Basin (W_{MAIN}) =	229.0	ft
Area of Main Basin (A_{MAIN}) =	92,286	ft^2
Volume of Main Basin (V_{MAIN}) =	445,586	ft^3
Calculated Total Basin Volume (V_{total}) =	**11.292**	acre-feet

Depth Increment = 1.00 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		27.5	27.5	757		0.017		
ISV	0.40		27.5	27.5	757		0.017	303	0.007
	1.00		47.8	37.5	1,794		0.041	805	0.018
	2.00		250.8	137.5	34,490		0.792	15,564	0.357
Floor	2.59		370.6	196.5	72,824		1.672	46,527	1.068
	3.00		373.0	199.0	74,226		1.704	76,672	1.760
Zone 1 (WQCV)	3.33		375.0	201.0	75,362		1.730	101,353	2.327
	4.00		379.0	205.0	77,694		1.784	152,625	3.504
	5.00		385.0	211.0	81,234		1.865	232,083	5.328
	6.00		391.0	217.0	84,846		1.948	315,117	7.234
Zone 2 (EURV)	6.11		391.7	217.6	85,248		1.957	324,472	7.449
	7.00		397.0	223.0	88,530		2.032	401,799	9.224
Zone 3 (100-year)	7.98		402.9	228.9	92,210		2.117	490,356	11.257
	8.00		403.0	229.0	92,286		2.119	492,201	11.299
	9.00		409.0	235.0	96,114		2.206	586,395	13.462
	10.00		415.0	241.0	100,014		2.296	684,453	15.713
	11.00		421.0	247.0	103,986		2.387	786,447	18.054
	12.00		427.0	253.0	108,030		2.480	892,450	20.488
	13.00		433.0	259.0	112,147		2.575	1,002,532	23.015
	14.00		439.0	265.0	116,335		2.671	1,116,767	25.637
	15.00		445.0	271.0	120,595		2.768	1,235,226	28.357
	16.00		451.0	277.0	124,927		2.868	1,357,980	31.175
	17.00		457.0	283.0	129,331		2.969	1,485,103	34.093
	18.00		463.0	289.0	133,807		3.072	1,616,666	37.114
	19.00		469.0	295.0	138,355		3.176	1,752,741	40.237
	20.00		475.0	301.0	142,975		3.282	1,893,401	43.466
	21.00		481.0	307.0	147,667		3.390	2,038,716	46.802
	22.00		487.0	313.0	152,431		3.499	2,188,759	50.247
	23.00		493.0	319.0	157,268		3.610	2,343,603	53.802
	24.00		499.0	325.0	162,176		3.723	2,503,318	57.468
	25.00		505.0	331.0	167,156		3.837	2,667,978	61.248
	26.00		511.0	337.0	172,208		3.953	2,837,654	65.144
	27.00		517.0	343.0	177,332		4.071	3,012,418	69.156
	28.00		523.0	349.0	182,528		4.190	3,192,342	73.286
	29.00		529.0	355.0	187,796		4.311	3,377,498	77.537
	30.00		535.0	361.0	193,136		4.434	3,567,958	81.909

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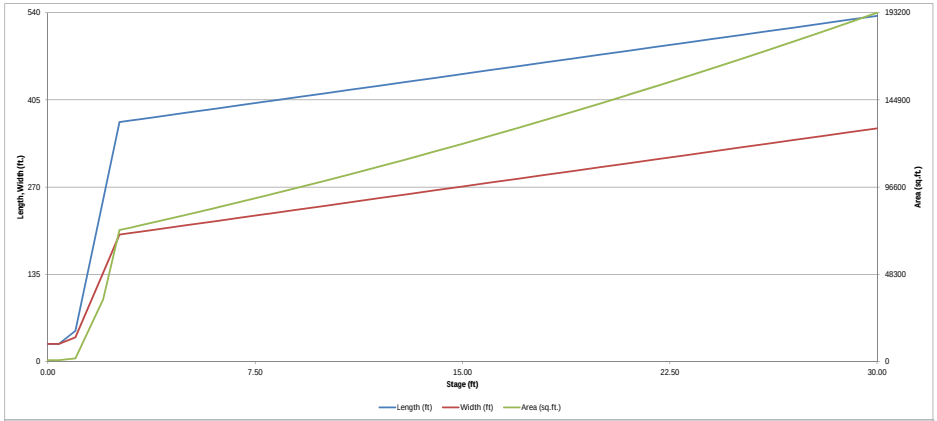
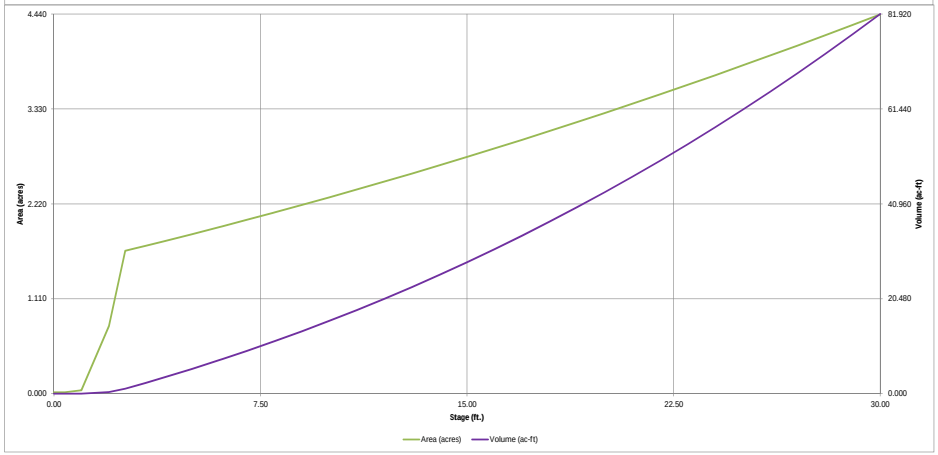
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.02 (February 2020)





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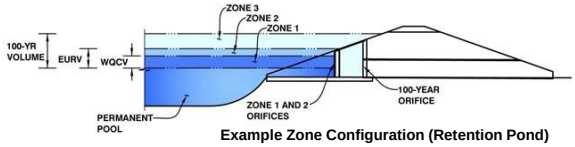
DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.02 (February 2020)

Project: **Waterview North**

Basin ID: **Pond JCD-D**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	3.33	2.317	Orifice Plate
Zone 2 (EURV)	6.11	5.124	Orifice Plate
Zone 3 (100-year)	7.98	3.812	Weir&Pipe (Restrict)
Total (all zones)		11.254	

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 Area =	N/A	ft²
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

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)	WQ Orifice Area per Row =	N/A	ft²
Depth at top of Zone using Orifice Plate =	6.00	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	N/A	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	inches	Elliptical Slot Area =	N/A	ft²

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.50	2.25	3.00	3.75	4.50	5.25	
Orifice Area (sq. inches)	7.20	7.20	7.20	7.20	7.20	7.20	10.00	

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

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected				
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A	N/A ft²
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A feet
Vertical Orifice Diameter =	N/A	N/A	inches			

Calculated Parameters for Vertical Orifice

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

	Zone 3 Weir	Not Selected				
Overflow Weir Front Edge Height, Ho =	6.00	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	7.00	N/A feet
Overflow Weir Front Edge Length =	16.00	N/A	feet	Overflow Weir Slope Length =	4.12	N/A feet
Overflow Weir Grate Slope =	4.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	7.42	N/A
Horiz. Length of Weir Sides =	4.00	N/A	feet	Overflow Grate Open Area w/o Debris =	52.78	N/A ft²
Overflow Grate Open Area % =	80%	N/A	%, grate open area/total area	Overflow Grate Open Area w/ Debris =	52.78	N/A ft²
Debris Clogging % =	0%	N/A	%			

Calculated Parameters for Overflow Weir

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 =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	7.11	N/A ft²
Outlet Pipe Diameter =	42.00	N/A	inches	Outlet Orifice Centroid =	1.36	N/A feet
Restrictor Plate Height Above Pipe Invert =	29.10		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.97	N/A radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	8.52	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.97	feet
Spillway Crest Length =	100.00	feet	Stage at Top of Freeboard =	10.49	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	2.34	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	16.85	acre-ft

Calculated Parameters for Spillway

Routed Hydrograph Results

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

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) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	2.317	7.441	6.656	8.777	10.527	12.444	14.246	16.293	20.810
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	6.656	8.777	10.527	12.444	14.246	16.293	20.810
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	9.0	25.2	38.2	68.3	85.7	108.8	151.7
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.11	0.31	0.47	0.83	1.05	1.33	1.85
Peak Inflow Q (cfs) =	N/A	N/A	123.3	159.8	186.2	225.2	257.4	299.5	379.6
Peak Outflow Q (cfs) =	1.1	4.9	2.6	14.4	29.0	58.5	85.5	100.9	127.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.6	0.8	0.9	1.0	0.9	0.8
Structure Controlling Flow =	Plate	Overflow Weir 1	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	0.04	N/A	0.2	0.5	1.0	1.6	1.8	2.0
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) =	38	66	64	68	66	65	64	63	60
Time to Drain 99% of Inflow Volume (hours) =	**40**	71	69	73	72	72	71	71	69
Maximum Ponding Depth (ft) =	3.33	6.11	5.51	6.31	6.53	6.84	7.08	7.53	8.68
Area at Maximum Ponding Depth (acres) =	1.73	1.96	1.91	1.97	1.99	2.02	2.04	2.08	2.18
Maximum Volume Stored (acre-ft) =	2.327	7.449	6.290	7.842	8.258	8.900	9.367	10.313	12.760

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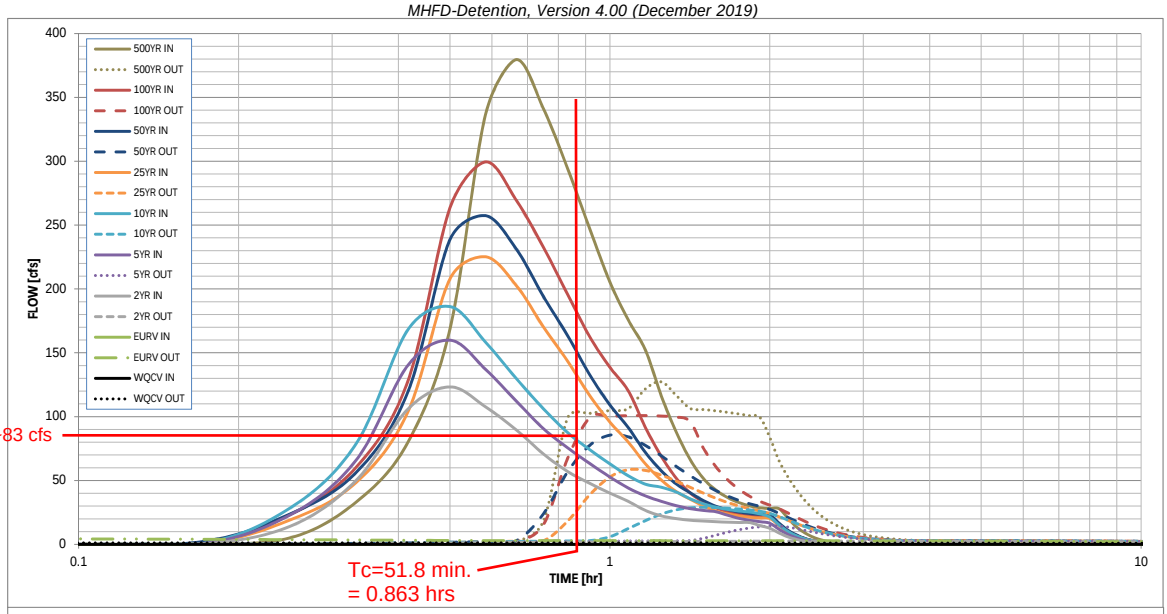
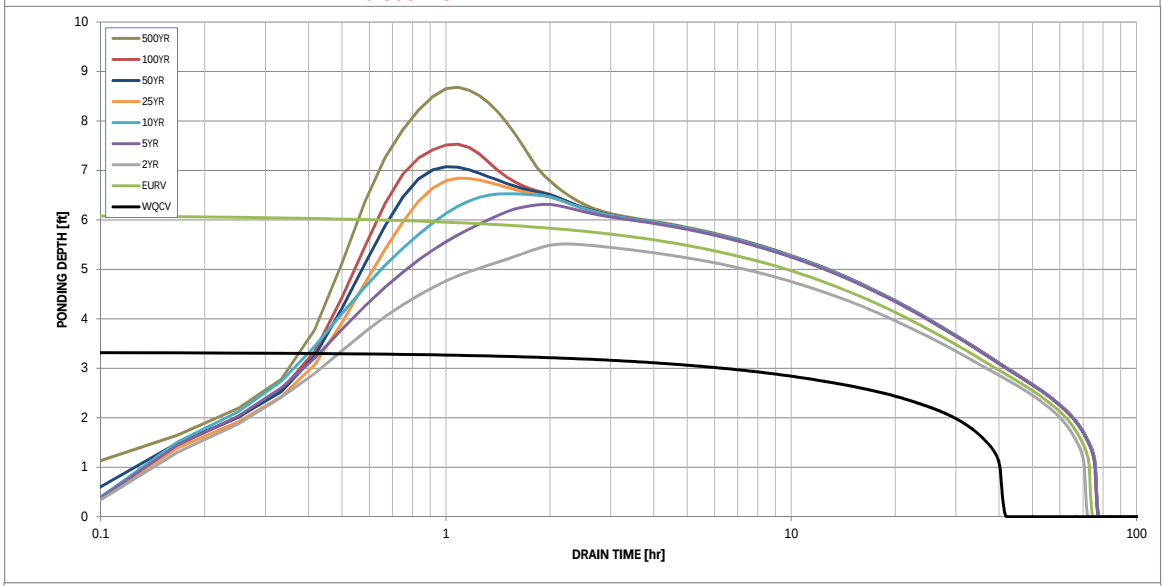
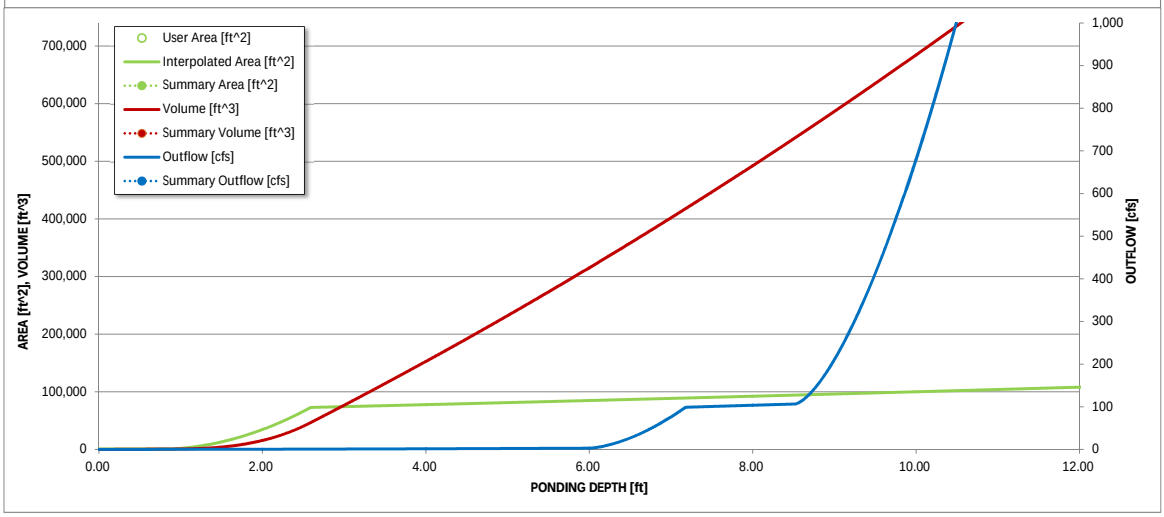
DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)







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

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DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	1.59	0.16	5.10
	0:15:00	0.00	0.00	14.15	23.04	28.48	19.10	23.80	23.23	33.29
	0:20:00	0.00	0.00	50.26	66.23	79.11	48.68	56.50	60.59	79.89
	0:25:00	0.00	0.00	105.91	140.18	168.04	103.66	119.29	127.90	168.58
	0:30:00	0.00	0.00	123.28	159.84	186.20	207.81	238.54	263.41	336.48
	0:35:00	0.00	0.00	107.68	137.06	158.38	225.16	257.38	299.46	379.56
	0:40:00	0.00	0.00	89.60	112.13	129.83	202.69	231.19	269.44	341.03
	0:45:00	0.00	0.00	70.76	90.54	106.18	170.19	194.04	232.50	293.96
	0:50:00	0.00	0.00	56.99	75.53	87.41	143.28	163.24	195.41	247.01
	0:55:00	0.00	0.00	47.78	63.30	74.13	116.43	132.70	162.49	205.52
	1:00:00	0.00	0.00	40.13	52.78	63.03	95.75	109.25	138.74	175.60
	1:05:00	0.00	0.00	33.67	44.13	53.67	80.04	91.39	120.16	152.11
	1:10:00	0.00	0.00	26.55	37.95	47.15	62.99	71.96	91.54	116.20
	1:15:00	0.00	0.00	22.31	33.70	44.73	50.35	57.60	68.88	87.99
	1:20:00	0.00	0.00	20.20	30.32	41.00	41.34	47.29	51.83	66.34
	1:25:00	0.00	0.00	18.91	28.03	35.68	35.34	40.40	40.27	51.59
	1:30:00	0.00	0.00	18.23	26.54	31.75	30.05	34.31	33.19	42.54
	1:35:00	0.00	0.00	17.75	25.57	29.13	26.21	29.89	28.58	36.62
	1:40:00	0.00	0.00	17.40	22.78	27.34	23.87	27.20	25.54	32.72
	1:45:00	0.00	0.00	17.17	20.42	26.13	22.25	25.33	23.52	30.14
	1:50:00	0.00	0.00	17.07	18.85	25.28	21.23	24.16	22.37	28.66
	1:55:00	0.00	0.00	14.71	17.77	23.89	20.66	23.49	21.97	28.12
	2:00:00	0.00	0.00	12.62	16.54	21.45	20.30	23.08	21.79	27.88
	2:05:00	0.00	0.00	8.89	11.73	15.12	14.57	16.56	15.73	20.13
	2:10:00	0.00	0.00	5.81	7.66	9.98	9.59	10.90	10.40	13.30
	2:15:00	0.00	0.00	3.79	4.96	6.55	6.36	7.22	6.89	8.81
	2:20:00	0.00	0.00	2.36	3.09	4.13	4.03	4.58	4.37	5.58
	2:25:00	0.00	0.00	1.39	1.92	2.53	2.52	2.87	2.73	3.49
	2:30:00	0.00	0.00	0.73	1.12	1.42	1.48	1.68	1.61	2.05
	2:35:00	0.00	0.00	0.31	0.53	0.64	0.72	0.81	0.77	0.99
	2:40:00	0.00	0.00	0.10	0.16	0.18	0.22	0.25	0.24	0.30
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.02 (February 2020)

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]

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).

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APPENDIX D

CULVERT ANALYSES

HY-8 Culvert Analysis Report
Ex. 10x6 RCBC Xing under Powers Blvd.

Crossing Discharge Data

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

Minimum Flow: 50 cfs

Design Flow: 98 cfs

Maximum Flow: 250 cfs

Flows at Crossing: Powers Blvd - Ex.10'x6' RCBC

Headwater Elevation (ft)	*Total Discharge (cfs)*	*Culvert 1 Discharge (cfs)*	*Roadway Discharge (cfs)*	*Iterations*
5974.65	*50.00*	*50.00*	*0.00*	*1*
5975.00	*70.00*	*70.00*	*0.00*	*1*
5975.44	*98.00*	*98.00*	*0.00*	*1*
5975.62	*110.00*	*110.00*	*0.00*	*1*
5975.90	*130.00*	*130.00*	*0.00*	*1*
5976.16	*150.00*	*150.00*	*0.00*	*1*
5976.43	*170.00*	*170.00*	*0.00*	*1*
5976.68	*190.00*	*190.00*	*0.00*	*1*
5976.92	*210.00*	*210.00*	*0.00*	*1*
5977.15	*230.00*	*230.00*	*0.00*	*1*
5977.38	*250.00*	*250.00*	*0.00*	*1*
5984.00	*798.03*	*798.03*	*0.00*	*Overtopping*

Rating Curve Plot for Crossing: Powers Blvd - Ex.10'x6' RCBC

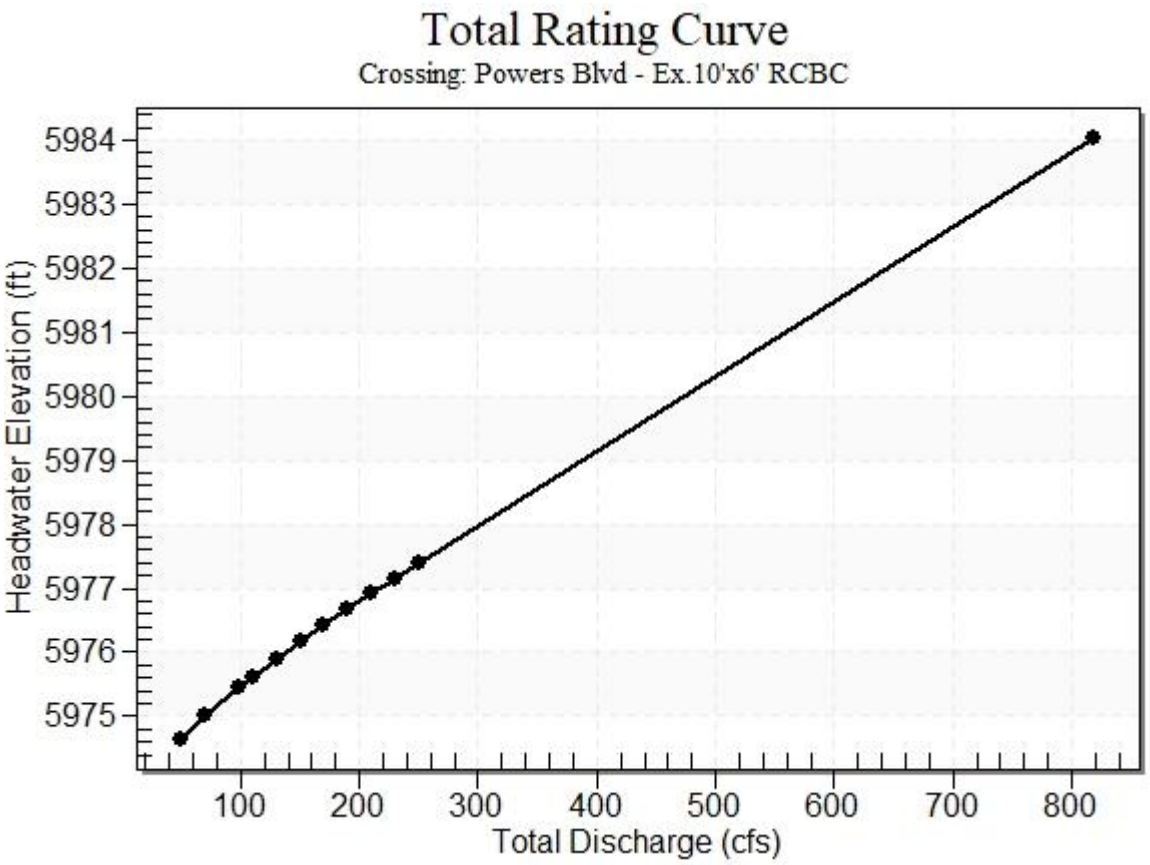
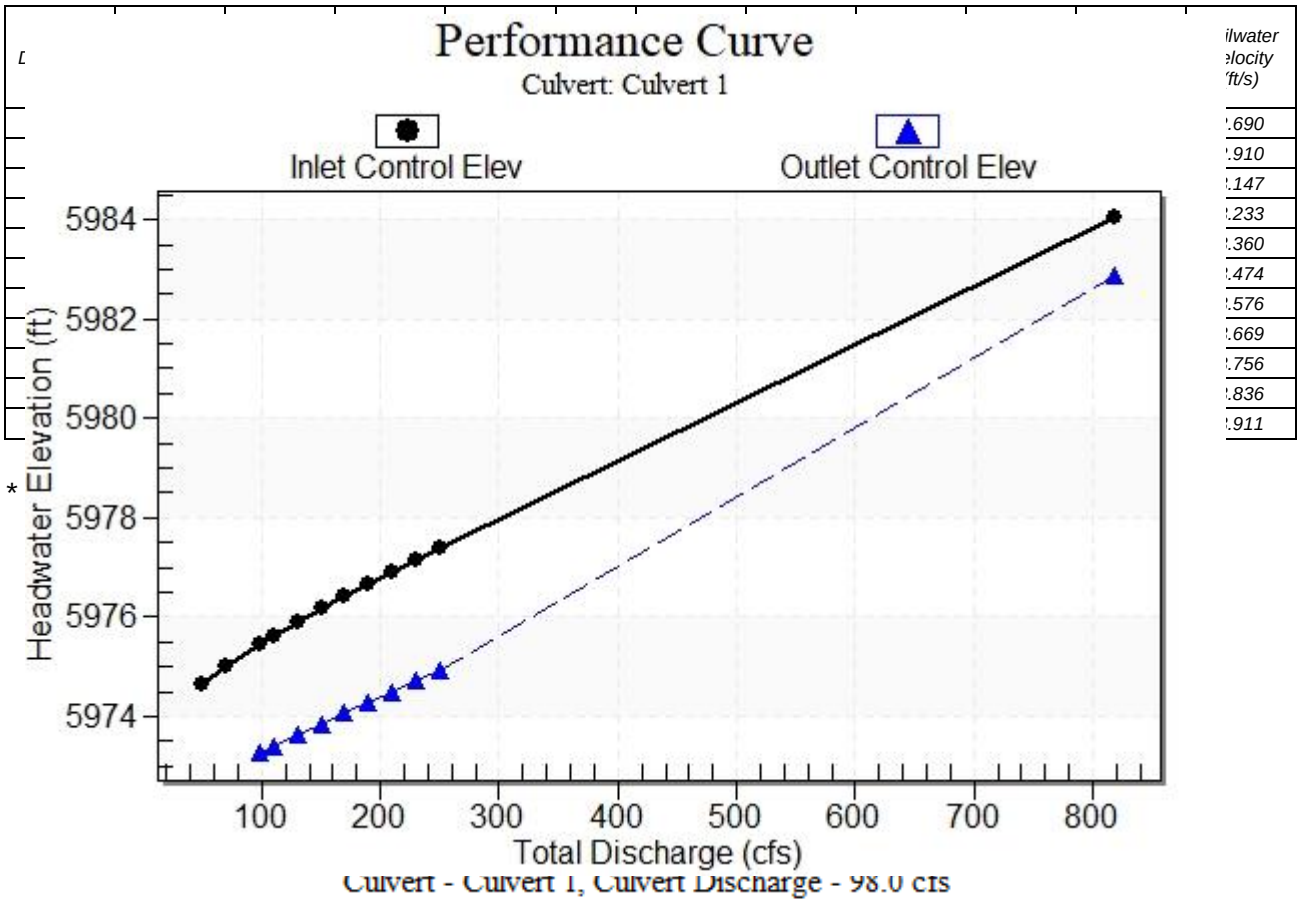
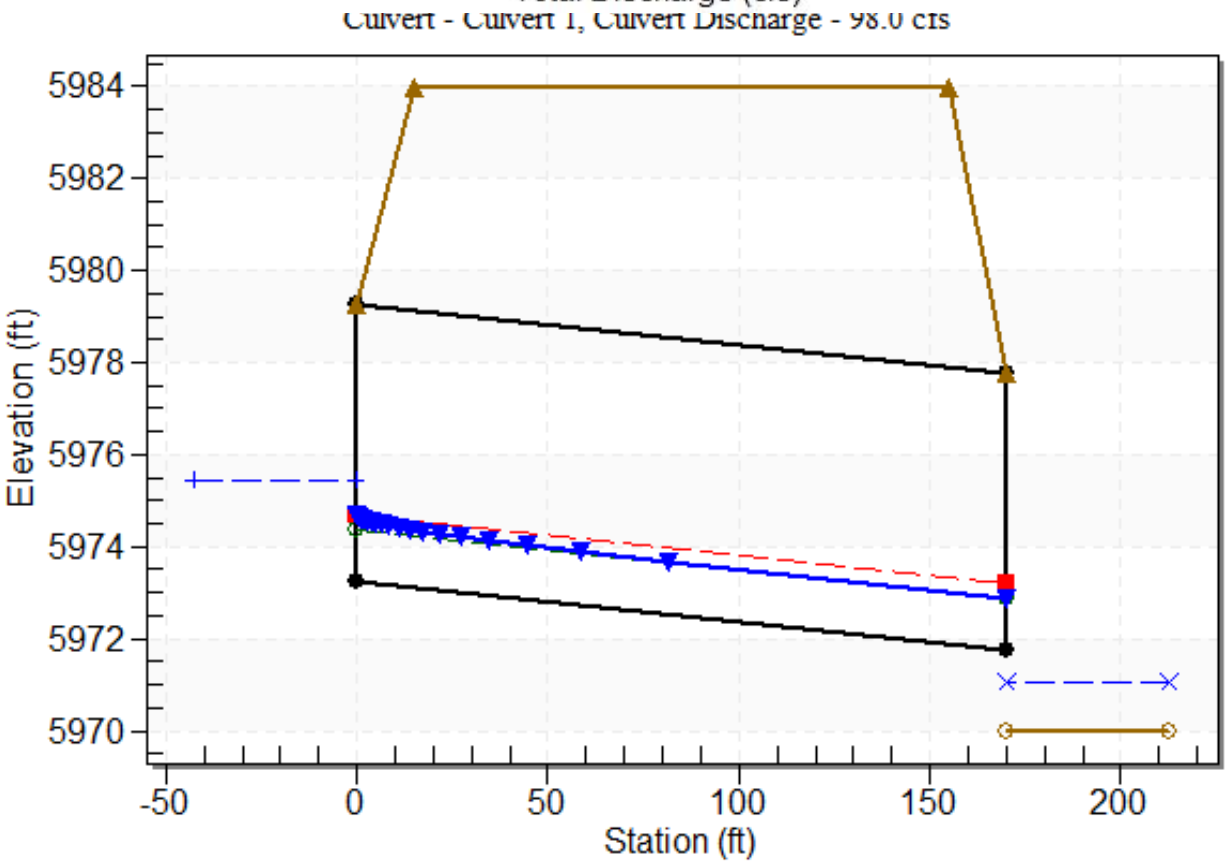


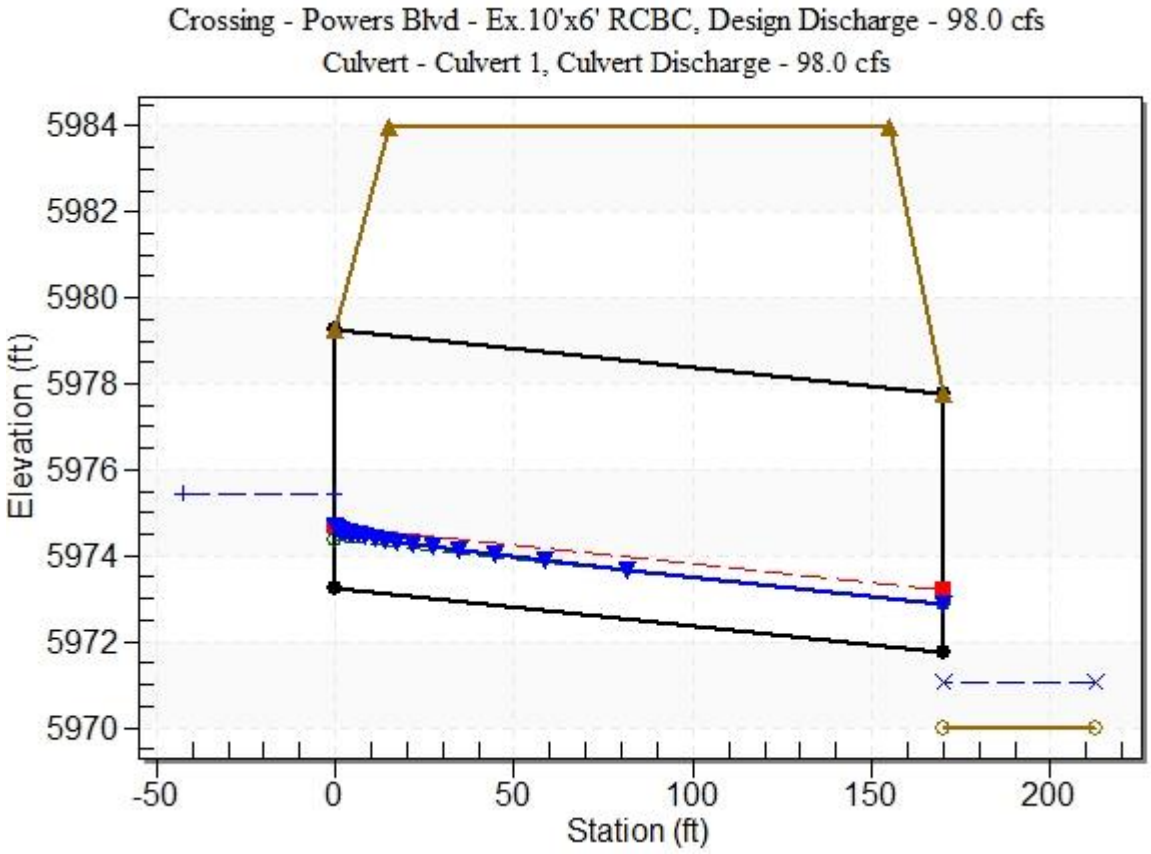
Table 2 - Culvert Summary Table: Culvert 1





Culvert Performance Curve Plot: Culvert 1

Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: *Culvert Invert Data*

Inlet Station: *0.00 ft*

Inlet Elevation: *5973.25 ft*

Outlet Station: *170.00 ft*

Outlet Elevation: *5971.75 ft*

Number of Barrels: *1*

Culvert Data Summary - Culvert 1

Barrel Shape: *Concrete Box*

Barrel Span: *10.00 ft*

Barrel Rise: *6.00 ft*

Barrel Material: *Concrete*

Embedment: *0.00 in*

Barrel Manning's n: *0.0150*

Culvert Type: *Straight*

Inlet Configuration: *Square Edge (30-75º flare) Wingwall*

Inlet Depression: *None*

Table 3 - Downstream Channel Rating Curve (Crossing: Powers Blvd - Ex.10'x6' RCBC)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
50.00	5970.77	0.77	2.69	0.30	0.70
70.00	5970.89	0.89	2.91	0.35	0.71
98.00	5971.04	1.04	3.15	0.41	0.72
110.00	5971.09	1.09	3.23	0.43	0.72
130.00	5971.17	1.17	3.36	0.46	0.72
150.00	5971.25	1.25	3.47	0.49	0.73
170.00	5971.32	1.32	3.58	0.52	0.73
190.00	5971.38	1.38	3.67	0.54	0.73
210.00	5971.44	1.44	3.76	0.57	0.74
230.00	5971.50	1.50	3.84	0.59	0.74
250.00	5971.56	1.56	3.91	0.61	0.74

Tailwater Channel Data - Powers Blvd - Ex.10'x6' RCBC

Tailwater Channel Option: Irregular Channel

Channel Slope: 0.0063

User Defined Channel Cross-Section:

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	5974.00	0.0300
2	112.00	5972.00	0.0300
3	147.00	5970.00	0.0250
4	155.00	5970.00	0.0300
5	205.00	5972.00	0.0300
6	330.00	5974.00	0.0000

Roadway Data for Crossing: Powers Blvd - Ex.10'x6' RCBC

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 510.00 ft

Crest Elevation: 5984.00 ft

Roadway Surface: Paved

Roadway Top Width: 140.00 ft

HY-8 Culvert Analysis Report

Ex. DUAL 42” CMP CULVERT CROSSING
BRADLEY ROAD

Crossing Discharge Data

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

Minimum Flow: 5 cfs

Design Flow: 47 cfs

Maximum Flow: 80 cfs

Table 1 - Summary of Culvert Flows at Crossing: BRADLEY XING DUAL 42 CMP

Headwater Elevation (ft)	*Total Discharge (cfs)*	*Culvert 2 Discharge (cfs)*	*Roadway Discharge (cfs)*	*Iterations*
5924.35	*5.00*	*5.00*	*0.00*	*1*
5924.38	*12.50*	*12.50*	*0.00*	*1*
5924.40	*20.00*	*20.00*	*0.00*	*1*
5924.43	*27.50*	*27.50*	*0.00*	*1*
5924.45	*35.00*	*35.00*	*0.00*	*1*
5924.47	*42.50*	*42.50*	*0.00*	*1*
5924.48	*47.00*	*47.00*	*0.00*	*1*
5924.53	*57.50*	*57.50*	*0.00*	*1*
5924.73	*65.00*	*65.00*	*0.00*	*1*
5924.93	*72.50*	*72.50*	*0.00*	*1*
5925.14	*80.00*	*80.00*	*0.00*	*1*
5930.00	*182.33*	*182.33*	*0.00*	*Overtopping*

Rating Curve Plot for Crossing: BRADLEY XING DUAL 42 CMP

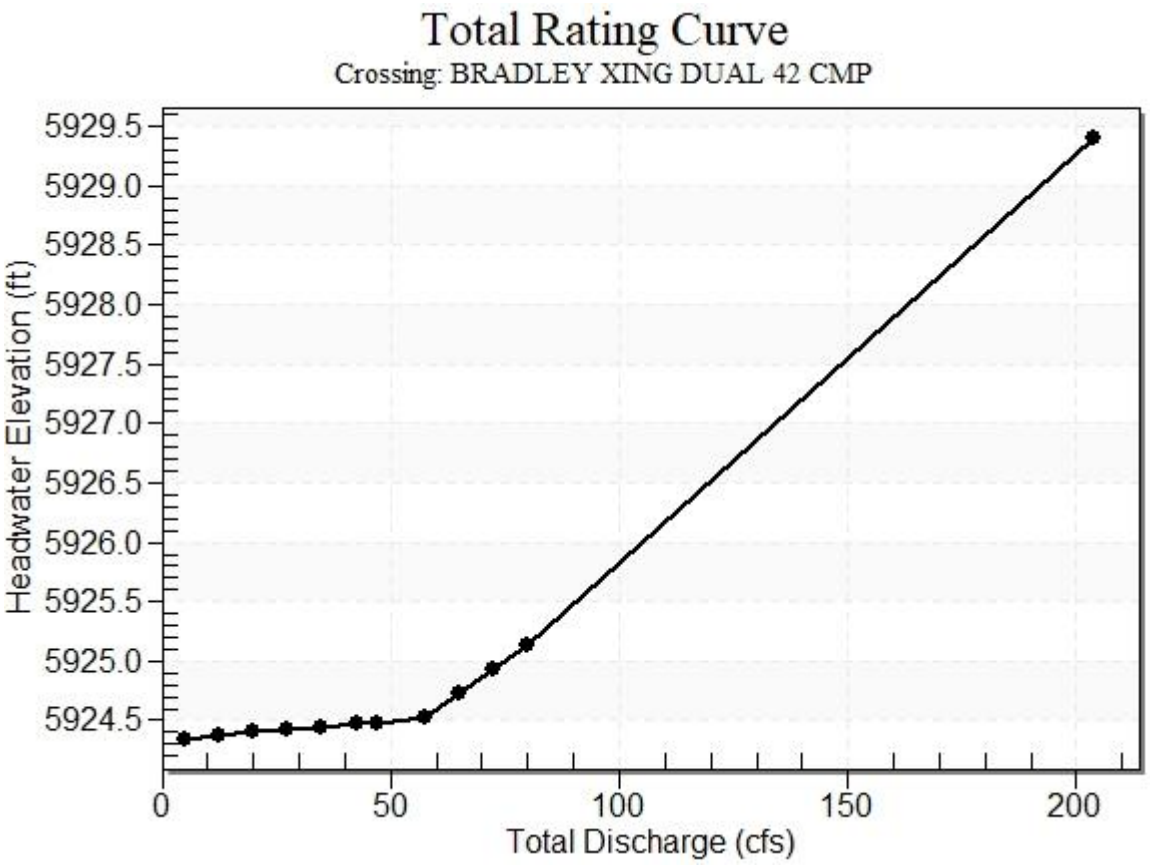


Table 2 - Culvert Summary Table: Culvert 2

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5.00	5.00	5924.35	2.347	0.0*	1-S2n	0.413	0.471	0.413	0.041	3.903	1.210
12.50	12.50	5924.38	2.379	0.0*	1-S2n	0.647	0.752	0.647	0.071	5.108	1.730
20.00	20.00	5924.40	2.405	0.0*	1-S2n	0.817	0.957	0.817	0.093	5.857	2.076
27.50	27.50	5924.43	2.427	0.0*	1-S2n	0.959	1.127	0.959	0.113	6.422	2.345
35.00	35.00	5924.45	2.448	0.0*	1-S2n	1.087	1.277	1.087	0.130	6.874	2.571
42.50	42.50	5924.47	2.467	0.0*	1-S2n	1.203	1.413	1.203	0.146	7.260	2.767
47.00	47.00	5924.48	2.478	0.0*	1-S2n	1.269	1.489	1.269	0.155	7.463	2.874
57.50	57.50	5924.53	2.525	0.0*	1-S2n	1.415	1.655	1.415	0.175	7.884	3.100
65.00	65.00	5924.73	2.730	0.0*	1-S2n	1.515	1.764	1.515	0.188	8.145	3.245
72.50	72.50	5924.93	2.934	0.0*	1-S2n	1.611	1.868	1.611	0.200	8.380	3.381
80.00	80.00	5925.14	3.139	0.0*	1-S2n	1.705	1.967	1.705	0.212	8.594	3.506

** Full Flow Headwater elevation is below inlet invert.*

****

Straight Culvert

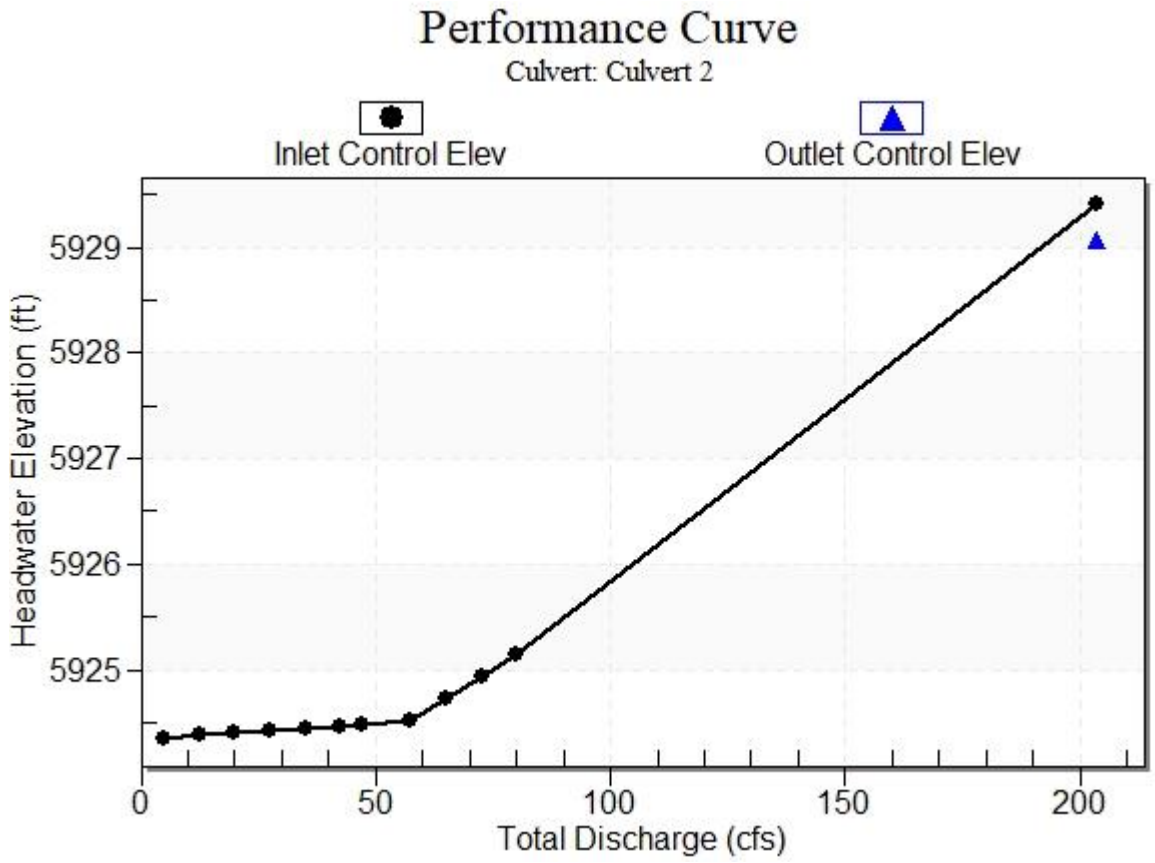
Inlet Elevation (invert): 5922.00 ft, Outlet Elevation (invert): 5918.32 ft

Culvert Length: 157.10 ft, Culvert Slope: 0.0234

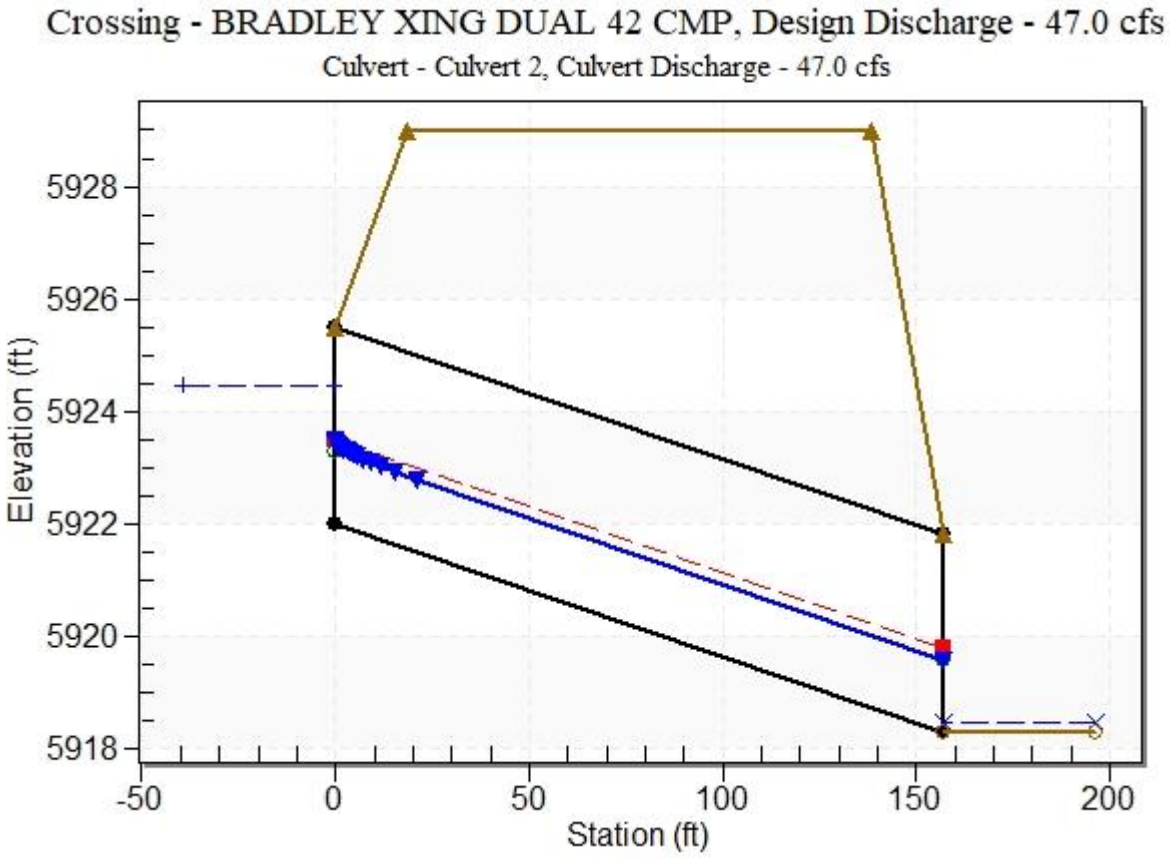
Inlet Throat Elevation: 5922.00 ft, Inlet Crest Elevation: 5924.31 ft

****

Culvert Performance Curve Plot: Culvert 2



Water Surface Profile Plot for Culvert: Culvert 2



Site Data - Culvert 2

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 5924.00 ft

Outlet Station: 157.00 ft

Outlet Elevation: 5918.32 ft

Number of Barrels: 2

Culvert Data Summary - Culvert 2

Barrel Shape: Circular

Barrel Diameter: 3.50 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting

Inlet Depression: Yes

Table 3 - Downstream Channel Rating Curve (Crossing: BRADLEY XING DUAL 42 CMP)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
5.00	5918.36	0.04	1.21	0.08	1.06
12.50	5918.39	0.07	1.73	0.13	1.16
20.00	5918.41	0.09	2.08	0.17	1.22
27.50	5918.43	0.11	2.34	0.21	1.25
35.00	5918.45	0.13	2.57	0.24	1.28
42.50	5918.47	0.15	2.77	0.27	1.31
47.00	5918.48	0.16	2.87	0.29	1.32
57.50	5918.49	0.17	3.10	0.33	1.34
65.00	5918.51	0.19	3.24	0.35	1.36
72.50	5918.52	0.20	3.38	0.38	1.37
80.00	5918.53	0.21	3.51	0.40	1.39

Tailwater Channel Data - BRADLEY XING DUAL 42 CMP

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 100.00 ft

Side Slope (H:V): 35.00 (_:1)

Channel Slope: 0.0300

Channel Manning's n: 0.0250

Channel Invert Elevation: 5918.32 ft

Roadway Data for Crossing: BRADLEY XING DUAL 42 CMP

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Irregular Roadway Cross-Section:

Coord No.	Station (ft)	Elevation (ft)
0	0.00	5929.00
1	60.00	5930.00
2	120.00	5929.00

Roadway Surface: Paved

Roadway Top Width: 120.00 ft

HY-8 Culvert Analysis Report

MODIFIED DUAL 42” CMP CULVERT CROSSING
INTO SLEEVED 24” RCP CULVERT CROSSING
BRADLEY ROAD

Crossing Discharge Data

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

Minimum Flow: 5 cfs

Design Flow: 47 cfs

Maximum Flow: 80 cfs

Table 1 - Summary of Culvert Flows at Crossing: BRADLEY XING DUAL 42 CMP

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 2 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
5924.35	5.00	5.00	0.00	1
5924.38	12.50	12.50	0.00	1
5924.40	20.00	20.00	0.00	1
5924.43	27.50	27.50	0.00	1
5924.45	35.00	35.00	0.00	1
5924.47	42.50	42.50	0.00	1
5924.48	47.00	47.00	0.00	1
5924.53	57.50	57.50	0.00	1
5924.73	65.00	65.00	0.00	1
5924.93	72.50	72.50	0.00	1
5925.14	80.00	80.00	0.00	1
5930.00	182.33	182.33	0.00	Overtopping

Rating Curve Plot for Crossing: BRADLEY XING DUAL 42 CMP

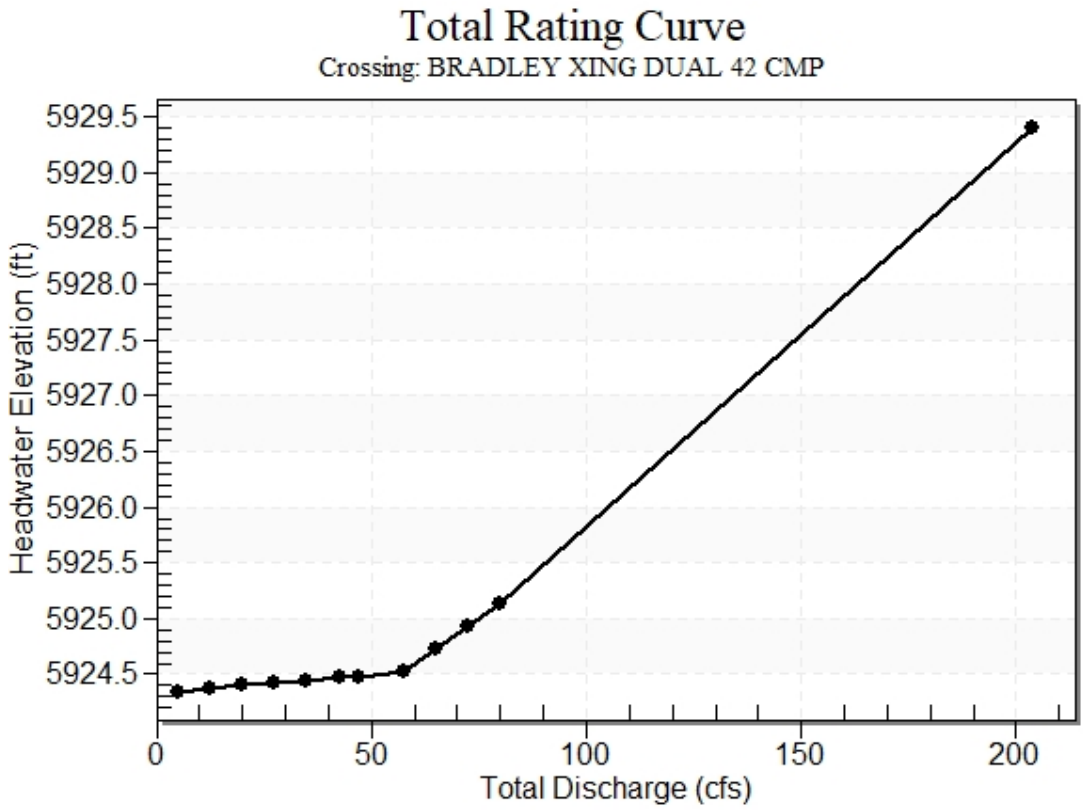


Table 2 - Culvert Summary Table: Culvert 2

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5.00	5.00	5924.35	2.347	0.0*	1-S2n	0.413	0.471	0.413	0.041	3.903	1.210
12.50	12.50	5924.38	2.379	0.0*	1-S2n	0.647	0.752	0.647	0.071	5.108	1.730
20.00	20.00	5924.40	2.405	0.0*	1-S2n	0.817	0.957	0.817	0.093	5.857	2.076
27.50	27.50	5924.43	2.427	0.0*	1-S2n	0.959	1.127	0.959	0.113	6.422	2.345
35.00	35.00	5924.45	2.448	0.0*	1-S2n	1.087	1.277	1.087	0.130	6.874	2.571
42.50	42.50	5924.47	2.467	0.0*	1-S2n	1.203	1.413	1.203	0.146	7.260	2.767
47.00	47.00	5924.48	2.478	0.0*	1-S2n	1.269	1.489	1.269	0.155	7.463	2.874
57.50	57.50	5924.53	2.525	0.0*	1-S2n	1.415	1.655	1.415	0.175	7.884	3.100
65.00	65.00	5924.73	2.730	0.0*	1-S2n	1.515	1.764	1.515	0.188	8.145	3.245
72.50	72.50	5924.93	2.934	0.0*	1-S2n	1.611	1.868	1.611	0.200	8.380	3.381
80.00	80.00	5925.14	3.139	0.0*	1-S2n	1.705	1.967	1.705	0.212	8.594	3.506

* Full Flow Headwater elevation is below inlet invert.

****

Straight Culvert

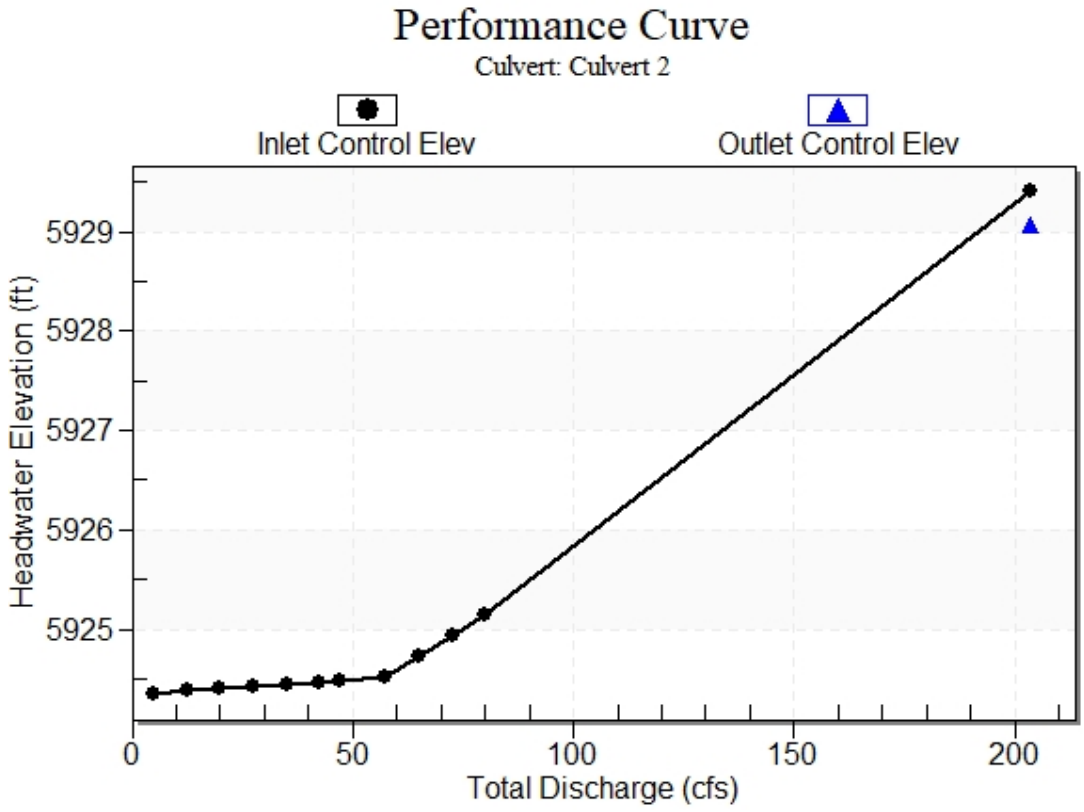
Inlet Elevation (invert): 5922.00 ft, Outlet Elevation (invert): 5918.32 ft

Culvert Length: 157.10 ft, Culvert Slope: 0.0234

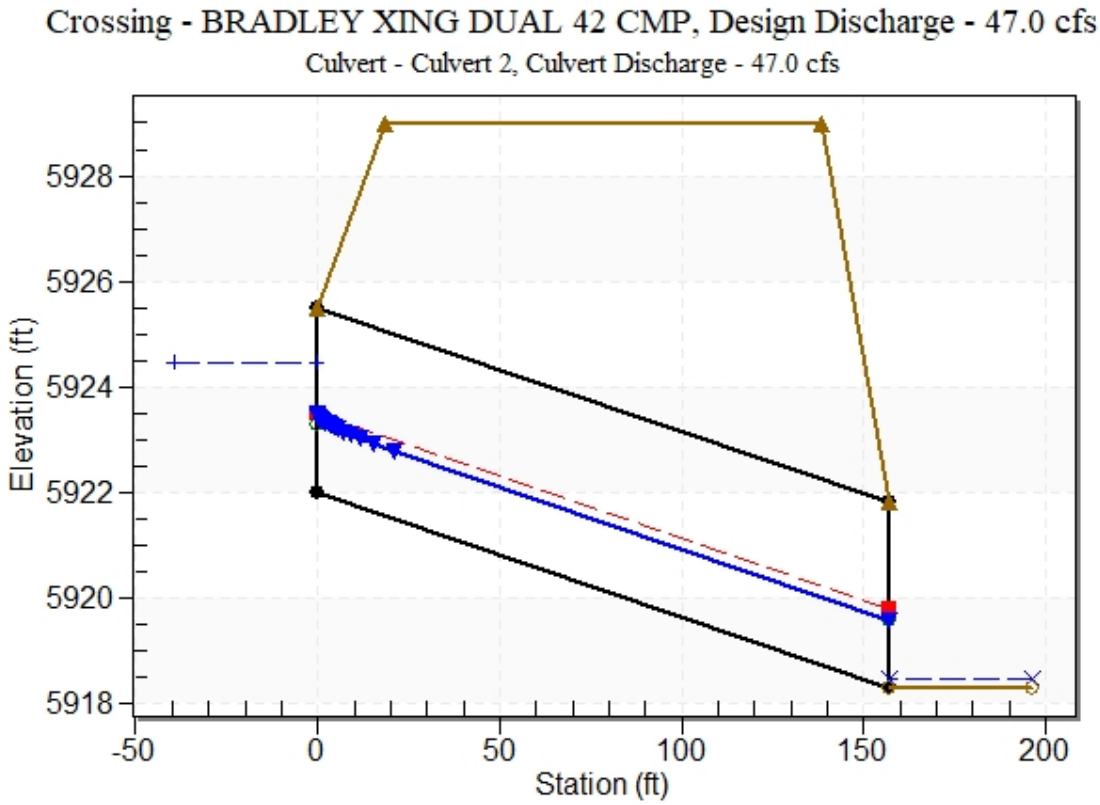
Inlet Throat Elevation: 5922.00 ft, Inlet Crest Elevation: 5924.31 ft

****

Culvert Performance Curve Plot: Culvert 2



Water Surface Profile Plot for Culvert: Culvert 2



Site Data - Culvert 2

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 5924.00 ft

Outlet Station: 157.00 ft

Outlet Elevation: 5918.32 ft

Number of Barrels: 2

Culvert Data Summary - Culvert 2

Barrel Shape: Circular

Barrel Diameter: 3.50 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting

Inlet Depression: Yes

Table 3 - Downstream Channel Rating Curve (Crossing: BRADLEY XING DUAL 42 CMP)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
5.00	5918.36	0.04	1.21	0.08	1.06
12.50	5918.39	0.07	1.73	0.13	1.16
20.00	5918.41	0.09	2.08	0.17	1.22
27.50	5918.43	0.11	2.34	0.21	1.25
35.00	5918.45	0.13	2.57	0.24	1.28
42.50	5918.47	0.15	2.77	0.27	1.31
47.00	5918.48	0.16	2.87	0.29	1.32
57.50	5918.49	0.17	3.10	0.33	1.34
65.00	5918.51	0.19	3.24	0.35	1.36
72.50	5918.52	0.20	3.38	0.38	1.37
80.00	5918.53	0.21	3.51	0.40	1.39

Tailwater Channel Data - BRADLEY XING DUAL 42 CMP

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 100.00 ft

Side Slope (H:V): 35.00 (_:1)

Channel Slope: 0.0300

Channel Manning's n: 0.0250

Channel Invert Elevation: 5918.32 ft

Roadway Data for Crossing: BRADLEY XING DUAL 42 CMP

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Irregular Roadway Cross-Section:

Coord No.	Station (ft)	Elevation (ft)
0	0.00	5929.00
1	60.00	5930.00
2	120.00	5929.00

Roadway Surface: Paved

Roadway Top Width: 120.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 5 cfs

Design Flow: 20 cfs

Maximum Flow: 40 cfs

Table 1 - Summary of Culvert Flows at Crossing: BRADLEY XING sleeved 24inRCP

Headwater Elevation (ft)	Total Discharge (cfs)	Design Point A Xing Discharge (cfs)	Roadway Discharge (cfs)	Iterations
5925.19	5.00	5.00	0.00	1
5925.60	8.50	8.50	0.00	1
5926.00	12.00	12.00	0.00	1
5926.49	15.50	15.50	0.00	1
5927.32	20.00	20.00	0.00	1
5927.87	22.50	22.50	0.00	1
5928.73	26.00	26.00	0.00	1
5929.18	29.50	27.71	1.71	23
5929.27	33.00	28.05	4.80	12
5929.33	36.50	28.28	8.07	9
5929.38	40.00	28.46	11.35	7
5930.00	27.03	27.03	0.00	Overtopping

Rating Curve Plot for Crossing: BRADLEY XING sleeved 24inRCP through 42 CMP

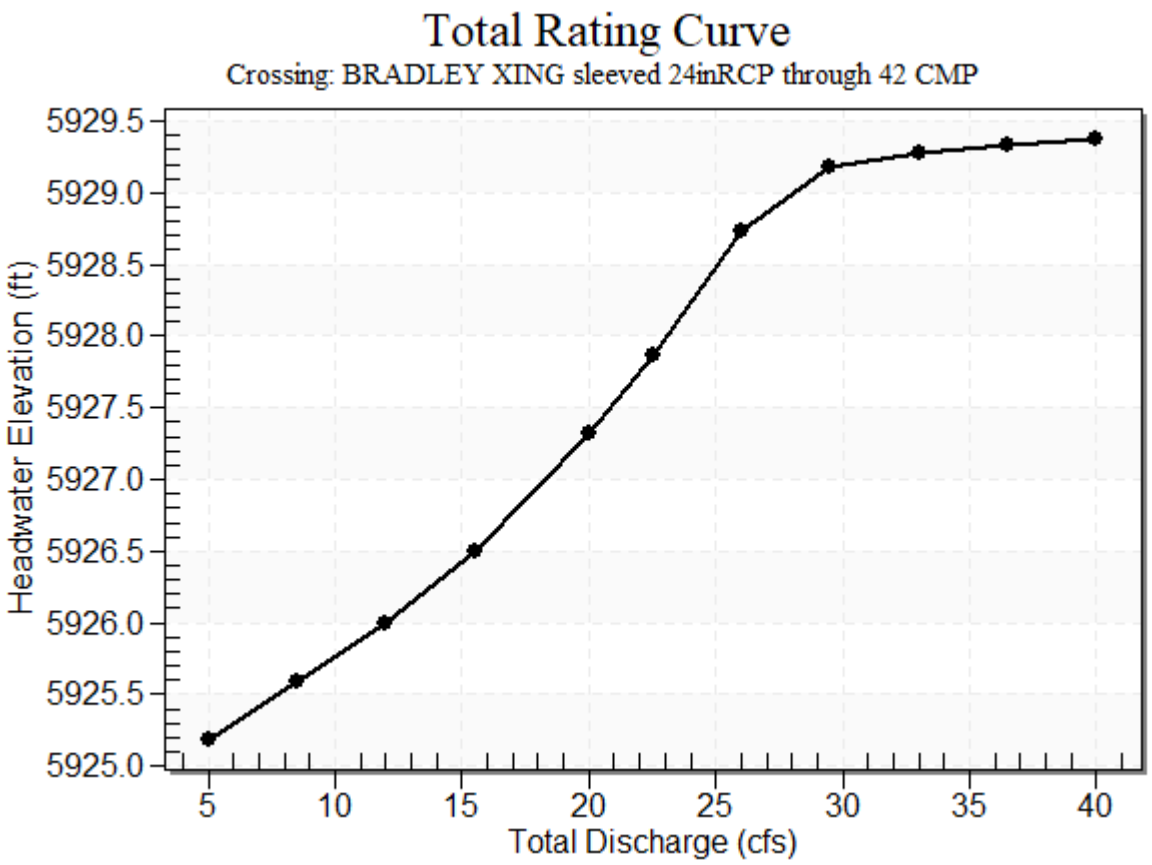


Table 2 - Culvert Summary Table: Design Point A Xing

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
5.00	5.00	5925.19	1.191	0.0*	1-S2n	0.441	0.788	0.441	0.041	9.710	1.210
8.50	8.50	5925.60	1.595	0.0*	1-S2n	0.577	1.039	0.577	0.056	11.308	1.489
12.00	12.00	5926.00	1.998	0.0*	1-S2n	0.691	1.244	0.691	0.069	12.458	1.701
15.50	15.50	5926.49	2.493	0.0*	5-S2n	0.793	1.419	0.793	0.080	13.362	1.879
20.00	20.00	5927.32	3.321	0.0*	5-S2n	0.914	1.606	0.941	0.093	13.762	2.076
22.50	22.50	5927.87	3.872	0.0*	5-S2n	0.978	1.691	0.998	0.100	14.364	2.172
26.00	26.00	5928.73	4.731	0.0*	5-S2n	1.066	1.786	1.090	0.109	14.847	2.295
29.50	27.71	5929.18	5.180	0.282	5-S2n	1.109	1.823	1.141	0.118	14.969	2.408
33.00	28.05	5929.27	5.271	0.386	5-S2n	1.117	1.829	1.151	0.126	14.994	2.513
36.50	28.28	5929.33	5.334	0.457	5-S2n	1.123	1.833	1.157	0.133	15.011	2.612
40.00	28.46	5929.38	5.382	0.512	5-S2n	1.127	1.837	1.163	0.141	15.025	2.705

* Full Flow Headwater elevation is below inlet invert.

****

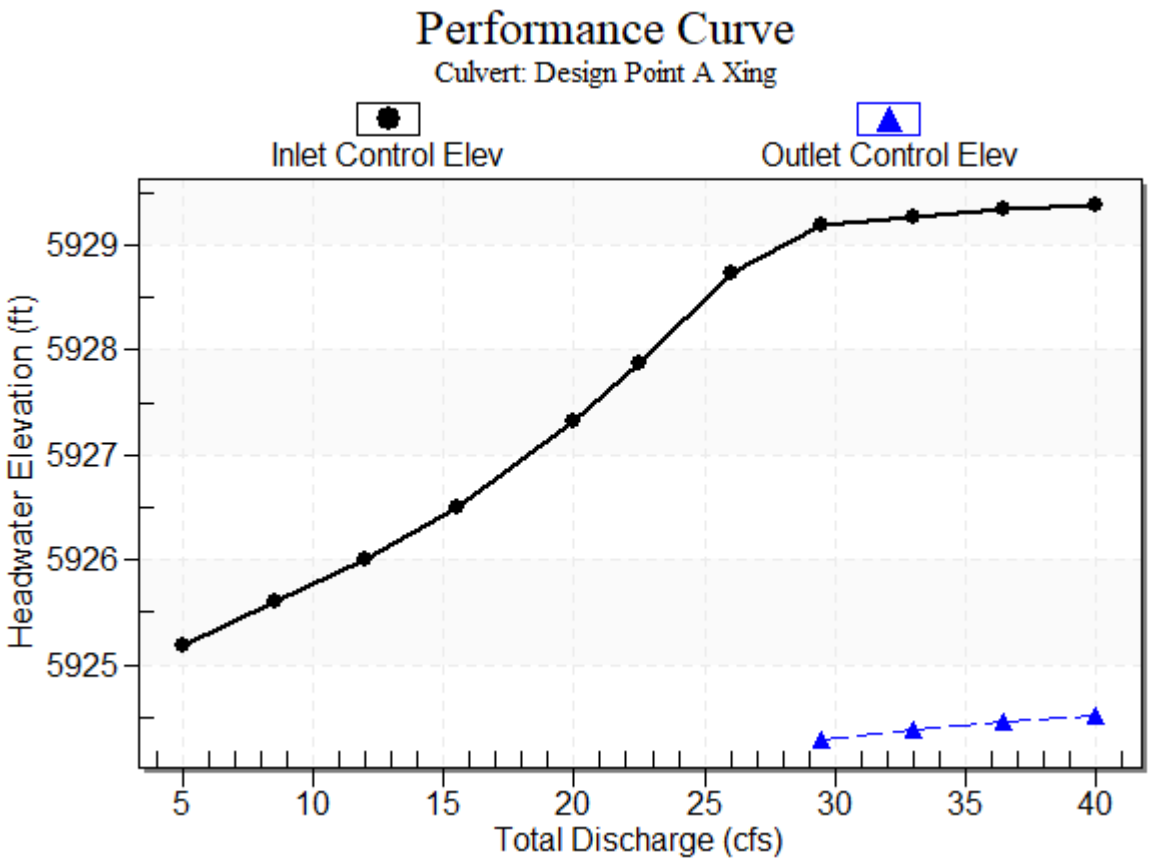
Straight Culvert

Inlet Elevation (invert): 5924.00 ft, Outlet Elevation (invert): 5918.32 ft

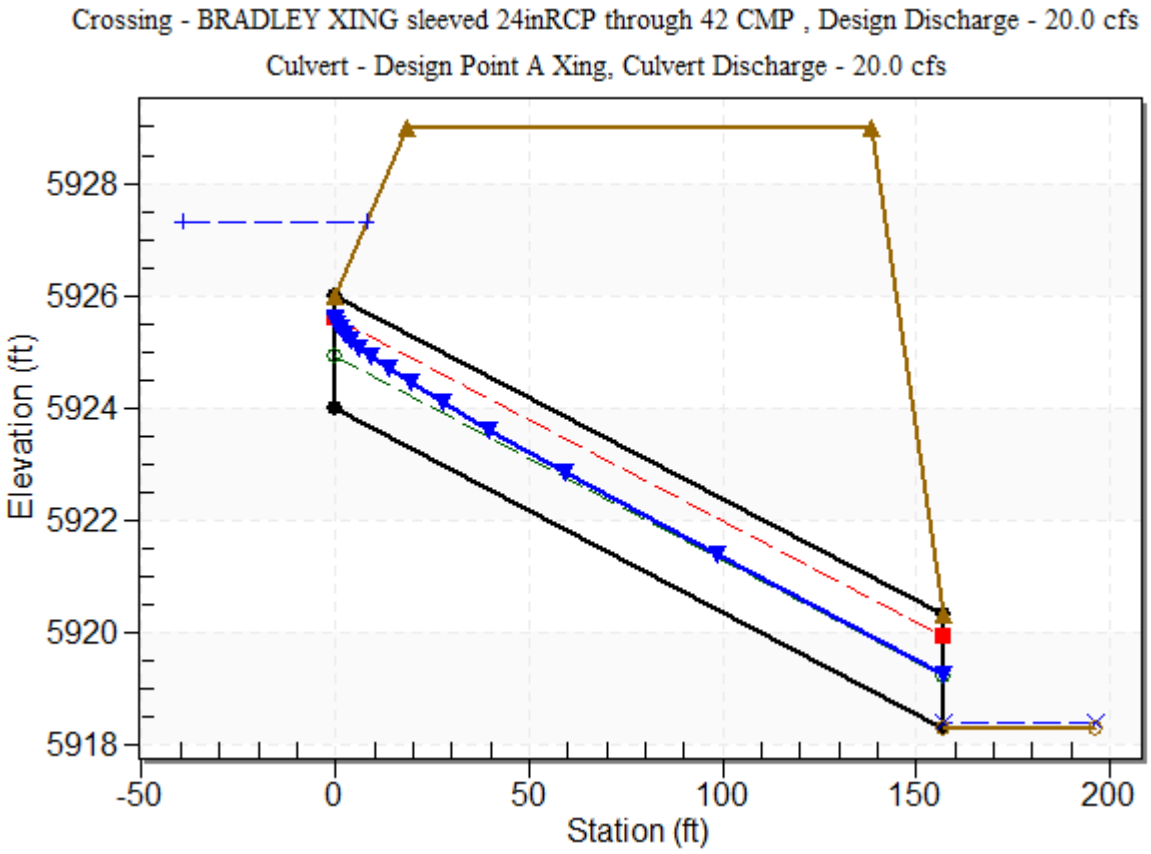
Culvert Length: 157.10 ft, Culvert Slope: 0.0362

****

Culvert Performance Curve Plot: Design Point A Xing



Water Surface Profile Plot for Culvert: Design Point A Xing



Site Data - Design Point A Xing

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 5924.00 ft

Outlet Station: 157.00 ft

Outlet Elevation: 5918.32 ft

Number of Barrels: 1

Culvert Data Summary - Design Point A Xing

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Mitered to Conform to Slope

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: BRADLEY XING sleeved

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
5.00	5918.36	0.04	1.21	0.08	1.06
8.50	5918.38	0.06	1.49	0.10	1.12
12.00	5918.39	0.07	1.70	0.13	1.16
15.50	5918.40	0.08	1.88	0.15	1.19
20.00	5918.41	0.09	2.08	0.17	1.22
22.50	5918.42	0.10	2.17	0.19	1.23
26.00	5918.43	0.11	2.30	0.20	1.25
29.50	5918.44	0.12	2.41	0.22	1.26
33.00	5918.45	0.13	2.51	0.24	1.27
36.50	5918.45	0.13	2.61	0.25	1.29
40.00	5918.46	0.14	2.70	0.26	1.30

Tailwater Channel Data - BRADLEY XING sleeved 24inRCP through 42 CMP

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 100.00 ft

Side Slope (H:V): 35.00 (_:1)

Channel Slope: 0.0300

Channel Manning's n: 0.0250

Channel Invert Elevation: 5918.32 ft

Roadway Data for Crossing: BRADLEY XING sleeved 24inRCP through 42 CMP

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Roadway Surface: Paved

Roadway Top Width: 120.00 ft

DIVERSION CHANNEL ANALYSES

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Hydraulic Analysis Report

Project Data

Project Title:

Designer:

Project Date: Friday, May 29, 2020

Project Units: U.S. Customary Units

Notes:

Channel Analysis: North Diversion Channel 1

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width: 8.0000 ft

Longitudinal Slope: 0.0309 ft/ft

Manning's n: 0.0300

Flow: 38.0000 cfs

Result Parameters

Depth: 0.6444 ft

Area of Flow: 6.8159 ft^2

Wetted Perimeter: 13.3136 ft

Hydraulic Radius: 0.5119 ft

Average Velocity: 5.5752 ft/s

Top Width: 13.1550 ft

Froude Number: 1.3650

Critical Depth: 0.7749 ft

Critical Velocity: 4.4178 ft/s

Critical Slope: 0.0158 ft/ft

Critical Top Width: 14.20 ft

Calculated Max Shear Stress: 1.2425 lb/ft^2

Calculated Avg Shear Stress: 0.9871 lb/ft^2

Channel Analysis: North Diversion Channel 2

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width: 8.0000 ft

Longitudinal Slope: 0.0344 ft/ft

Manning's n: 0.0300

Flow: 72.0000 cfs

Result Parameters

Depth: 0.8874 ft

Area of Flow: 10.2487 ft^2

Wetted Perimeter: 15.3175 ft

Hydraulic Radius: 0.6691 ft

Average Velocity: 7.0253 ft/s

Top Width: 15.0990 ft

Froude Number: 1.5027

Critical Depth: 1.1205 ft

Critical Velocity: 5.1482 ft/s

Critical Slope: 0.0143 ft/ft

Critical Top Width: 16.96 ft

Calculated Max Shear Stress: 1.9048 lb/ft^2

Calculated Avg Shear Stress: 1.4362 lb/ft^2

Selected Profile: FHWA Profile (read-only)

Culvert Assessment Profiles

Culvert Assessment Profile Name: Standard (read-only)

Maximum Excavation Depth: 20 ft

Maximum Shallow Cover: 4 ft

Maximum Small Pipe Size: 36 in

Minimum Manned Entry Size: 48 in

Riprap Classes

Riprap Name: CLASS I

Riprap Class: I

The following values are an 'average' of the size fraction range for the selected riprap class.

d100: 12 in

d85: 9 in

d50: 6.5 in

d15: 4.5 in

Riprap Name: CLASS II

Riprap Class: II

The following values are an 'average' of the size fraction range for the selected riprap class.

d100: 18 in

d85: 13 in

d50: 9.5 in

d15: 7 in

Riprap Name: CLASS III

Riprap Class: III

The following values are an 'average' of the size fraction range for the selected riprap class.

d100: 24 in

d85: 17 in

d50: 12.5 in

d15: 9 in

Riprap Name: CLASS IV

Riprap Class: IV

The following values are an 'average' of the size fraction range for the selected riprap class.

d100: 30 in

d85: 21 in

d50: 15.5 in

d15: 10.5 in

Riprap Name: CLASS V

Riprap Class: V

The following values are an 'average' of the size fraction range for the selected riprap class.

d100: 36 in

d85: 25.5 in

d50: 18.5 in

d15: 13 in

Riprap Name: CLASS VI

POND JCD-D OUTLET TO
N. BRADLEY ROAD DITCH
SINGLE 48” RCP CUVLERT

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 80 cfs

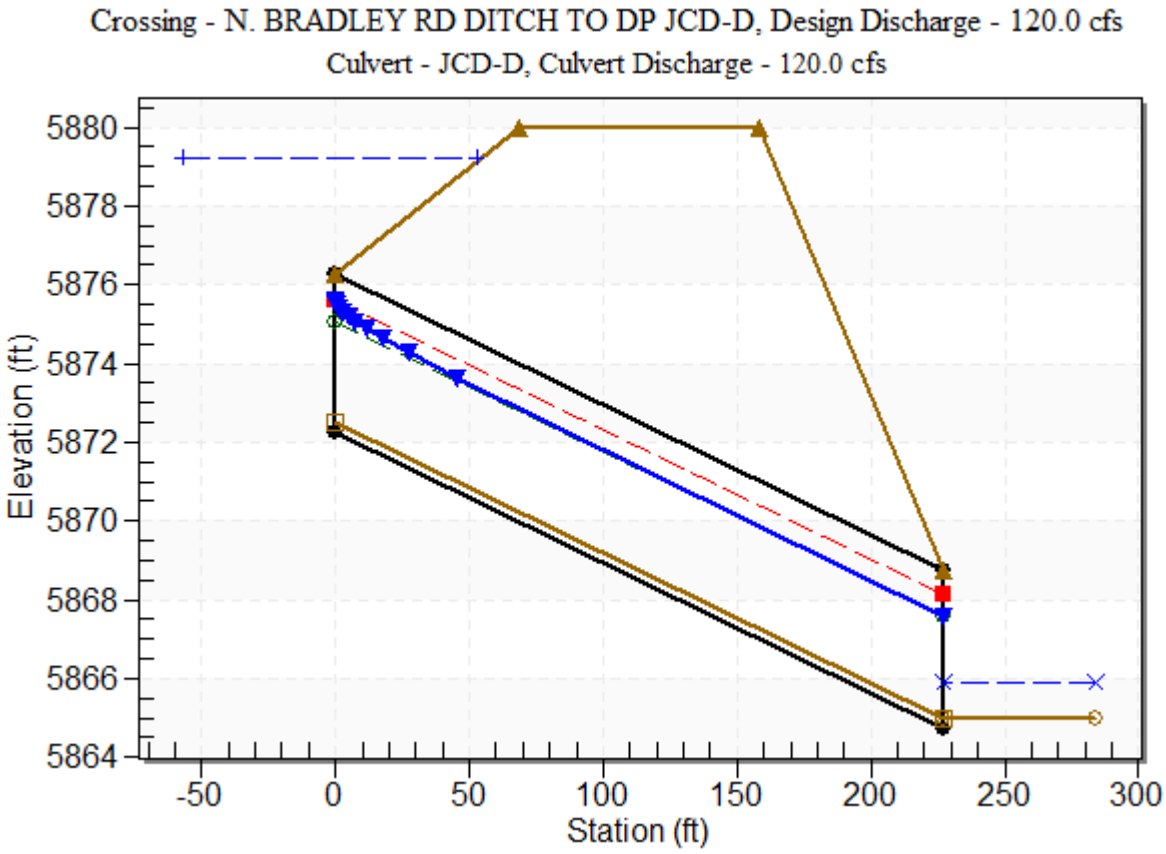
Design Flow: 120 cfs

Maximum Flow: 150 cfs

Table 1 - Summary of Culvert Flows at Crossing: N. BRADLEY RD DITCH TO DP

Headwater Elevation (ft)	Total Discharge (cfs)	JCD-D Discharge (cfs)	Roadway Discharge (cfs)	Iterations
5876.84	80.00	80.00	0.00	1
5877.19	87.00	87.00	0.00	1
5877.57	94.00	94.00	0.00	1
5877.98	101.00	101.00	0.00	1
5878.41	108.00	108.00	0.00	1
5878.86	115.00	115.00	0.00	1
5879.21	120.00	120.00	0.00	1
5879.86	129.00	129.00	0.00	1
5880.03	136.00	131.20	4.42	16
5880.06	143.00	131.53	11.08	5
5880.08	150.00	131.79	17.74	4
5880.00	130.80	130.80	0.00	Overtopping

Water Surface Profile Plot for Culvert: JCD-D



Culvert Data Summary - JCD-D

Barrel Shape: Circular

Barrel Diameter: 4.00 ft

Barrel Material: Concrete

Embedment: 3.00 in

Barrel Manning's n: 0.0120 (top and sides)

Manning's n: 0.0250 (bottom)

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: Yes

Table 2 - Culvert Summary Table: JCD-D

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
80.00	80.00	5876.84	4.339	0.0*	5-S2n	2.008	2.539	2.019	0.700	11.433	5.172
87.00	87.00	5877.19	4.694	0.0*	5-S2n	2.107	2.656	2.107	0.735	11.842	5.330
94.00	94.00	5877.57	5.073	0.258	5-S2n	2.205	2.768	2.205	0.769	12.163	5.478
101.00	101.00	5877.98	5.477	1.473	5-S2n	2.302	2.869	2.302	0.802	12.466	5.619
108.00	108.00	5878.41	5.908	2.228	5-S2n	2.398	2.966	2.398	0.834	12.754	5.754
115.00	115.00	5878.86	6.365	3.014	5-S2n	2.495	3.058	2.495	0.865	13.024	5.882
120.00	120.00	5879.21	6.708	3.553	5-S2n	2.564	3.114	2.564	0.887	13.207	5.969
129.00	129.00	5879.86	7.363	4.655	5-S2n	2.692	3.212	2.692	0.925	13.520	6.122
136.00	131.20	5880.03	7.530	4.834	5-S2n	2.723	3.236	2.723	0.954	13.593	6.234
143.00	131.53	5880.06	7.556	4.880	5-S2n	2.728	3.239	2.728	0.982	13.603	6.343
150.00	131.79	5880.08	7.576	4.917	5-S2n	2.732	3.242	2.732	1.010	13.612	6.449

* Full Flow Headwater elevation is below inlet invert.

****

Straight Culvert

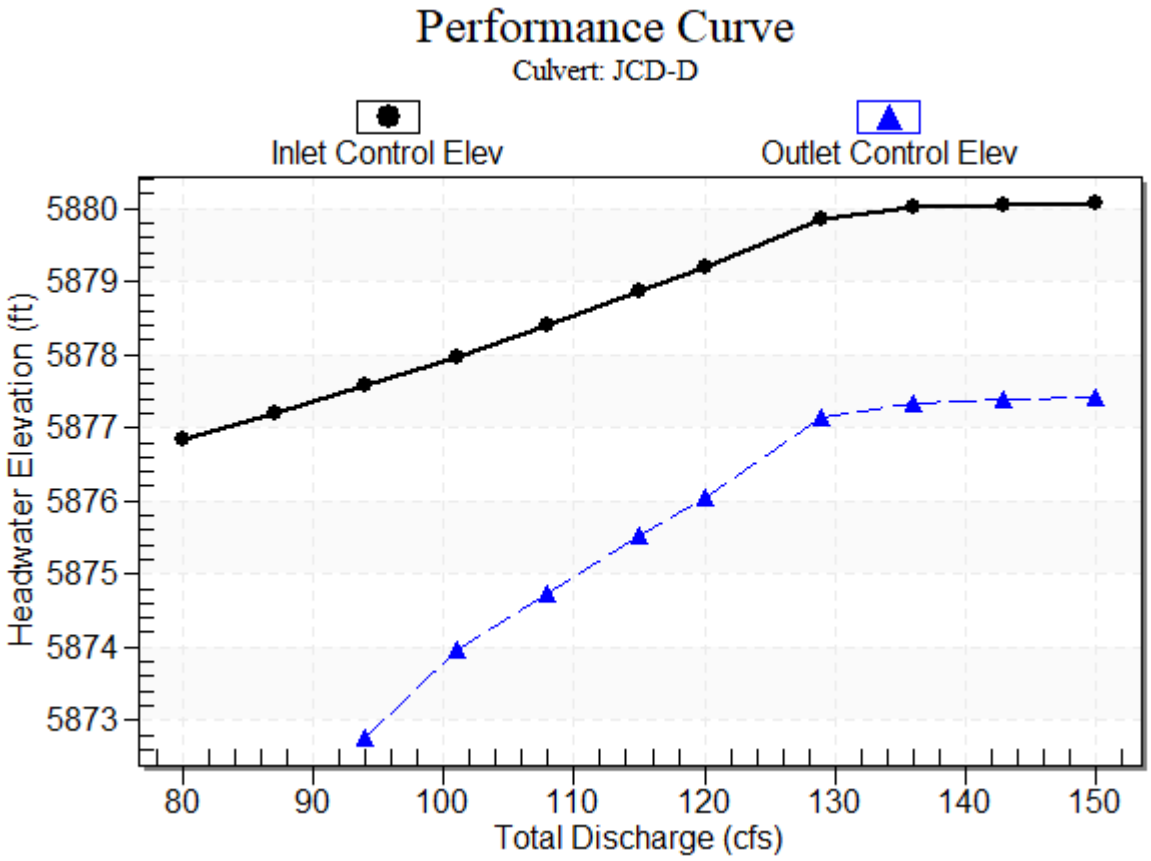
Inlet Elevation (invert): 5872.50 ft, Outlet Elevation (invert): 5865.00 ft

Culvert Length: 227.14 ft, Culvert Slope: 0.0330

Inlet Throat Elevation: 5872.50 ft, Inlet Crest Elevation: 5873.13 ft

****

Culvert Performance Curve Plot: JCD-D



Site Data - JCD-D

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 5872.75 ft

Outlet Station: 227.00 ft

Outlet Elevation: 5864.75 ft

Number of Barrels: 1

Rating Curve Plot for Crossing: N. BRADLEY RD DITCH TO DP JCD-D

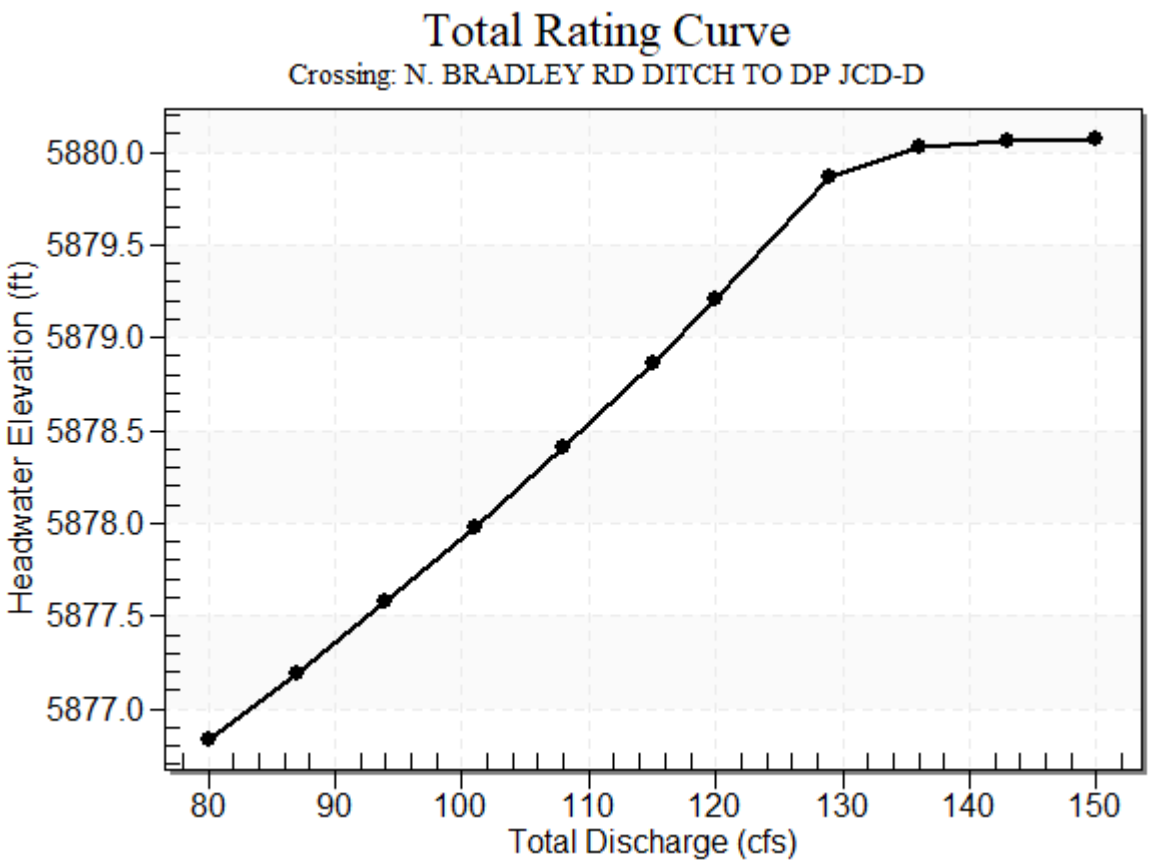


Table 3 - Downstream Channel Rating Curve (Crossing: N. BRADLEY RD DITCH TO

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
80.00	5865.70	0.70	5.17	1.19	1.14
87.00	5865.74	0.74	5.33	1.25	1.15
94.00	5865.77	0.77	5.48	1.31	1.16
101.00	5865.80	0.80	5.62	1.37	1.16
108.00	5865.83	0.83	5.75	1.42	1.17
115.00	5865.87	0.87	5.88	1.47	1.18
120.00	5865.89	0.89	5.97	1.51	1.18
129.00	5865.93	0.93	6.12	1.58	1.19
136.00	5865.95	0.95	6.23	1.63	1.19
143.00	5865.98	0.98	6.34	1.67	1.20
150.00	5866.01	1.01	6.45	1.72	1.20

Tailwater Channel Data - N. BRADLEY RD DITCH TO DP JCD-D

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 20.00 ft

Side Slope (H:V): 3.00 (_:1)

Channel Slope: 0.0273

Channel Manning's n: 0.0350

Channel Invert Elevation: 5865.00 ft

Roadway Data for Crossing: N. BRADLEY RD DITCH TO DP JCD-D

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 333.00 ft

Crest Elevation: 5880.00 ft

Roadway Surface: Gravel

Roadway Top Width: 90.00 ft

DIVERSION CHANNEL ANALYSES

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Hydraulic Analysis Report

Project Data

Project Title:

Designer:

Project Date: Friday, May 29, 2020

Project Units: U.S. Customary Units

Notes:

Channel Analysis: North Diversion Channel 1

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 3.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Channel Width: 4.0000 ft

Longitudinal Slope: 0.0309 ft/ft

Manning's n: 0.0350

Flow: 18.0000 cfs

Result Parameters

Depth: 0.6577 ft

Area of Flow: 3.9285 ft^2

Wetted Perimeter: 8.1597 ft

Hydraulic Radius: 0.4815 ft

Average Velocity: 4.5819 ft/s

Top Width: 7.9462 ft

Froude Number: 1.1484

Critical Depth: 0.7115 ft

Critical Velocity: 4.1238 ft/s

Critical Slope: 0.0229 ft/ft

Critical Top Width: 8.27 ft

Calculated Max Shear Stress: 1.2681 lb/ft^2

Calculated Avg Shear Stress: 0.9283 lb/ft^2

Channel Analysis: North Diversion Channel 2

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 3.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Channel Width: 8.0000 ft

Longitudinal Slope: 0.0344 ft/ft

Manning's n: 0.0350

Flow: 39.0000 cfs

Result Parameters

Depth: 0.7078 ft

Area of Flow: 7.1656 ft^2

Wetted Perimeter: 12.4767 ft

Hydraulic Radius: 0.5743 ft

Average Velocity: 5.4427 ft/s

Top Width: 12.2469 ft

Froude Number: 1.2539

Critical Depth: 0.8120 ft

Critical Velocity: 4.6023 ft/s

Critical Slope: 0.0211 ft/ft

Critical Top Width: 12.87 ft

Calculated Max Shear Stress: 1.5194 lb/ft^2

Calculated Avg Shear Stress: 1.2328 lb/ft^2

Selected Profile: FHWA Profile (read-only)

Culvert Assessment Profiles

Culvert Assessment Profile Name: Standard (read-only)

Maximum Excavation Depth: 20 ft

Maximum Shallow Cover: 4 ft

Maximum Small Pipe Size: 36 in

Minimum Manned Entry Size: 48 in

Riprap Classes

Riprap Name: CLASS I

Riprap Class: I

The following values are an 'average' of the size fraction range for the selected riprap class.

d100: 12 in

d85: 9 in

d50: 6.5 in

d15: 4.5 in

Riprap Name: CLASS II

Riprap Class: II

The following values are an 'average' of the size fraction range for the selected riprap class.

d100: 18 in

d85: 13 in

d50: 9.5 in

d15: 7 in

Riprap Name: CLASS III

Riprap Class: III

The following values are an 'average' of the size fraction range for the selected riprap class.

d100: 24 in

d85: 17 in

d50: 12.5 in

d15: 9 in

Riprap Name: CLASS IV

Riprap Class: IV

The following values are an 'average' of the size fraction range for the selected riprap class.

d100: 30 in

d85: 21 in

d50: 15.5 in

d15: 10.5 in

Riprap Name: CLASS V

Riprap Class: V

The following values are an 'average' of the size fraction range for the selected riprap class.

d100: 36 in

d85: 25.5 in

d50: 18.5 in

d15: 13 in

Riprap Name: CLASS VI

Hydraulic Analysis Report

Project Data

Project Title:

Designer:

Project Date: Friday, May 29, 2020

Project Units: U.S. Customary Units

Notes:

Channel Analysis: North Diversion Channel 1

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width: 8.0000 ft

Longitudinal Slope: 0.0309 ft/ft

Manning's n: 0.0300

Flow: 38.0000 cfs

Result Parameters

Depth: 0.6444 ft

Area of Flow: 6.8159 ft^2

Wetted Perimeter: 13.3136 ft

Hydraulic Radius: 0.5119 ft

Average Velocity: 5.5752 ft/s

Top Width: 13.1550 ft

Froude Number: 1.3650

Critical Depth: 0.7749 ft

Critical Velocity: 4.4178 ft/s

Critical Slope: 0.0158 ft/ft

Critical Top Width: 14.20 ft

Calculated Max Shear Stress: 1.2425 lb/ft^2

Calculated Avg Shear Stress: 0.9871 lb/ft^2

Channel Analysis: North Diversion Channel 2

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width: 8.0000 ft

Longitudinal Slope: 0.0344 ft/ft

Manning's n: 0.0300

Flow: 72.0000 cfs

Result Parameters

Depth: 0.8874 ft

Area of Flow: 10.2487 ft^2

Wetted Perimeter: 15.3175 ft

Hydraulic Radius: 0.6691 ft

Average Velocity: 7.0253 ft/s

Top Width: 15.0990 ft

Froude Number: 1.5027

Critical Depth: 1.1205 ft

Critical Velocity: 5.1482 ft/s

Critical Slope: 0.0143 ft/ft

Critical Top Width: 16.96 ft

Calculated Max Shear Stress: 1.9048 lb/ft^2

Calculated Avg Shear Stress: 1.4362 lb/ft^2

Selected Profile: FHWA Profile (read-only)

Culvert Assessment Profiles

Culvert Assessment Profile Name: Standard (read-only)

Maximum Excavation Depth: 20 ft

Maximum Shallow Cover: 4 ft

Maximum Small Pipe Size: 36 in

Minimum Manned Entry Size: 48 in

Riprap Classes

Riprap Name: CLASS I

Riprap Class: I

The following values are an 'average' of the size fraction range for the selected riprap class.

d100: 12 in

d85: 9 in

d50: 6.5 in

d15: 4.5 in

Riprap Name: CLASS II

Riprap Class: II

The following values are an 'average' of the size fraction range for the selected riprap class.

d100: 18 in

d85: 13 in

d50: 9.5 in

d15: 7 in

Riprap Name: CLASS III

Riprap Class: III

The following values are an 'average' of the size fraction range for the selected riprap class.

d100: 24 in

d85: 17 in

d50: 12.5 in

d15: 9 in

Riprap Name: CLASS IV

Riprap Class: IV

The following values are an 'average' of the size fraction range for the selected riprap class.

d100: 30 in

d85: 21 in

d50: 15.5 in

d15: 10.5 in

Riprap Name: CLASS V

Riprap Class: V

The following values are an 'average' of the size fraction range for the selected riprap class.

d100: 36 in

d85: 25.5 in

d50: 18.5 in

d15: 13 in

Riprap Name: CLASS VI

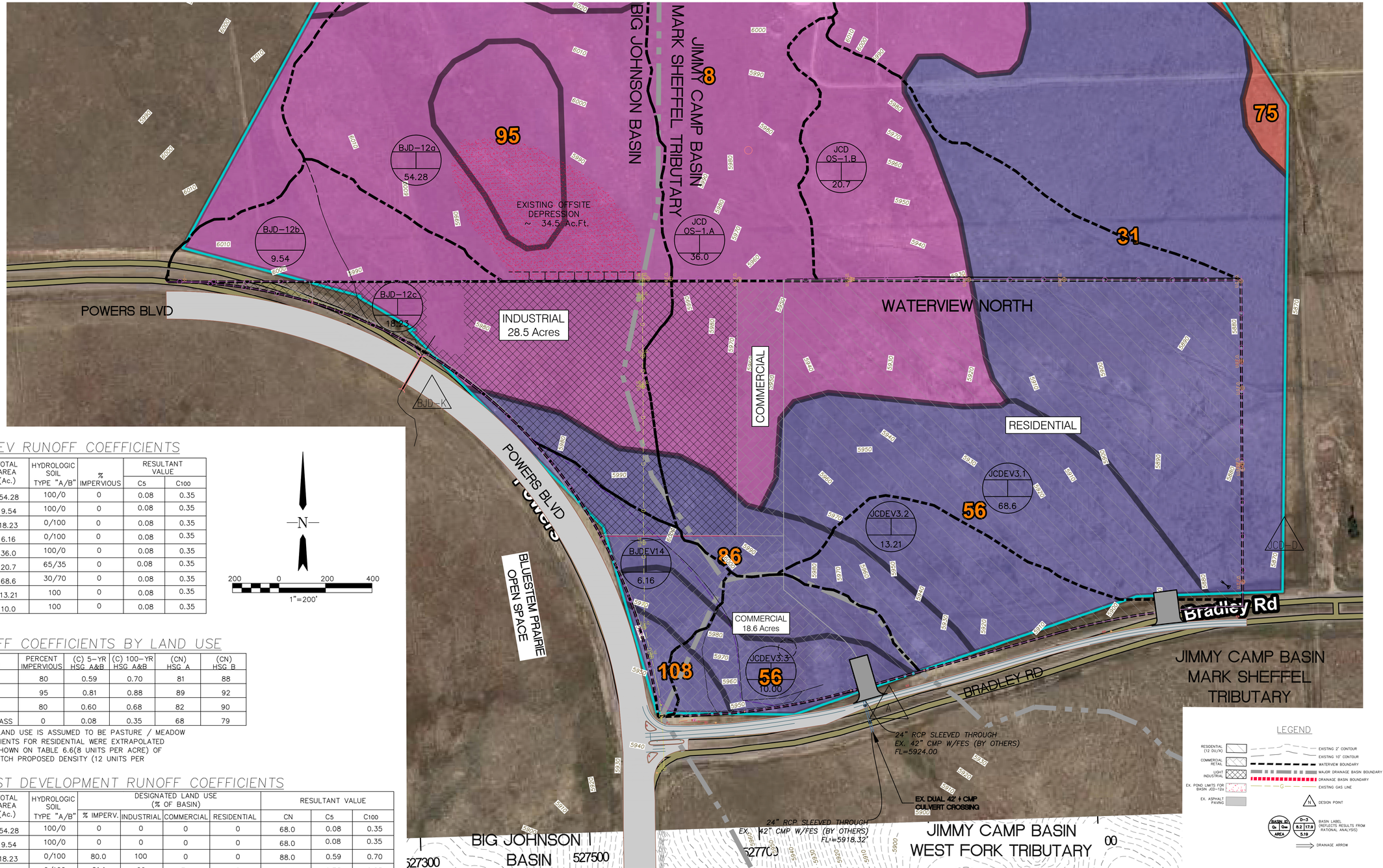
APPENDIX E

RUNOFF COEFFICIENT EXHIBIT

PRE-DEVELOPMENT BASIN MAP

POST DEVELOPMENT DRAINAGE PLAN

RUNOFF COEFFICIENT EXHIBIT



PRE-DEV RUNOFF COEFFICIENTS

BASIN ID	TOTAL AREA (Ac.)	HYDROLOGIC SOIL TYPE "A/B"	% IMPERVIOUS	RESULTANT VALUE C5	RESULTANT VALUE C100
BJD-12a	54.28	100/0	0	0.08	0.35
BJD-12b	9.54	100/0	0	0.08	0.35
BJD-12c	18.23	0/100	0	0.08	0.35
BJDEX-14	6.16	0/100	0	0.08	0.35
JCD-OS1A	36.0	100/0	0	0.08	0.35
JCD-OS1B	20.7	65/35	0	0.08	0.35
JCDEX-3.1	68.6	30/70	0	0.08	0.35
JCDEX-3.2	13.21	100	0	0.08	0.35
JCDEX-3.3	10.0	100	0	0.08	0.35

—N—

200 0 200 400

1"=200'

RUNOFF COEFFICIENTS BY LAND USE

LAND USE CLASSIFICATION	PERCENT IMPERVIOUS	(C) 5-YR HSG A&B	(C) 100-YR HSG A&B	(CN) HSG A	(CN) HSG B
INDUSTRIAL	80	0.59	0.70	81	88
COMMERCIAL	95	0.81	0.88	89	92
**RESIDENTIAL	80	0.60	0.68	82	90
*BRUSH\WEEDS\GRASS	0	0.08	0.35	68	79

* OFFSITE BASIN LAND USE IS ASSUMED TO BE PASTURE / MEADOW

** RUNOFF COEFFICIENTS FOR RESIDENTIAL WERE EXTRAPOLATED FROM VALUES SHOWN ON TABLE 6.6(8 UNITS PER ACRE) OF THE DCM TO MATCH PROPOSED DENSITY (12 UNITS PER ACRE).

POST DEVELOPMENT RUNOFF COEFFICIENTS

BASIN ID	TOTAL AREA (Ac.)	HYDROLOGIC SOIL TYPE "A/B"	DESIGNATED LAND USE (% OF BASIN) % IMPERV.	INDUSTRIAL	COMMERCIAL	RESIDENTIAL	RESULTANT VALUE CN	C5	C100
BJD-12a	54.28	100/0	0	0	0	0	68.0	0.08	0.35
BJD-12b	9.54	100/0	0	0	0	0	68.0	0.08	0.35
BJD-12c	18.23	0/100	80.0	100	0	0	88.0	0.59	0.70
BJDEV-14	6.16	0/100	91.1	26	74	0	91.0	0.75	0.83
JCD-OS1A	36.0	100/0	0	0	0	0	68.0	0.08	0.35
JCD-OS1B	20.7	65/35	0	0	0	0	71.9	0.08	0.35
JCDEV-3.1	68.6	0/100	82.2	12	10	79	90.7	0.60	0.71
JCDEV-3.2	13.21	0/100	80.0	0	0	100	90	0.60	0.68
JCDEV-3.3	10.0	0/100	91.7	0	78	22	91.6	0.76	0.84

REVISIONS:

NO.	DESCRIPTION	DATE

ENGINEER:
DESIGNED BY: CEB DATE: 11-05-20
DRAWN BY: CEB DATE: 11-05-20
CHECKED BY: CKC DATE: 11-05-20

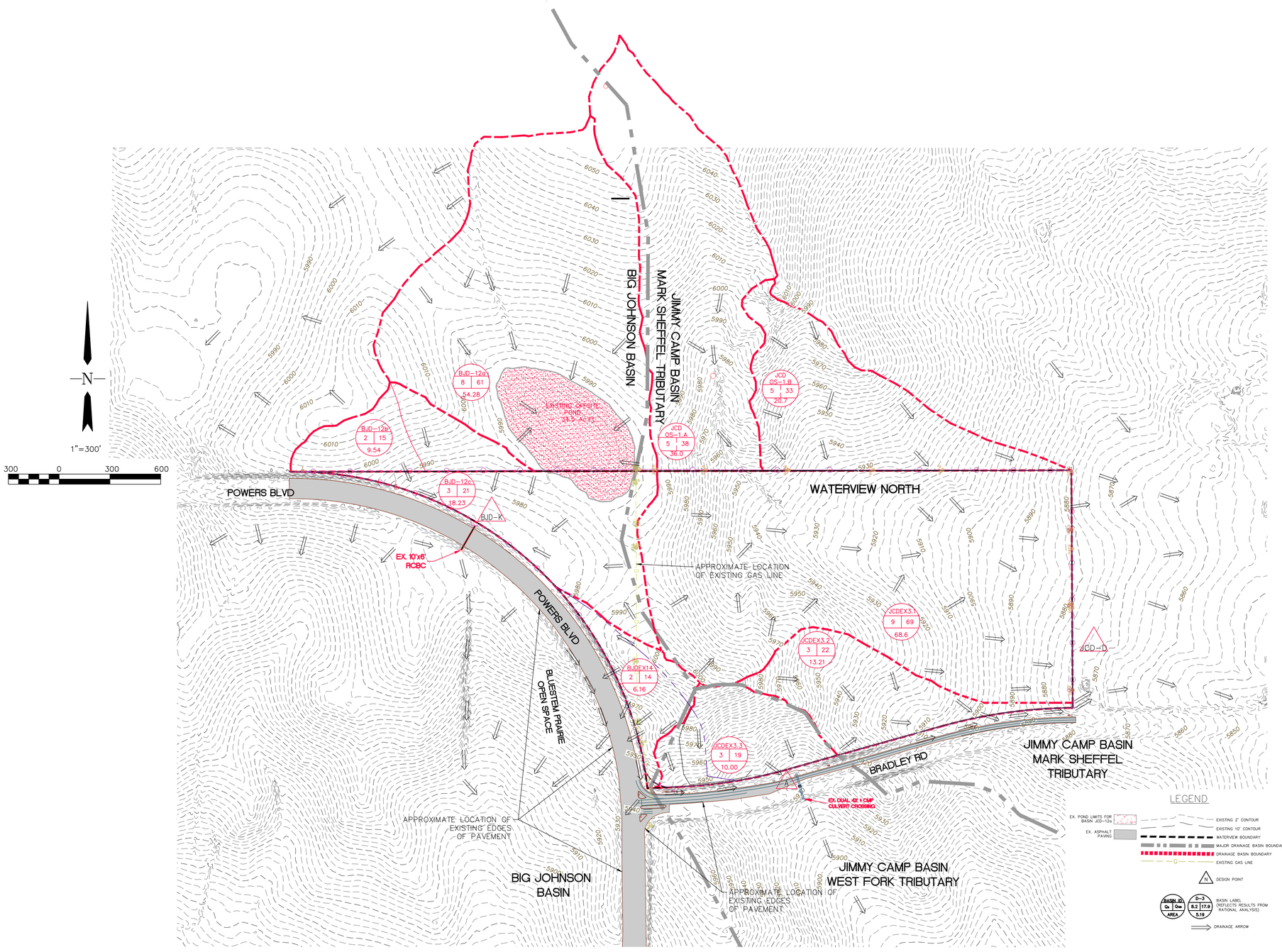
48 HOURS BEFORE YOU DIG, CALL UTILITY LOCATORS
1-800-922-1987
CITY OF COLORADO SPRINGS DEPT. OF UTILITIES GAS, ELECTRIC, WATER AND WASTEWATER

DSE Dakota Springs Engineering
31 N. TEJON, SUITE 518
COLORADO SPRINGS, CO 80903
P: (719) 227-7388
F: (719) 227-7392

PROJECT WATERVIEW NORTH
SHEET TITLE RUNOFF COEFFICIENT EXHIBIT
FROM n/a TO n/a
JOB NO. 02-19-05 SHEET 1 OF 3

Z:\2021 Dakota Springs\20 Waterview Pinehoe\19-05 Waterview North Bnd Civil\Pinehoe\MXD\PH Basin Exhibit.dwg, RUNOFF COEFFICIENT EXHIBIT, 11/3/2020 12:20:14 PM, ARCH full sheet D (36.00 x 24.00 Inches)

PRE-DEVELOPMENT BASIN MAP



BASIN ID	BASIN AREA (Ac.)	DESIGN POINT	RATIONAL ANALYSIS RESULTS	
			Q_5 (CFS)	Q_{100} (CFS)
BJD-12a	54.28		8	61
BJD-12b	9.54		2	15
BJD-12c	18.23		3	21
		BJD-K	4	31
JCD OS-1A	36.0		5	38
JCD OS-1B	20.7		5	33
JCDEX-3.1	68.6		9	69
JCDEX-3.2	13.21		3	22
		JCD-D	12	84
JCDEX-3.3	10.0		3	19
BJDEX14	6.16		2	14
		A	3	19
		A*	5	25

A* – MODELLED AS BASIN OS-1 IN THE FINAL DRAINAGE REPORT FOR FILING 1 OF TRAILS AT ASPEN RIDGE, APP'D ON FEBRUARY 13, 2020.

REVISIONS:

NO.	DESCRIPTION	DATE

ENGINEER:
DESIGNED BY: CEB DATE: 11-05-20
DRAWN BY: CEB DATE: 11-05-20
CHECKED BY: CKC DATE: 11-05-20

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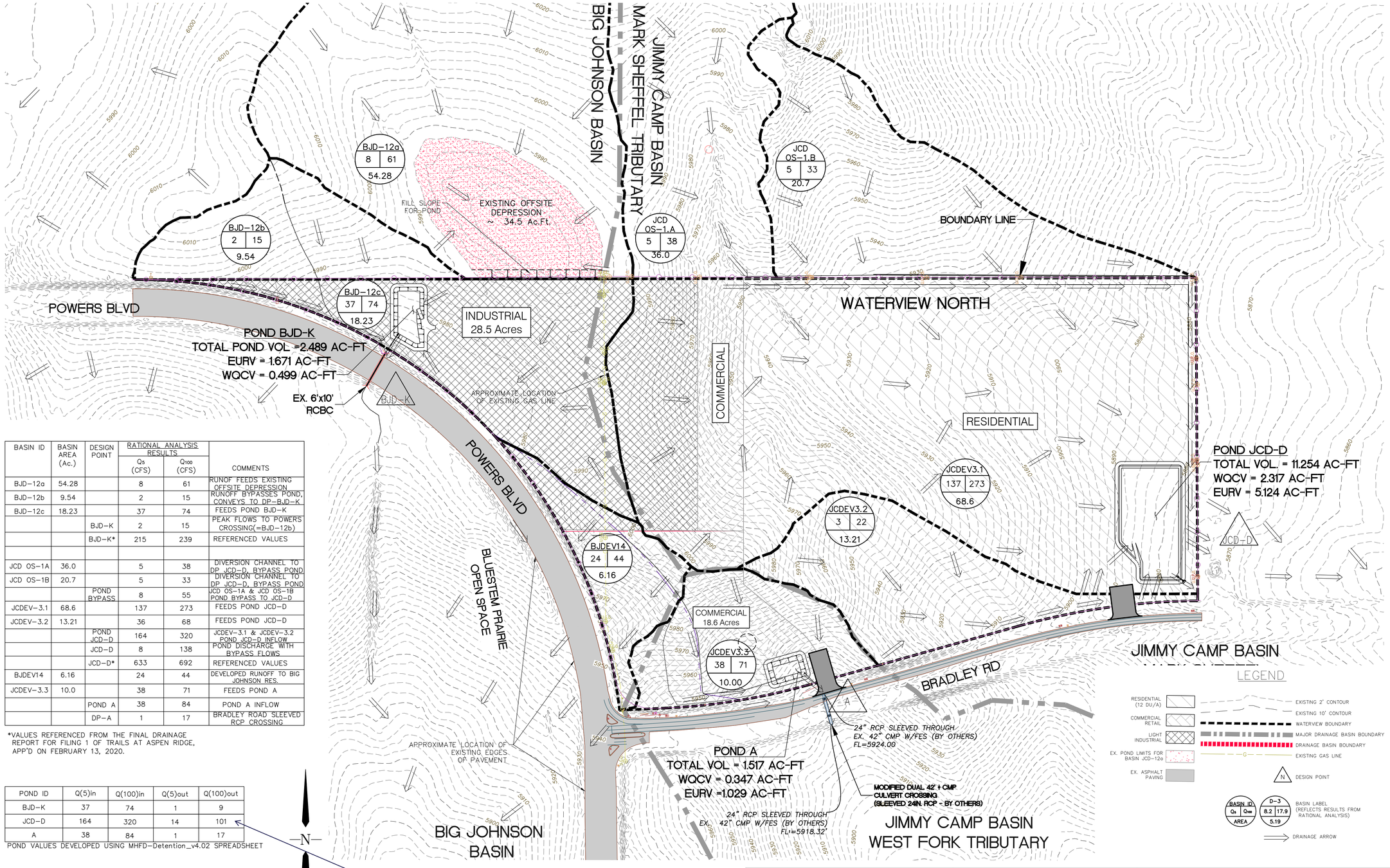
DSE Dakota Springs Engineering
31 N. TEJON, SUITE 518
COLORADO SPRINGS, CO 80903
P: (719) 227-7388
F: (719) 227-7392

PROJECT WATERVIEW NORTH
SHEET TITLE PRE-DEVELOPMENT BASIN MAP
FROM n/a TO n/a
JOB NO. 02-19-05 SHEET 2 OF 3

POST DEVELOPMENT DRAINAGE PLAN



BASIN ID	BASIN AREA (Ac.)	DESIGN POINT	RATIONAL ANALYSIS RESULTS Q_5 (CFS)	RATIONAL ANALYSIS RESULTS Q_{100} (CFS)	COMMENTS
BJD-12a	54.28		8	61	RUNOF FEEDS EXISTING OFFSITE DEPRESSION
BJD-12b	9.54		2	15	RUNOFF BYPASSES POND, CONVEYS TO DP-BJD-K
BJD-12c	18.23		37	74	FEEDS POND BJD-K
		BJD-K	2	15	PEAK FLOWS TO POWERS CROSSING(=BJD-12b)
		BJD-K*	215	239	REFERENCED VALUES
JCD OS-1A	36.0		5	38	DIVERSION CHANNEL TO DP JCD-D, BYPASS POND
JCD OS-1B	20.7		5	33	DIVERSION CHANNEL TO DP JCD-D, BYPASS POND
		POND BYPASS	8	55	JCD OS-1A & JCD OS-1B POND BYPASS TO JCD-D
JCDEV-3.1	68.6		137	273	FEEDS POND JCD-D
JCDEV-3.2	13.21		36	68	FEEDS POND JCD-D
		POND JCD-D	164	320	JCDEV-3.1 & JCDEV-3.2 POND JCD-D INFLOW
		JCD-D	8	138	POND DISCHARGE WITH BYPASS FLOWS
		JCD-D*	633	692	REFERENCED VALUES
BJDEV14	6.16		24	44	DEVELOPED RUNOFF TO BIG JOHNSON RES.
JCDEV-3.3	10.0		38	71	FEEDS POND A
		POND A	38	84	POND A INFLOW
		DP-A	1	17	BRADLEY ROAD SLEEVED RCP CROSSING

*VALUES REFERENCED FROM THE FINAL DRAINAGE REPORT FOR FILING 1 OF TRAILS AT ASPEN RIDGE, APP'D ON FEBRUARY 13, 2020.

POND ID	Q(5)in	Q(100)in	Q(5)out	Q(100)out
BJD-K	37	74	1	9
JCD-D	164	320	14	101
A	38	84	1	17

POND VALUES DEVELOPED USING MHFD-Detention_v4.02 SPREADSHEET

Flow at DP JCD_D must be equal to or less than historic.
The pre-development map notes (12 and 84 cfs)
Update drainage design/pond release.

JCDEX-3.2	13.21		3	22
		JCD-D	12	84
JCDEX-3.3	10.0		3	19

REVISIONS:

NO.	DESCRIPTION	DATE

ENGINEER:
DESIGNED BY: CEB DATE: 11-05-20
DRAWN BY: CEB DATE: 11-05-20
CHECKED BY: CKC DATE: 11-05-20

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DSE Dakota Springs Engineering
31 N. TEJON, SUITE 518
COLORADO SPRINGS, CO 80903
P: (719) 227-7388
F: (719) 227-7392

PROJECT WATERVIEW NORTH
SHEET TITLE POST DEVELOPMENT DRAINAGE PLAN
FROM n/a TO n/a
JOB NO. 02-19-05 SHEET 3 OF 3

P:\2001 Dakota Springs\05 Waterview Partners\19-05 Waterview North Site\CAD\Planset\ESDP\PS Basin Exhibit.dwg, POST DEV DRAINAGE PLAN, 11/19/2020 9:18:48 PM, ANDY-HP, User (1) (36.00 x 24.00 Inches)